MODEL GeoMag

Underwater
Magnetic Gradiometer

OPERATING INSTRUCTIONS AND USER MANUAL

Schonstedt Instrument Company
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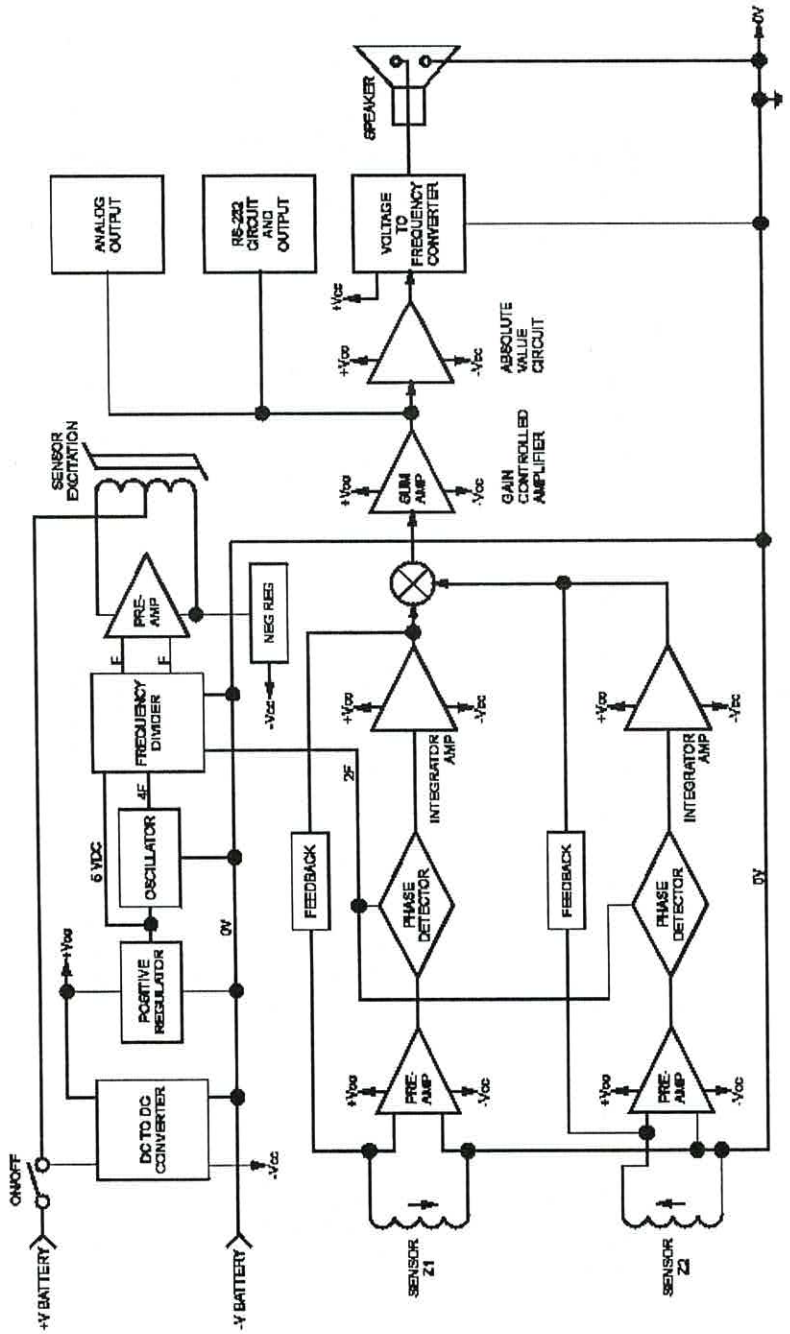

Figure 9. Block Diagram

Specifications

Electronics Unit

Power	:	12VDC Battery
Power Consumption	:	85 mA Nominal
Weight	:	8.36 lb (3.79 kgm)
Size	:	14" x 10" x 6" (356mm x 254mm x 152mm)

Sensor Unit(s)

GAU-30

Weight	:	4.40 lbs (2.00 kgm)
Diameter	:	1.32" Dia. (33.5mm)
Length	:	45" (1143mm)

MG-235

Weight (with cable)	:	2.68 lbs (1.22 kgm)
Diameter	:	1.32" Dia. (33.5mm)
Length	:	17" (440.5mm)

