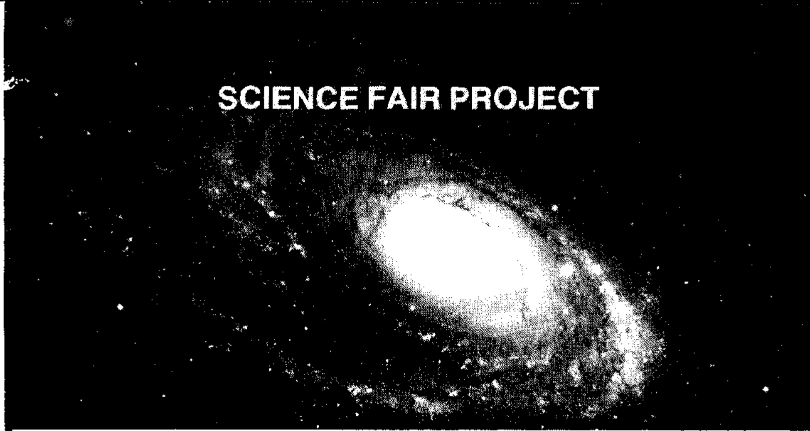

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BY L. GEORGE LAWRENCE

Magnetometers FOR INVESTIGATING UFO's AND OTHER MAGNETIC PHENOMENA

A variety of home-built detectors to indicate magnetic disturbances such as those reported to accompany UFO sightings

OVER the past 30 years, thousands of UFO sightings have been reported to and investigated by government and scientific researchers. Most have been readily attributed to such things as aircraft, the planets, meteors, and luminescent swamp gas. A small but significant number of incidents remain unexplained. The possible extraterrestrial nature of UFO's therefore is still an open question.

Common to many reported UFO incidents are magnetic disturbances which affect compasses, auto speedometers, electric power meters, etc. Presented in this article are various types of sensing circuits which will detect such magnetic anomalies. The circuits are inexpensive to build and use readily available parts and materials. Their use, however, is not limited to amateur UFO investigations. These magnetometers will be of interest to anyone who wants to explore magnetic phenomena, and—students take note—make fine Science Fair projects.

All the magnetic-detection systems presented here employ audio and/or visual intrusion alarms.

Home Magnetometers. Although professionals monitor magnetic fields with such sophisticated devices as proton free-precession magnetometers, good results can be obtained using the inexpensive home-built magnetometers described here. These devices have low power consumption and can be battery-powered for lengthy periods. Although they have less sensitivity than the proton magnetometer, which measures the precession (wobble) of protons in the presence of a magnetic field, the inertialess CRT and electro-induction magnetometers are faster by a factor of about 1,000.

Sky Magnetometer. Shown in Fig. 1 is a field-induction magnetometer designed to have its sensor mounted on the exterior of a building. Two separate detection principles are employed.

The high-speed sensor, shown schematically in Fig. 1A and photographically in Fig. 2, is of the electromagnetic induction type. The actual sensor is comprised of a 2' (61-cm) long mu-metal (a soft iron alloy) bar that serves as a flux concentrator for the coils. The larger of the two coils (*Ll*) is a 10,000-ohm coil slipped over the bar and positioned at its center. Inductor *L2* consists of 30 turns of No. 24 enamelled wire wound over the main coil. Coil *L2* is used to induce a voltage across *L1* for testing.

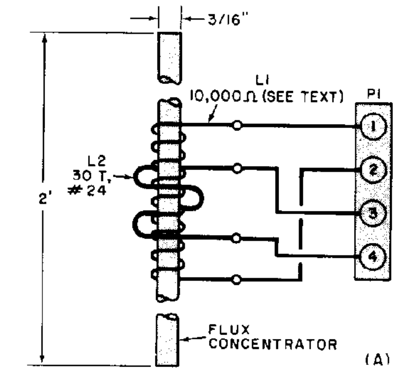
Signals induced across *L1* are amplified by emitter follower *Q1* (Fig. 1B). (Transistor *Q1* is a Darlington pair with a beta of at least 12,000.)

When IMPULSE TEST switch *S1* is depressed, capacitor *C1* discharges through potentiometer *R3* and coil *L2*, inducing a current pulse in main sensing coil *L1*. Potentiometer *R2* is used to adjust the sensitivity threshold. The amplified current pulse is indicated on meter *M1* and can be passed to a paper chart recorder via resistor *R9*.

The current pulse at the emitter of *Q1* is also passed via TRIGGER LEVEL control *R7* to the gate of *SCR1*. When *SCR1* fires, it activates alarm *A1*. Because the power source is dc, *A1* will remain on even after the triggering signal has passed. Normally closed RESET pushbotton switch *S2* must be momentarily depressed to silence the alarm.

Operating power is obtained from a conventional line-operated, regulated 9-volt dc supply. If line power should fail, relay *K1* automatically switches to *B2*, a back-up battery supply.

