

Heathkit of the Month #53:
by Bob Eckweiler, AF6C



GENERAL PRODUCTS

**Heathkit GD-48
Metal Locator.**

Introduction:

Buried Treasure? Aye Matey, I was saving this series of Heathkits for September as that is the month of "Talk Like a Pirate Day" which falls on the 19th. Alas, so does the OCARC gatherin'. I expect a fun time!

However, our rotating editor this month is Ken, W6HHC, and since he passed along manuals for the GD-48 and GD-348, I thought I'd honor him with an article on them for his turn as editor.

I'm sure many a pirate of olde would have liked to have a metal locator for finding those treasures that they buried, only to later realize the map they made was later used at the bottom of the parrot's cage.

Heathkit Metal Locators:

Heathkit used the nomenclature "metal 'locator'" instead of "metal 'detector'" for their treasure seeking products. Heathkit produced four models over the years that I'm aware of. The first was the GD-48 which was listed as new in the 1969 Summer catalog. The Deluxe GD-348 followed in 1972 and sold concurrently with the less expensive GD-48 for five years.

Around 1978 Heathkit introduced the GD-1190, a third model designed specifically for hunting small coins. In ads it was called the "CoinTrack". Around 1979 the last of the Metal Locators, the deluxe GD-1290 "GroundTrack" was released.

Table 1 gives the production dates as best I can determine with the catalogs in my files.

Heathkit Metal 'Locators':			
Model	Name	From	To
GD-48	(none)	1969	1977
GD-348	(none)	1972	1981
GD-1190	"CoinTrack"	1978	1983
GD-1290	"GroundTrack"	1979	1985

Table 1

The Heathkit GD-48 Metal Locator:

The first Heathkit metal locator, the GD-48 originally cost \$59.95. By 1976 the price had increased to \$69.95; but in the fall of that year it was offered again for \$59.95 on a "save \$10" special. The last catalog (1977) I have showing it listed had the price back at the original \$59.95.

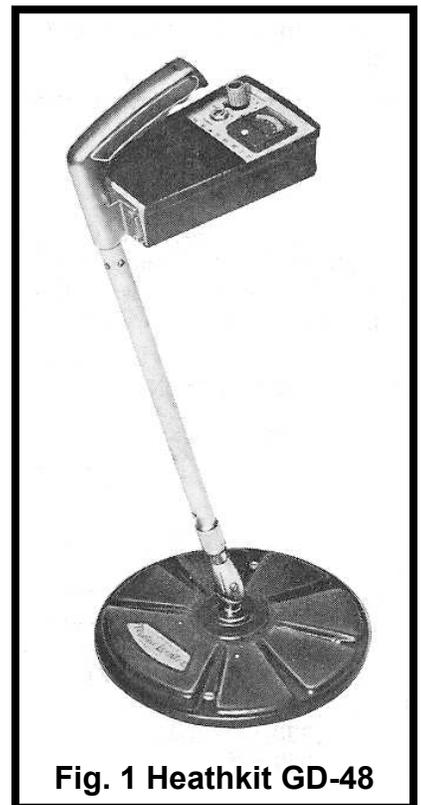


Fig. 1 Heathkit GD-48

The GD-48 is shown in Figure 1. It weighs 4 lbs. and has a 10.5" diameter coil housing. The arm length is adjustable from 26" to 36". It is powered by a NEDA #1602 9-volt battery (Heath part # GDA-48-1). This is a different battery than the common 9V battery used in so many products today. It is rated at 850 ma/hr and measures approximately 1.3" x 1.4" x 2.7". (The Eveready part # is 246). These batteries now run about \$11.00 each and will power the GD-48 for about 80 hours of operation. The cheaper, more available, NEDA #1604 may be used but will provide shorter operation time. The man-



Figure 2: NEDA 1602

ual warns that the smaller metal batteries can also short out the circuitry. Figure 2 shows the Eveready 246 #1602 battery.

The GD-48 is capable of detecting dime-size metal at 6", quarter-size metal at 7-1/2" and a 5" square piece of aluminum at 20".

The search-coil housing is not waterproof so it cannot be used in shallow water.

Assembly:

Most of the wiring for the GD-48 is on two circuit boards. The search circuit board mounts in the search-coil housing and the audio board mounts up in the control panel housing. The components are first mounted on these two boards. The search and pickup coils come pre-wound and attached to the coil housing base. After the search circuit board is mounted to the coil housing base, the five leads of the search coil, and the three terminals of the pickup coil are soldered to the board; the latter by short jumper wires.