List of Components

Electronics Unit

Mfg. Part Number	SICO Part No.	Description	
XSJJ-4-BCR SEACON	C41110	Sensor (GAU)	4 Pin
XSJJ-5-BCR SEACON	C41115	Sensor (MG)	5 Pin
HCG-1B-202-CLVP LEMO	C40107	Headset	2 Pin
HCG-2B-302-CLV LEMO	C40108	Power	2 Pin
HCG-2B-306-CLVP LEMO	C40109	RS-232	6 Pin
2274331-1 AMP	C40112	Analog	2 Pin
EHT-108-01-S-D SAMTEC	C40111	Board to Board	16 Pin
Hardware for C41110	CH41110	Nut and Washer	
71B30-01-4-2S-F	S35095	Mode Switch	2 Pos.

Cable Information

Mfg. Part Number	SICO Part No.	Description
FGG-2B-306-CLAD52 LEMO	C41109	RS-232 Connector
FGG-1B-302-CLAD52 LEMO	C41107	Headset Connector
FGG-2B-302-CLAD72 LEMO	C41108	Power Connector
	208548-1	50' Sensor Cable*
	208548-2	100' Sensor Cable*
	208548-3	200' Sensor Cable*
	208555	15' Power Cable
	208552	Headset Cable
	208551	RS-232 Cable

* Available for GAU-30 Sensor only

Sensor Unit(s)

Mfg. Part Number	SICO Part No.	Description
MSXJJ4BCR SEACON	C41113	GAU Sensor Conn.
XSJJ-5-CCP SEACON	C40115	MG Sensor Connector
XSJJ-5-CCP-RA SEACON	B55010	Conn. Boot for C40115

Assembly Drawing and Parts List

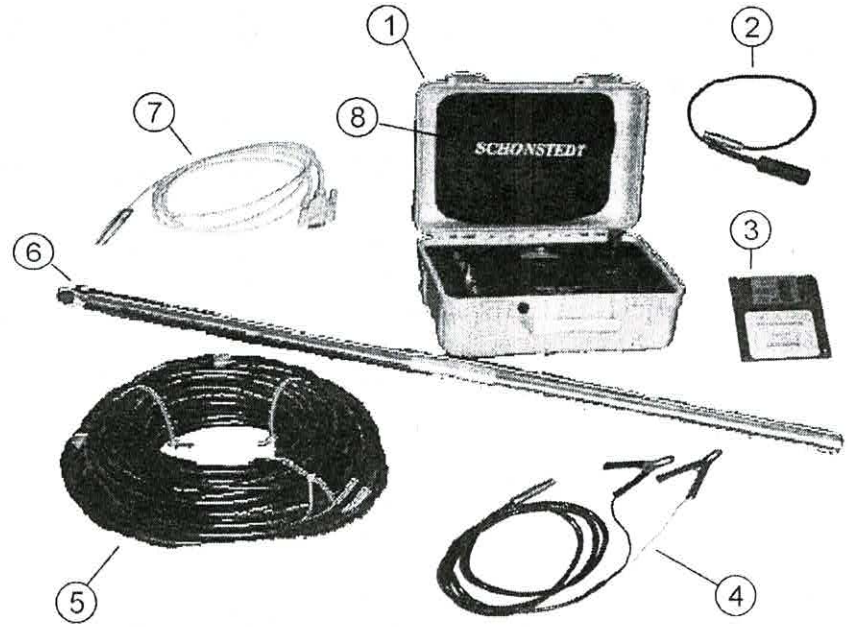

Figure 10. GeoMag Repair Parts

ITEM NO.		DESCRIPTION	PART NUMBER
1		GeoMag Electronics Unit	302353
2		Headset Adapter Cable	208552
3		RS-232 Program Disk	208569
4		Power Cable	208555
5		GAU Sensor Cable (not included)**	298548
6		GAU Sensor	302327
7		RS-232 Cable	208551
8		Nylon Storage Pocket	208513
9	*	Cap, Protective	C45004
10	*	Cap, Protective	C45005
11	*	Knob, Round	K20012
12	*	Knob, Pointer	K20011
13	*	MG Sensor Assembly	302290

* Not Shown

** Lengths available are 50 foot, 100 foot and 200 foot cables for GAU sensor only.

Warranty Statement

The Schonstedt Instrument Company (Schonstedt) warrants each product of its manufacture to be free from defects in material and workmanship subject to the following terms and conditions. The warranty is effective for twelve (12) months (with the return of the Customer Registration Card) after shipment by Schonstedt to the original purchaser.