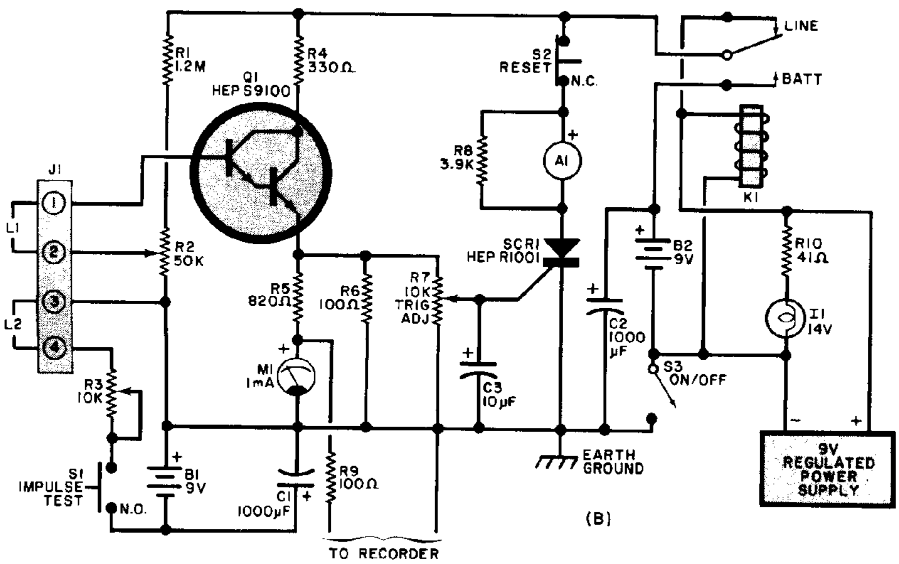
TRIGGER ADJUST control *R7* should be set to prevent the alarm from being triggered during lightning storms. Meter *M1* is not critical, but it should be able to indicate the triggering threshold for the SCR, which is about 0.8 mA. A superimposed current of about 50 μA, the output of *L1* amplified by *Q1*, will trigger the



PARTS LIST FOR FIG. 1

A1—Electronic alarm (Mallory Sonalert® No. S-628 or similar)
B1, B2—9-volt transistor battery
C1, C2—1000-µF, 15-volt electrolytic
C3—10-µF, 15-volt electrolytic
I1—No. 1815 lamp (14 volts, .2 amperes, T-3¼ configuration)
J1—Four-contact male connector (Amphenol No. 91-859 or similar)
K1—12-volt, 250-ohm spdt relay
L1—10,000-ohm, ¼" inner-diameter reed relay coil
L2—See text
M1—1-mA meter (Calectro No. D1-912 or similar)
P1—Four-contact female connector to mate with J1 (Amphenol No. 91-458 or similar)
Q1—HEP S9100 Darlington transistor (Motorola)
The following are ½-watt, 10% tolerance resistors:
R1—1.2 megohms
R4—330 ohms
R5—820 ohms
R6, R9—100 ohms
R8—3900 ohms
R10—41-ohm, 4-watt resistor
R2—50,000-ohm linear-taper potentiometer
R3—10,000-ohm linear-taper potentiometer
R7—10,000-ohm linear-taper, screwdriver-adjustable potentiometer
S1—Spst normally open pushbutton switch
S2—Spst normally closed pushbutton switch
S3—Spst switch (part of R2)
SCR1—HEP R1001 silicon controlled rectifer (or any 200-µA gate-current SCR)
Misc.—2' (61-cm) × 3/16" (4.8-mm) mu-metal or soft iron rod; miniature test magnet; PVC plastic tube with plastic terminal containers; aluminum or brass hardware; suitable enclosure; wall feedthrough; cement for mounting L1; 9-volt dc line-powered supply; etc.

Fig. 1. Circuit of the inductive sensor for the sky magnetometer is at left. (See also Fig. 2.) The electronics portion of the magnetometer (below) can be mounted separately.



magnetometer. Near-trigger conditions can be observed on the meter, providing a built-in test facility in addition to *L2*.

The instrument's construction and packaging, including the external sensor shown in Fig. 2, are not critical. The flux concentrator and coils can be protected from the elements by a length of magnetically neutral PVC plastic pipe, supported by aluminum brackets. The upper part of the sensor is enclosed in a glass or plastic container which can house another (optional) sensing coil made from an automotive ignition coil with its metal shield removed to provide full magnetic exposure.

The lower end of the pipe contains the electrical connections to the coils and is also protected by a glass or plastic enclosure. Connections between the coils and electronics console are made via shielded cables that pass through the support structure. Ground the cable shields to a true earth ground to avoid the danger of lightning strikes.

Compass Magnetometer. The second sensing system comprises a compass-needle assembly and a geared compass of the automotive or marine type and is used for detecting slow magnetic field variations.