Next the control panel is assembled. The speaker and its grill, the controls, phone jack and meter are attached. A short length of 8-conductor wire is then connected to the audio board, as is the negative lead of the battery connector. The handle is assembled and attached to the control panel.

A four wire spiral cable connects the two circuit boards (one of the wires is not used). This cable is now fed through the handle assembly and into the control panel before it is soldered to

the still-loose circuit board. Finally the audio board is bolted to the back of the speaker and the eight-wire cable is dressed and wired to the meter, speaker, phone jack, and **SENSITIVITY** potentiometer which contains the **OFF**-on switch. The red battery lead is also connected to the switch.

The shaft and swivel are then assembled and the shaft is attached to the control panel and handle after the spiral cable is snaked through the shaft. Next, the coil housing top is connected to the shaft; the spiral cable is then sealed with a tube of supplied sealant where it enters the coil housing cover.

After the sealant is given time to dry, the spiral cable end is wired to the search circuit board and the two halves of the coil housing are joined by four non-magnetic screws. Finally the battery and the control panel cover are installed and the well known Heathkit "blue and white" label containing the model and serial numbers is placed on the outside of the control panel cover.

Alignment:

Alignment involves adjustment of two capacitors C3 and C5 located on the search board. First they are moved to a preset condition, then they are adjusted in an iterative manner until the proper null is established. A "coin test" is then conducted to check for proper phasing and sensitivity. This test can be repeated occasionally to assure the metal locator alignment has not degraded.

Final Assembly:

Once you've determined the GD-48 is working properly, the coil cover is removed, sealant is placed around part of the circuit board to prevent vibration or jarring, and the coil housing cover is sealed to the coil assembly using the remaining sealant.

Circuit Description:

The Heathkit GD-48 uses eight transistors, all type 2N3393 (silicon small signal NPN), and a

single 1N4002 silicon diode (Heath part# 57-65). Figure 5 shows the block diagram and Figure 6 shows the schematic diagram.

The heart of the GD-48 metal locator is the search and pickup coils, L1 and L2 respectively. Q1 is a VLF oscillator that uses L1 and C2 to produce a 100 KHz signal. The transistor's bias is provided through R1. This oscillator has an additional feature; feedback is provided through an RC network that includes R2 and C1 which causes Q1 to stop and start oscillating at an audio rate of about 650 Hz, effectively modulating the 100 KHz signal with an audio tone. This circuit is called a relaxation oscillator.

The pickup coil is situated so that the coupling between it and the search coil is minimal. Trimmer capacitor C3 and fixed capacitor C10 each provide some coupling between the two coils; however, they are out of phase with each other so C3 can be adjusted to balance out any stray coupling. The pickup coil is tuned by C5, and any signal from the coil is capacitively coupled to two stages of direct coupled amplification provided by Q2 and Q3. All this circuitry is on the search board located in the coil housing.

The output of Q3 is fed up the three conductor spiral coil (which carries battery voltage, ground and the amplified pickup coil signal) to the audio board in the control assembly. On this board the signal is fed to a differential amplifier composed of Q4 and Q5. The transistors are coupled through a common emitter resistor. The signal is fed to the base of Q4 while a voltage level, adjusted by R16 the **SENSITIVITY** pot is fed to base of Q5. This level varies from approximately 2.2V fully CCW to 0.9V fully CW (maximum sensitivity). This voltage sets the current through the emitter resistor R14 and hence the bias point of Q4 with respect to the 0.37 volts on the base of Q4 (established by R11 and R12). The sensitivity pot is normally set to the point where, with no input signal Q4 is just cut off. When a signal becomes present Q4 conducts and amplifies the changes in the input signal. Transistors Q4 and

Q5 share the same metal heatsink; this is not for heat dissipation, but to keep the two transistors at the same temperature and reduce drift in the differential amplifier. The output of Q5 is further amplified by Q6, which is a basic common emitter amplifier.

The audio output and meter driving stage is handled by Q7 and Q8 which are wired as a single Darlington transistor running class B. A class B amplifier is biased so the transistor is just cutoff with no signal. You might be more familiar with class B push-pull amplifiers that are used in hi-fidelity audio. However, the GD-48 uses just half of the push-pull design since audio quality of the tone is not important in this case. Class B also means that there is little current used until metal is detected improving battery life. The meter effectively measures the collector current of Q7 and Q8. The diode and associated resistors scale and protect the meter from excessive overloads. The collector current also passes through the speaker. When earphones are plugged into the **PHONES** jack the speaker is disconnected and the current passes through the earphones.