Our obligation under the warranty is limited to servicing or adjusting any product returned to the factory for this purpose and to replace any defective part thereof. Such product must be returned by the original purchaser, transportation charges prepaid, with proof in writing, to our satisfaction, of the defect. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. Prior to repair in this instance, a cost estimate will be submitted. Service or shipping information will be furnished upon notification of the difficulty encountered. Model and serial numbers must be supplied by user. Batteries are specifically excluded under the warranty.

Schonstedt shall not be liable for any injury to persons or property or for any other special or consequential damages sustained or expenses incurred by reason of the use of any Schonstedt product.

Returns For Repair and Replacement Parts

FOR SERVICE OR REPAIR
Please ship instrument(s) to:

Schonstedt Instrument Company
4 Edmond Road
Kearneysville, WV 25430

(304) 725-1050 Fax: (304) 725-1095
Toll Free 800-999-8280

NOTES

List of Figures

Introduction

The GeoMag Magnetic Gradiometer was designed exclusively to provide a fast and accurate method for locating underwater ferrous objects, particularly pipelines and shipwrecks.

Utilizing the patented Schonstedt HeliFlux® magnetometer sensors, and the most modern integrated circuit, solid state technology electronics, the GeoMag is designed to operate in severe environmental extremes without performance degradation.

The sensor assembly(ies), cable and electronic unit are detachable and interchangeable, which provide for easy on-site troubleshooting and repair. Moreover, each sensor assembly is preset and sealed at Schonstedt Instrument Company, which guarantees performance and replication of measurements with any sensor. (Only one sensor can be used at a time.)

The electronic unit provides a meter readout of the magnetic gradient, along with a variable frequency speaker output proportional to the output signal level. An analog output connector is supplied for driving an external strip chart recorder. A digital RS-232 connector is supplied for data logging via a personal computer. By selecting the appropriate instrument sensitivity, the sensor can be towed at a convenient depth, producing a visual, audio and/or permanent record.

If required, the sensor may be secured to a subsurface platform for towing in search operations. The platform should be magnetically neutral. A zeroing control on the instrument's electronics console can be used to neutralize small magnetic fields up to ±300 gammas.

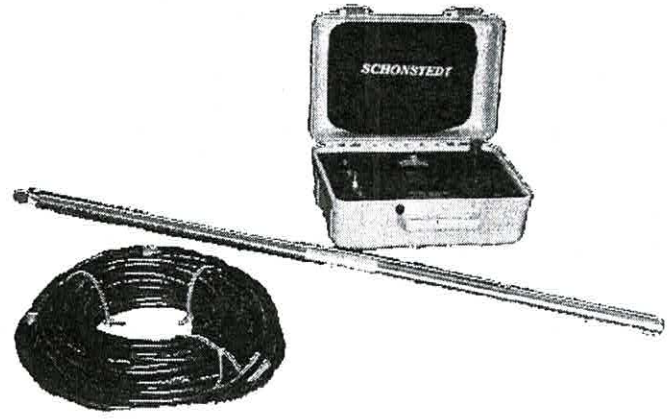

Figure 1. Unit Components (MG-235 Sensor not shown)

Operating Instructions

Equipment Setup

Connect the sensor cable to the appropriate sensor connector on the electronics unit. Connect external power to +12 VDC source with cable supplied. Connect any desired recording device to the appropriate connector on the electronics unit with cables supplied (see figure 2). Set the Range Control to desired sensitivity.

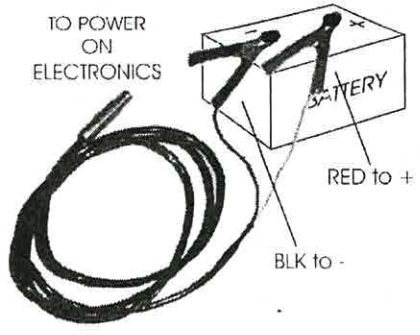

Figure 2. Power Connections

Range Control

A. Power - OFF - (full CCW)

B. Battery Condition - BT on analog meter
Green sector - +12 VDC input.
Red sector - check battery or power supply

C. 100 Milligauss

D. 30 Milligauss

E. 10 Milligauss

F. 3 Milligauss

G. 1 Milligauss

H. 0.3 Milligauss (full CW)

Speaker Control

For minimum sound turn volumn control fully counterclockwise.
For maximum sound turn volumn control fully clockwise.