The compass-needle assembly is shown in Fig. 3A. The primary sensor is a 6" (15.2-cm) magnetic needle mounted on a low-friction agate bearing. Two equally balanced opaque paper extensions are attached to the needle.

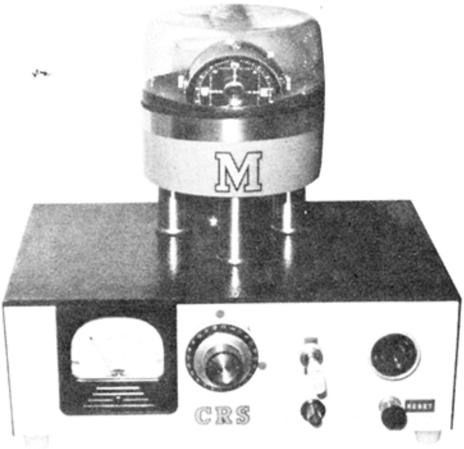
Once the magnetic needle settles down to a stable state, optical coupler *OC1* must be positioned so that one of the opaque paper extensions fits into the narrow gap of the module. This module consists of a LED and a Darlington phototransistor, the two separated by a narrow gap into which the opaque paper extension is fitted. When the paper is in the gap, the light path is interrupted. This approach affords contactless and friction-free sensing of the needle's motion, and can also be used with meter pointers, cursor devices, eddy-current disks and mechanical indicators.

As shown in Fig. 3B, potentiometer *R1* and current-limiting resistor *R2*, determine the light output of the LED in the pickup assembly. Only a minimal amount of LED output is required.

With the LED illuminating the phototransistor, the potential between *Q1* pins 3 and 4 is typically about one volt. Comparator *IC1* is wired so that its output is high when the light path inside *OC1* is blocked, and goes low when the motion of the magnetic needle moves to allow an uninterrupted light path. Since *IC1* is powered by a 5-volt supply, its output is TTL compatible. If desired, the output from *IC1* can be used to power a relay (*K1*). Because the voltage comparator used is limited to a 20-mA output, the coil resistance of the relay must be at least 250 ohms.

If desired, the compass needle can be mounted vertically so that it dips up and down in the presence of a magnetic anomaly or disturbance.

CRT Detector. The inertialess cathode-ray tube instrument shown in Fig. 4 is an extremely sensitive, high-speed magnetometer. Professional CRT magnetometers can measure extremely weak magnetic fields. The sensitivity of