Operation:

The GD-48 has two operating modes, normal and high sensitivity. In normal mode the sensitivity control is adjusted, with the coil away from metal, until a tone is heard and then reduced until the tone just goes away.

In high sensitivity mode, the sensitivity control is advanced until the meter reads about 2 on the scale of 1 to 10. As metal is encountered the meter will increase. Its movement is much more noticeable than a change in the level of the tone.

Heathkit recommends that you practice with known pieces of metal to become familiar with the operation and sensitivity of the instrument. The most sensitive part of the search coil is underneath the spot just in front of where the swivel joins the coil housing.

GD-48 Accessories:

Heathkit offered two accessories for the GD-48, the GDA-48-1 NEDA 1602 battery (\$1.30 in 1969) and the GDA-396 2,000Ω earphones made by Superex (\$3.50 in 1969). These headphones were also offered as accessories for many of the shortwave radios sold at the time.

The Heathkit GD-348 Deluxe Metal Locator:

The GD-348 (Figure 3) is a refined version of the GD-48. It was introduced in late 1972 at the price of \$89.95. It remained at this price in the catalogs I have until 1980 when the price actually dropped to \$79.95, which may have been a clearance price as it didn't appear in the 1981 catalog.

Overview:

The GD-348 weighs 3-1/2 lbs.; a half-pound lighter than its predecessor. It uses the same NEDA #1602 9-volt battery to provide 50 hours of operation. The sensitivity is given in the specifications as detecting "dime-sized metal at up to 6 inches in air", on a par with the non-deluxe model. The search coil housing is specified as waterproof up to 2' depth. Like the GD-48 the shaft is adjustable from 28" to 36".

The circuitry is significantly changed from the GD-48. The GD-348 uses ten transistors and four diodes. The relaxation oscillator itself uses two transistors to provide more stable operation. It also operates at a frequency of 100 KHz, but the modulation frequency has changed to 500 Hz. The amplifier that buffers the signal from the pickup coil now incorporates an active filter to reduce harmonics, and a diode detector to remove the 100 KHz carrier before it leaves the coil housing. Like its predecessor, the GD-348 also has two circuit boards, one in the coil housing that uses four transistors and handles the relaxation oscillator and active filter-amplifier, and one in the control handle that uses six transistors and processes the audio.

The audio processing board contains a fixed high-gain amplifier, followed by a temperature compensated variable gain amplifier that is set by the

SENSITIVITY

control. This amplifier drives a single transistor that drives the speaker and meter. The final transistor is a shunt across the meter that conducts on strong signals and protects the meter.

Another feature of the GD-348 is the coil nulling circuit. Instead of using adjusting capacitors in the head housing that time-to-time requires removal of the label and readjust-

ment. The GD-348 uses a **BALANCE** potentiometer located on the handle control box. This pot is across two taps of the search coil and is capacitively coupled to the pickup coil. The two taps are located so as to be of equal voltage but opposite polarity resulting in a small signal of adjustable amplitude and phase that can be adjusted to cancel any residual coupling between the search and pickup coil. The advantage of this circuit is that the coil housing can be sealed and made waterproof. The older GD-48 has two holes for access to the adjusting capacitors which are sealed merely by a metallic label and is not considered waterproof.

The GD-348 continued production until 1981.

GD-348 Accessories:

Heathkit offered three accessories for their deluxe metal locator. The GDA-48-1 battery, the GDA-396 headphones, both described above, and the GDA-348-1 carrying case. These accessories cost \$3.25, \$5.95 and \$11.95 respectively in the Spring 1977 mail order catalog.