Meter Zero Control (10 Turn Potentiometer)

The zero control is provided to cancel ambient gradients during maximum sensitivity measurements. Counterclockwise rotation will move the meter needle to the left. Clockwise rotation will move the meter needle to the right.

Operation

The GeoMag Magnetic Gradiometer detects the magnetic field of a ferromagnetic object. It responds to the difference in the magnetic field between two sensors which are spaced about 20 inches apart in the GAU-30 sensor and 10-1/2 inches apart in the MG-235 Sensor. The response is a change in the frequency of the signal emitted by the piezoelectric speaker.

Figure 3 illustrates an application of the gradiometer in which it is used to detect an iron bar. As shown, the magnetic field of the iron bar is stronger at sensor A than it is at sensor B. As a result, the frequency of the signal from the piezo-electric speaker is higher than the idling frequency, 40 Hz, which exists when the field is the same at both sensors.

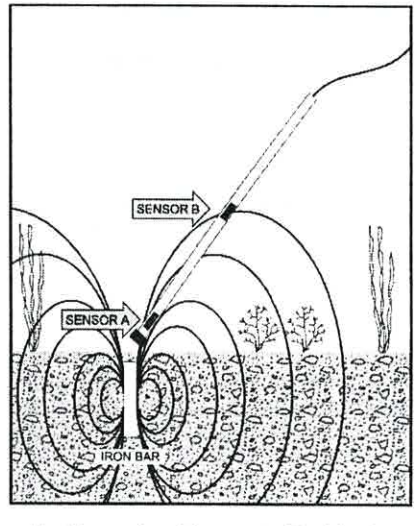

Figure 3. Detecting Magnetic Field of an Iron Bar

MG-235 Down Hole Mode

The MG-235 portion of the instrument can be used for down hole purposes because of a smaller sensor unit. It is rugged and can be easily lowered periodicaly into a borehole during the drilling progress. As the sensor nears the bottom of the borehole you will be alerted to the presence of any iron or stell objects in the borehole's path. The pitch of the MG-235's audio signal and the meter readout will increase in direct proportion to size and the proximity of ferrous material.

The MG-235 sensor can also be used in shallow water to locate ferrous material. Articles of significant value can be recovered by detecting the magnetic field of the ferrous metal within the object. The MG-235's standard 100 foot cable enables the sensor to be towed from a boat using a tether rope or pulled back and forth from bank-to-bank. Tether ropes are easily attached to both ends of the sensor.

The MG-235 sensor is connected to the GeoMag front panel using a 5-pin connector. The sensor panel connector is located to the left of the GAU-30 sensor panel connector on the electronic unit. To operate the instrument in the MG-235 mode, connect the MG-235 sensor to the proper sensor panel connector (labeled "Sensor MG-235"), and move the "Select" switch to "MG" mode. With the power turned on, the MG-235 sensor is now the sensor providing the signal for the electronic unit.

Strongly Magnetized Markers

A strongly magnetized marker at or near the surface may provide location information that is misleading.

The heavy line in Figure 4 represents the variation in tone frequency when the gradiometer is moved over the marker. When moving the instrument from A to B, the frequency of the tone increases and then suddenly decreases at B. From just beyond B the frequency of the tone increases sharply, becomes very high directly over the marker and decreases just before reaching C. From C to D the pattern is the reverse of that from A to B. It is obvious that the gradiometer must enter the B-C region. Otherwise the marker might be assumed to be between A and B or C and D.