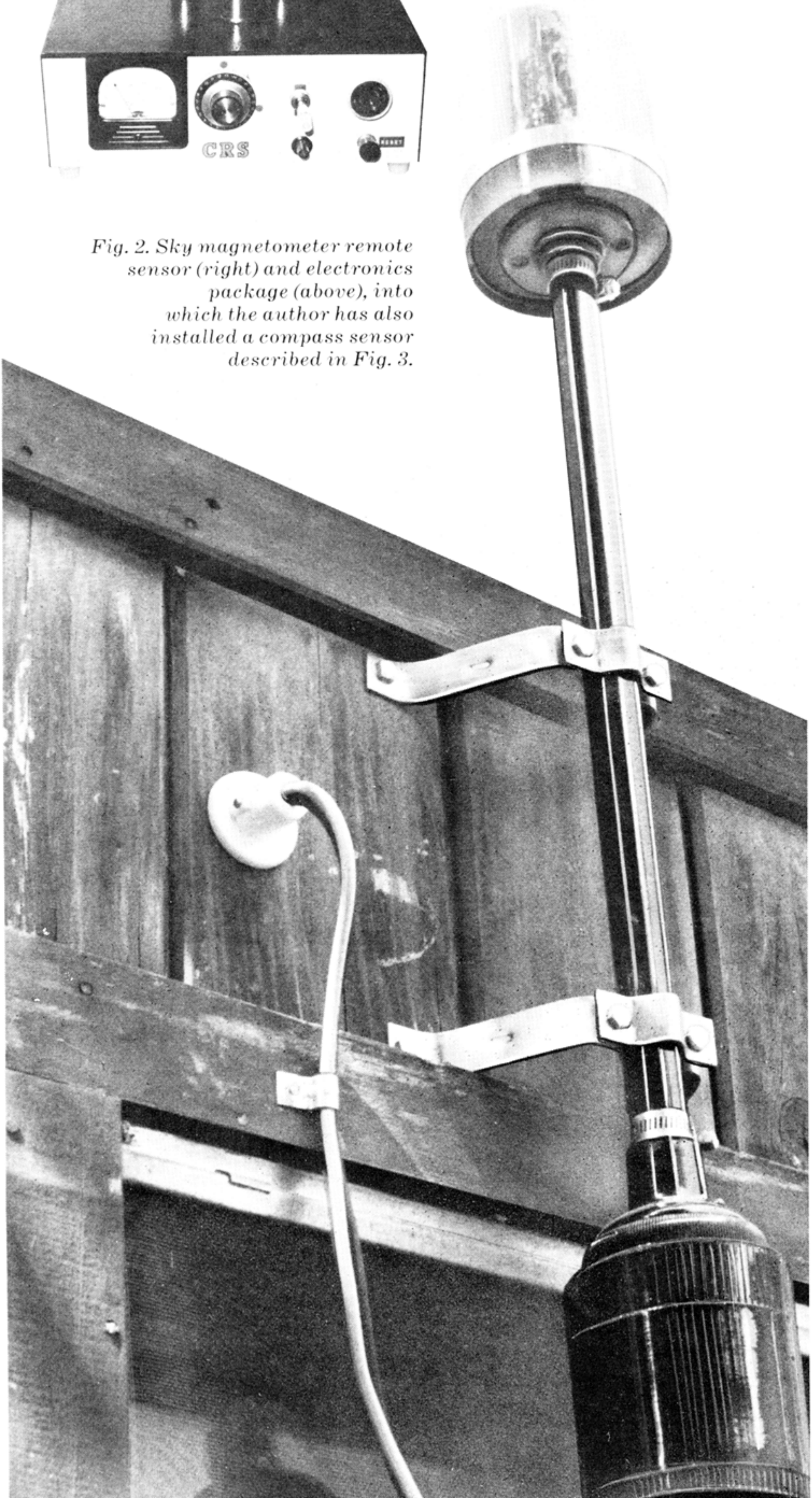


Fig. 2. Sky magnetometer remote sensor (right) and electronics package (above), into which the author has also installed a compass sensor described in Fig. 3.

these CRT detectors exceeds that of both nuclear and rubidium-vapor magnetometers by a factor of two to four. However, commercial CRT systems are very expensive. This forces the experimenter to fashion a home-brew CRT magnetometer such as that shown in Fig. 4. The display speed of this system is contingent only on the signal-transfer time of the electronics package.

The CRT can be obtained from an oscilloscope or similar instrument. It should be an electrostatic—*not* electromagnetic—system. Because the CRT must be operated 30′ (9.1m) or more from its parent housing, lengthy cables are required to deliver the filament, centering, focus, and high voltages.

Attached to the glass faceplate of the CRT is light-dependent resistor *LDR1* and an opaque mask with a tiny aperture cut in it. The size of the aperture should be about the same diameter as the focused spot on the CRT screen. The photocell/aperture mask assembly should be secured to the center of the CRT's faceplate in an opaque retainer cup. Do not use a permanent cement when attaching this assembly to the CRT because it may have to be moved somewhat if a phosphor burn (dark spot) developes on the screen.

The CRT must be operated without any type of shielding and should be supported by a nonmagnetic structure. Use well-insulated cables for the various CRT operating potentials. Set the brightness to produce a relatively low intensity spot, and then focus the spot. Using the horizontal and vertical centering controls, position the spot directly in the hole in the aperture mask. You can tell when the spot is properly positioned with the aid of an ohmmeter. Connect the meter across the leads of the photocell and operate the centering controls. The photocell's resistance will be very low when the spot is properly positioned.

When *LDR1* is illuminated, the circuit in Fig. 4B causes *K1* to close, applying power to READY lamp *I1*. If for any reason the CRT's beam moves away from the small aperture, *K1* will momentarily deenergize and extinguish *I1*. This triggers an alarm circuit composed of *SCR1* (whose gate is protected by *D3*) and audible alarm *A1*. Even if the beam returns to the aperture in the mask, the alarm will continue to sound until RESET switch *S1* is momentarily depressed to interrupt the dc path through *SCR1*. Diode *D2* protects transistor *Q3* from voltage transients generated by *K1* during switching.

Excursions of the CRT's electron

beam can easily be calibrated in terms of gauss by using a small calibrating permanent magnet of known field strength and a square-ruled paper interface or plastic grid on the CRT's screen.

With the beam intensity set low and the spot's focus adjusted, *R1* can be used to control the system's sensitivity. The CRT sensor can be given some directionality by housing it in a steel container whose sky-facing side has been removed. If the CRT is mounted outdoors, use a nonmagnetic weather cover to protect the CRT and high-voltage cables from the elements.

As is the case with proton-precession and field-induction magnetometers, the inertialess CRT instrument is a total-field magnetometer, rather than an incremental field device.

Ground-Loop Sensing System. The chopper-interrogated ground-loop approach shown in Fig. 5 can be used to augment a magnetometer setup. The inductor, typically consisting of two turns of insulated copper wire measuring from 2' to 200' (0.6 to 61 m) in diameter, employs a 330-Hz chopper in which *Q1* and *Q2* operate as an astable multivibrator.

The chopper converts dc or low-frequency ac signals induced across the loop by an airborne magnetic agent into a serrated ac signal train. The train can then be processed by conventional audio systems. The nulling circuit consisting of *B1*, *R2*, *R3*, and nulling potentiometer *R4* sets the quiescent state of the detector. An optional alarm circuit, shown in the dotted box, can be connected to the output of the audio amplifi-

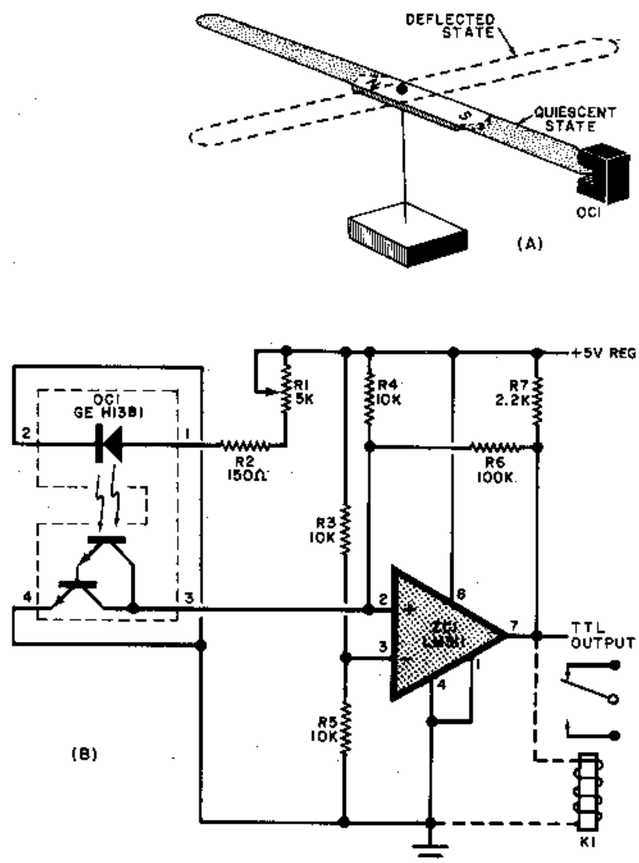
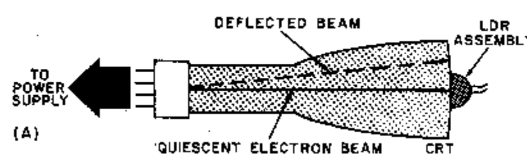
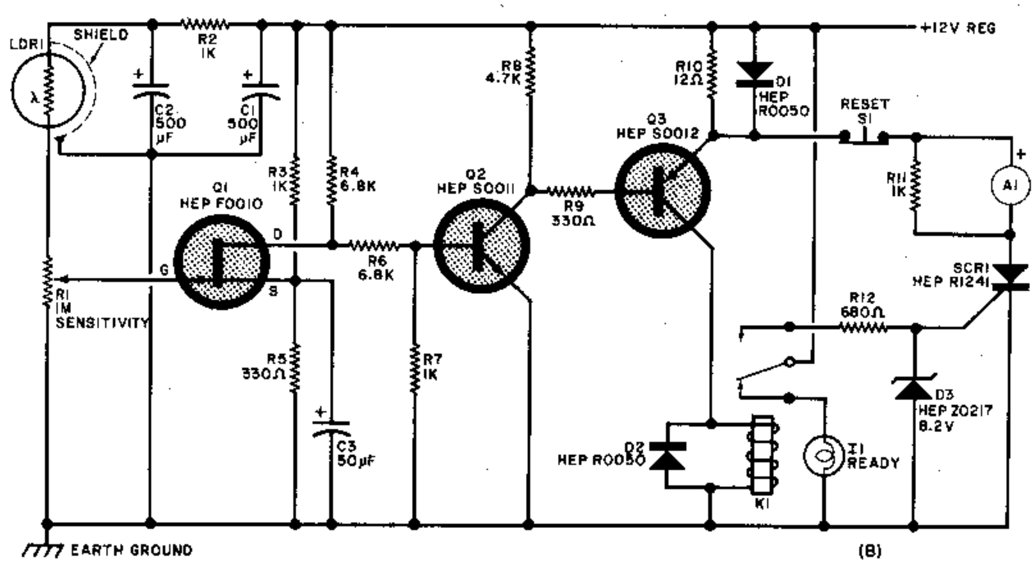


Fig. 3. Compass magnetometer's sensor (A) is a magnetic needle whose motion is sensed optically. Circuit (B) provides a TTL-compatible output and, if desired, activates a relay.

Fig. 4. Cathode-ray tube magnetometer is very sensitive. Details of sensor are at (A); detector's circuit at (B).