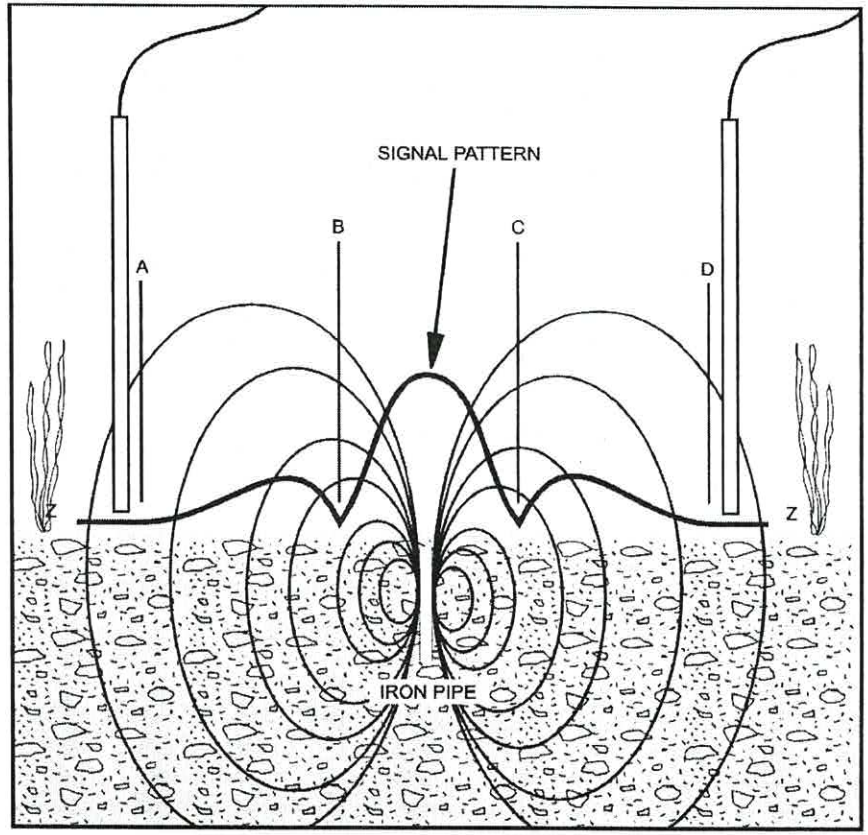

Figure 4. Signal Pattern from a Strongly Magnetized Marker

Range

The GeoMag allows for six different sensitivity levels, 100 milligauss being the least sensitive and .3 milligauss being the most sensitive. The GAU30 is also equipped with a battery supply test position. To test your battery supply turn the Sensitivity Control knob to "Battery". If the needle moves into the green sector proceed to set the desired range. This control allows the selection of progressively sensitive ranges. The greatest sensitivity selection provides full-scale meter and recorder output for a differential magnetic field of ± 0.3 milligauss (±30 gammas). If the needle will only move into the red sector, the power source needs to be replaced.

Meter Zero

This control allows you to cancel spurious magnetic fields up to ± 3.0 milligauss when operating on the more sensitive ranges.

Speaker Control

At or near a zero magnetic gradient, the speaker output will idle at a low frequency. With any increase in magnetic gradient, positive or negative, the speaker output will increase in frequency.

RS-232

The GeoMag includes an RS-232 circuit for sending digitized readings to the users personal computer.

The serial stream from the GeoMag is a sixteen BIT word received in two consecutive bytes each reading. The Data is binary not ASCII. The two bytes are converted to a decimal value representing the A/D output and then converted to a voltage value. The first byte is High byte and the second byte is Low byte. This is done by opening the COM port, taking a reading, and closing the COM port. The data conversion is then performed. The converted output is a voltage corresponding to 100uV per gamma.

The settings for your terminal should be:

BAUD Rate	:	2400
Stop Bits	:	2
Parity	:	None
Data Bits	:	8

Two executable files are included on the disk as well as the source code. If BASIC programming is used, it is suggested that you use POWER BASIC. QuickBASIC does not use the COM port efficiently enough to get reliable readings. These files are included to help with integrating the GeoMag into a broader software package.

The files included are:

PBRS232E.EXE	Prints continuous readings on the screen.
PBRS232F.EXE	Prints a reading to the screen each time "S" is pressed.
PBRS232E.BAS	Source code
PBRS232F.BAS	Source code
Readme.TXT	Notes

The source code files are included for the user to incorporate the routine into his system program.

To run the GeoMag RS-232 program in Windows 95

1. Connect the 6 pin plug end of the RS-232 cable connector to the RS-232 connector on the electronics unit on the front panel.

2. Connect the other end of the cable, the 9 pin 'D' connector, to a COM Port on the users personal computer.

3. Turn on the computer and start Windows 95.

4. Insert the 3 1/2" software disk supplied into appropriate drive on the personal computer.

5. From the desktop select the *Start* button and then left click on the *Run* button.

6. Open PBRS232F or PBRS232E executable file on the 3 1/2" disk drive and click on *OK* to start program.

To run the GeoMag RS-232 programs in earlier versions of Windows or in DOS, boot the computer in DOS or close Windows to DOS. Insert the 3 1/2" disk into the appropriate drive, then select the correct drive. Type + **ENTER** (e.g., A:\+ ENTER) to start the program. At the next prompt type **DIR** + **ENTER**, note the exact name of the program. Type the program name at the next prompt then press *ENTER* on the keyboard.