PARTS LIST FOR FIG. 3

IC1--LM311 voltage-comparator integrated circuit (National)
K1--Spdt relay with 250-ohm or greater coil resistance
OC1—GE H13B1 optoelectronic coupler (Poly-Paks No. 92CU 2784, 2 for $1.19)
R1--5000-ohm screwdriver-adjustable wire-wound potentiometer
The following are ½-watt, 10% tolerance resistors:
R2—150 ohms
R3, R4, R5—10,000 ohms
R6—100,000 ohms
R7—2200 ohms
Misc.—6" (15.2-cm) compass needle with agate bearings and support stand (No. A2-1871 for $10.50 plus $1.00 postage from Sargent-Welch Scientific Co., 7300 N. Linder Ave., Skokie, IL 60076); nonmagnet housing with cover; aluminum or brass hardware; two stiff paper extensions; suitable enclosure for electronics package; hookup wire; solder; etc.

PARTS LIST FOR FIG. 4

A1—Electronic alarm (Mallory Sonalert® or similar)
C1, C2—500-µF, 15-volt electrolytic
C3—50-µF, 15-volt electrolytic
CRT—Electrostatic cathode-ray tube
D1, D2—1-ampere, 50-PIV diode (Motorola HEP R0050 or similar)
D3—8.2-volt zener diode (Motorola HEP Z0217 or similar)
I1—No. 756 lamp (14-volt, 8.2-mA in T-3¼ configuration)
K1—12-volt spdt relay
LDR1—CdS light-dependent resistor with 100-ohm light and 5-megohm dark resistance (Radio Shack No. 276-116 or similar)
Q1—HEP F0010 n-channel FET (Motorola)
Q2—HEP S0011 npn transistor (Motorola)
Q3—HEP S0012 pnp transistor (Motorola)
R1—1-megohm linear-taper screwdriver-adjustable potentiometer
The following are ½-watt, 10% resistors:
R2, R3, R7, R11—1000 ohms
R4, R6—6800 ohms
R5, R9—330 ohms
R8—4700 ohms
R10—12 ohms
R12—680 ohms
S1—Spst normally closed pushbutton switch
SCR1—HEP R1241 silicon controlled rectifier (Motorola)
Misc.—Power sources for acceleration and filament voltages, brightness, focus and centering controls and high-voltage cables; aperture mask and opaque cup for LDR1; nonmagnetic mount for CRT; 12-volt power supply; suitable enclosure for electronics; machine hardware; hookup wire; etc.

er. Diode *D2* provides the rectification required by the gate of *SCR1*. The magnitude of this gate signal is determined by the value of *Rd*.

Diode *D1* "despikes" chopper coil *K1*, and *C4* maintains the frequency stability of the multivibrator. The circuit should be housed in a small, earth-grounded metal enclosure. The loop can be wound around suitably spaced wooden pegs and connected to the circuit via shielded cable. If the loop is installed indoors, it should be mounted against a ceiling. Alternatively, it can be mounted on the roof.

Eddy-Disk Magnetometer. According to some sources, one presently unexplained phenomenon influences the behavior of eddy-disk devices like those in automotive speedometers and domestic power meters. It has been claimed that electrically disabled speedometers have indicated high road speeds while the vehicle was stationary. Similarly, there have been reports that home power meters exhibit sudden bursts of high speed without any increase in energy consumption.

Shown in Fig. 6 is an instrument that can detect anomalous eddy currents. The heart of the device, shown in A, is an aluminum disk that rotates above an iron-core coil containing 15 turns of 3/32" (2.38-mm) wire connected to a pair of receptor stubs formed from 0.25" (6.35-mm) diameter copper tubing. A small, thin iron "flag" that opposes a relatively weak permanent magnet provides a force sufficient to prevent the disk from rotating under unenergized conditions. The overall design resembles that of a standard home power meter. The permanent magnet used for the