General Description

Figure 5 shows the mathematical sensor characteristics (see figure below).

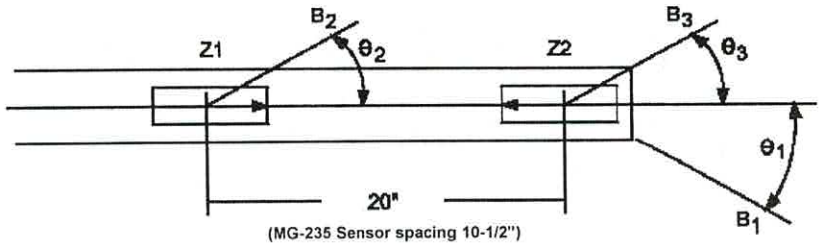

Figure 5. Mathematical Sensor Characteristics

B1 = Magnetic field common to both sensors, e.g., the earth's magnetic field.
B2 = Localized magnetic field seen by sensor Z1.
B3 = Localized magnetic field seen by Z2.
BZ1Z2 = BZ1+BZ2
= (B1Cos(1 + B3Cos(3) - (B1Cos(1 + B2Cos(2)
= B3Cos(3 - B2Cos(2

The sensors respond to that component of the magnetic field parallel to the sensor axis.

Application Notes

Basic Signal Patterns

If you find more than one signal in the vicinity of a target, just raise the gradiometer several inches higher or reduce the sensitivity setting. Any signal that disappears when the gradiometer is raised or the sensitivity reduced is probably not coming from the actual target. The signal from a rusty bolt or other small item will decrease much faster with distance than the signal from a larger target. An 18-inch length of 3/4-inch pipe can be located at distances below the sensor of up to 7 feet.

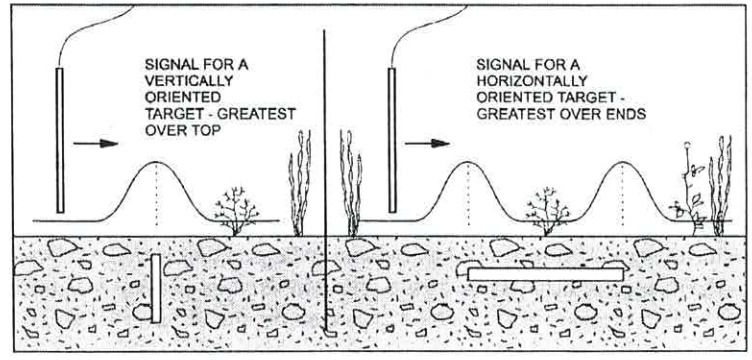

Figure 6. Signals from Vertical and Horizontal Targets

Locating Cast-Iron Pipes

As illustrated in Figure 7, cast-iron pipes produce the strongest magnetic signals at their joints.

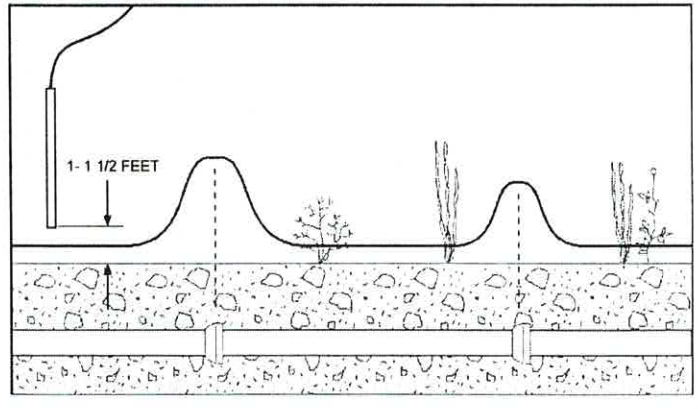

Figure 7. Signal Pattern Provided by Cast-Iron Pipes

The initial search should be performed as follows:

1. Adjust the sensitivity level for maximum.

2. Hold the gradiometer vertically approximately 1 to 1-1/2 feet above the covering.

3. Move along without turning or tilting the gradiometer.

4. Mark the locations where the maximum signal levels occur.

5. Return to an area of maximum signal strength and hold the gradiometer several inches above the covering. The sensitivity will probably have to be reduced during this second pass. Four-inch pipes can be located at covered depths of up to 8 feet.