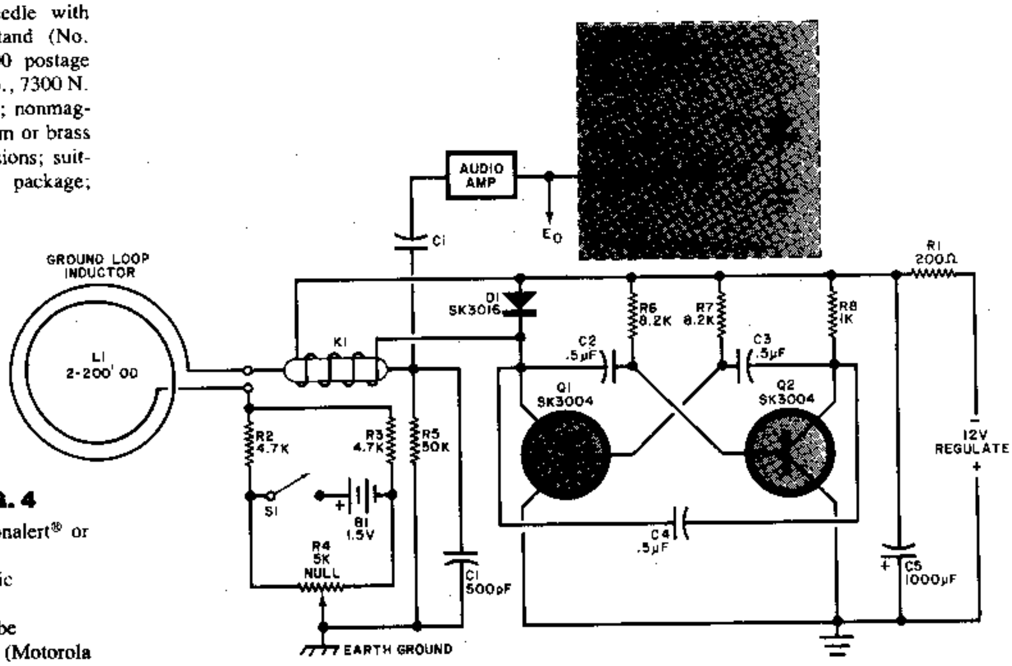


Fig. 5. Ground-loop magnetic detector responds to dc and low-frequency ac signals.

PARTS LIST FOR FIG. 5

B1—1.5-volt D cell
C1—500-pF capacitor
C2, C3, C4—0.5-µF, 50-volt capacitor
C5—1000-µF, 15-volt electrolytic capacitor
D1—SK3016 (RCA) or similar diode
K1—Reed switch (Hamlin No. MRMF-2-206, ¾" size or similar) fitted with 600-ohm coil (COTO coil No. U-12 or similar)
L1—Induction coil (see text)
Q1, Q2—SK3004 (RCA) or similar transistor
R1—200-ohm, 2-watt resistor
The following are ½-watt, 10% resistors:
R2, R3—4700 ohms
R5—50,000 ohms
R6, R7—8200 ohms
R8—1000 ohms
R4—5000-ohm linear-taper potentiometer
S1—Spst switch
Misc.—Metal enclosure; shielded cable; insulated wire for L1; machine hardware; external audio system; hookup wire; solder; hardware, etc.

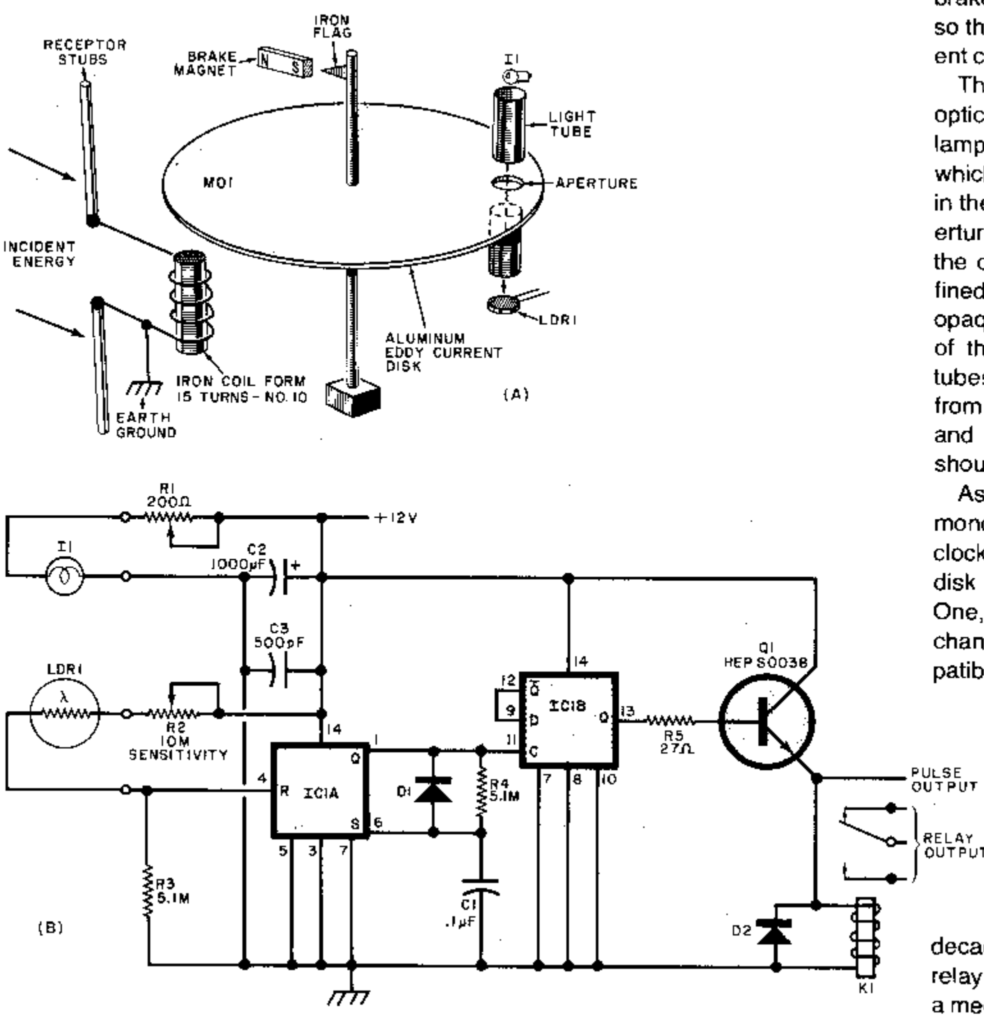
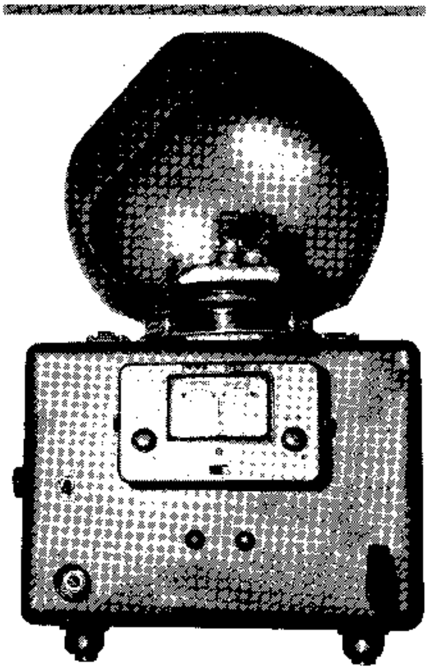


Fig. 6. *Eddy-disk magnetometer is similar to power meter in action. Disk sensor is at (A); circuit schematic shown at (B).*

PARTS LIST FOR FIG. 6

C1—0.1-µF capacitor
C2—1000-µF, 15-volt electrolytic
C3—500-pF ceramic capacitor
D1, D2—HEP R0050 (Motorola) or similar diode
I1—No. 1815 lamp (14 volts, 0.2 amperes, T-3¼ size)
IC1—HEP C4020P (Motorola) dual-D flip-flop
K1—Spdt relay with 250-ohm or greater coil resistance
LDR1—CdS light-dependent resistor with 50,000:1 dark-to-light resistance ratio (Radio Shack No. 276-116 or similar)
MO1—Converted power meter eddy-disk assembly (see text)
Q1—Transistor (Motorola HEP S0038 or similar)
R1—200-ohm, 5-watt variable resistor
R2—10-megohm linear-taper screwdriver-adjustable potentiometer
R3, R4—5.1-megohm, ½-watt resistor
R5—27-ohm, ½-watt, 10% tolerance resistor
Misc.—Iron-core (mu-metal) form; No. 10 insulated wire; copper tubing; brake magnet; opaque light tubes; protective covers; machine hardware; hookup wire; etc.



At right is author's prototype of eddy-disk magnetometer.

brake should be positioned near the flag so that the disk is stationary under ambient conditions.

The motion of the disk is detected by optical means (see Fig. 6A). Exciter lamp *I1* generates a luminous output which passes through a small aperture in the disk. Light passing through the aperture falls on *LDR1* on the other side of the disk. The light path should be confined to the aperture in the disk. A small opaque tube can be used on either side of the disk to confine the light. These tubes will keep the light emitted by *I1* from spilling over the edge of the disk and possibly biasing *LDR1*. The tubes should not contact the disk surface.

As shown in Fig. 6B, *LDR1* triggers monostable multivibrator *IC1A* which clocks flip-flop *IC1B* on and off as the disk rotates. Two outputs are provided. One, at the emitter of *Q1*, can be changed in level to produce a TTL-compatible output for driving conventional decade counters. The other output is via relay *K1*, which can be used to activate a mechanical counter or an alarm.

Potentiometer *R2* allows the experimenter to adjust the sensitivity of the sensing circuitry. Because of *Q1*'s limited current-handling ability, the coil resistance of *K1* must be at least 250 ohms. Control *R1* provides a means for adjusting the intensity of *L1*.

To keep out any extraneous light, a nonmagnetic, opaque cover can be mounted over the disk, *L1*, and the *I1/LDR1* assembly. A larger nonmagnetic (glass or plastic) dome is recommended to safeguard the package against moisture and air currents. The receptor stubs can be mounted outside the package.

In Closing. The various home magnetometers that have been presented in this article should be operated as far away as possible from any contaminating magnetic fields produced by electrical machines, permanent magnets, etc. They should also be housed in nonmagnetic structures. Armed with these detectors and scientific curiousity, you will be well equipped to investigate magnetic phenomena—whether they are produced by natural, man-made, or perhaps even extra-terrestrial causes. ◇