Locating Steel Drums

As shown in Figure 8, the GeoMag's signal pattern will vary depending on the vertical or horizontal orientation of the drum and also how deep it is buried. A fifty-five gallon drum can be located at covered depths of up to 10 feet.

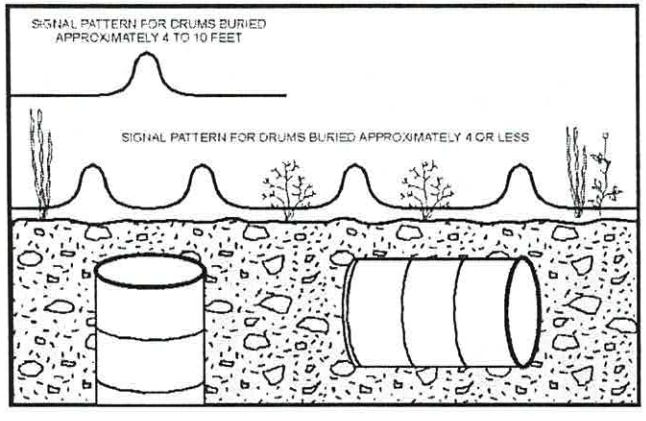

Figure 8. Signal Pattern provided by Steel Drums

Other Notes

1. A burbling sound indicated the presence of an energized power line.

2. The instrument will not detect nonmagnetic materials such as gold, silver, copper, brass and aluminum.

Circuit Description and Block Diagram

A simplified block diagram of the GeoMag is shown in Figure 9. The DC regulator in the upper right hand corner supplies regulated positive and negative DC voltages. Twelve volts is supplied to the sensor where it is then regulated to 5 volts, so that voltage drop in the cable is ignored.

When power is applied, the oscillator produces a square wave output at approximately 15 kHz. This is then divided to produce f at approximately 7.5 kHz, which is then applied to a complimentary FET pair. The output from the fluxgate sensors is an AC signal, that is twice the excitation frequency that is directly proportional to the external magnetic field. This signal is AC amplified by the preamplifier and then phase detected and rectified in the detector circuit. The output of the detector circuit is amplified by the power amplifier to produce a DC output proportional to the magnetic field seen by the sensor. A portion of this output is used for negative feedback, converted to a current, and then fed back to the sensor to produce a magnetic field opposing the field being measured. This insures good stability and linearity.

Outputs of both channels are then added in the summing amplifier. Since the magnetometer sensors are coaxial and wired opposing, any signal common to both sensors will sum to zero and only the difference signal will produce an output. The gain of this summing amplifier is selected by the external range control and the output is applied to a bipolar panel meter. The panel meter displays the magnetic gradient seen by the sensors directly in milligauss.

In order to eliminate constant monitoring of the meter, recorder and/or RS232 output(s), an audio output is also provided. The DC voltage output proportional to magnetic gradient is first rectified and then applied to a voltage-to-frequency converter to produce an output proportional to magnetic gradient. When the sensor is in a gradient free area, the speaker will idle at a low frequency, approximately 50 Hz. The frequency will then increase linearly to a maximum of about 5 Hz as increased gradient at the sensors deflects the meter from zero to full scale. The speaker frequency is a direct function of meter deflection regardless of polarity or sensitivity setting.

Service Information

If your MG-230 needs service, please return it to the factory along with the following information: Name, Address, Where Purchased, Date, and Description of Trouble(s). A telephone estimate will be provided prior to service work being done. See shipping information on Page 10.

Specifications

(Specifications subject to change without notice.)

Controls	
Range Select	4 Position switch (OFF, BATT, 20, and 200)
Volume	Potentiometer adjusts level of audio signal
Outputs	
Audio Frequency	Proportional to the full scale reading
Visual Display	Three decimal characters to 199 with automatic polarity and decimal point.
Operating voltage	6 V (four alkaline C-size batteries)
Battery Life	100 hrs (intermittent usage at 70°F)
Sensor Spacing	10.5 in. (26.6 cm)
Temperature Range	- 13°F to 140°F (-25°C to 60°C)
Dimensions	
Overall	18.5 in. W x 7.75 in. H x 14.75 in.D (47 cm W x 19.7 cm H x 37.5 cm D)
Sensor	1.4 in. dia. x 16 in. (3.55 cm dia. x 40.6 cm)
Cable	Standard: 50 ft. (15.2 m) Optional: 100 ft. (30.4 m)