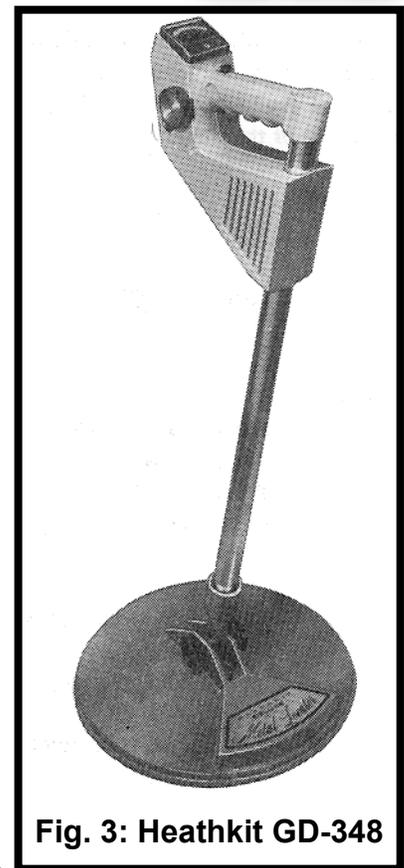


Fig. 3: Heathkit GD-348

The Heathkit GD-1190 “CoinTrack”:

In 1978 Heathkit introduced a new metal locator. It is believed to originally have sold for \$119.95. This device was designed specifically for finding small coins. The GD-1190 weighs 3.4 lbs. The over all length is adjustable from 22-1/2” to 45-1/2”. The small coil housing measures 6” in diameter. The meter may be assembled for left or right-hand operation. Power is supplied by 6 AA batteries. An optional nicad battery pack and charger are available. The cable from the coil housing to the control unit is external to the adjustable shaft and wraps around it. The cable can be unplugged at the control unit.

Unlike the coil system of the previous metal locators, this locator uses a search coil but no pickup coil. Instead of relying on the metal being located creating its own magnetic field that is then sensed by a pickup coil, the GD-1190 relies on the metal detuning the resonance of the coil and associated capacitance. The coil is excited by a stable 3.59 crystal oscillator divided down to 56 KHz. Detection is done by a discriminator circuit.

This is the first Heathkit metal locator to use integrated circuits. The five ICs are an LF211 FET comparator, LM2902 quad op-amp, CA3130 op-amp, CD4011 CMOS quad NAND gate and a CD4024 CMOS binary counter. One JFET and five bipolar transistors (one a Darlington) are also used, along with 4 diodes (one general purpose, one varactor and two zener diodes).

External controls include **VOLUME**, **DISCRIMINATE**, **TUNING**, a 4-position **MODE** switch and auto **TUNE** pushbutton. A meter, speaker and **PHONES** jack mount on the control cabinet which also supports a handle. The “CoinTracker” custom balances for less fatigue during use.

GD-1190 Accessories:

Three accessories were available for the GD-1190. The GDA-1190-1 nicad battery pack, the new GDA-1190-2 Superex headphones and the

GDA-110-3 carrying case. In the Fall 1980 catalog these sold for \$19.95, \$11.95 and \$11.95 respectively.

The accessory nicad battery pack can be charged either from a car cigarette lighter socket or from a standard 120V AC outlet.

The Heathkit GD-1290 “GroundTrack”:

In 1979, shortly after the GD-1190 was introduced, Heathkit introduced another metal locator, the GD-1290 “GroundTrack”. In the Fall 1980 catalog it sold for \$189.95. (Later it sold for \$219.95. The ad called this locator “Our finest Locator”; it was also the last locator that I am aware they built. Unlike the “CoinTrack” this unit uses search and pickup coils (induction balance) like the older units, though its circuitry is significantly advanced. Physically this locator is similar to the “CoinTrack” in size, weight and appearance, with some minor variations in controls.

GD-1290 Accessories:

The GD-1290 uses the same three accessories (the nicad battery pack, the Superex headphones, and the carrying case) that were available for the GD-1190.

Comments:

While I was in possession of manuals for the GD-48 and GD-348. Finding information, or even a clear schematic, for the other two units proved inadequate to give a more thorough description.

GD-48 User Interview:

I got a chance to interview Ken - W6HHC on his thoughts about the GD-48 Metal Locator. Mostly his comments were positive. The kit was easy to build, calibrated easily and operated as it was supposed to do. He mentioned he liked to take it along on the family outings to the beach; his kids enjoyed searching in the sand too.

Ken did comment on two faults he had with the GD-48. The first was that it needed to be adjusted whenever he took it out. However he said that once adjusted it stayed in adjustment

Find buried valuables on dry land or at the beach with Heathkit's Metal Locator

With the Groundtrack Metal Locator you can punch through ground clutter to uncover rare coins, artifacts, old trinkets and treasure. The Groundtrack is a professional model – able to pinpoint even tiny metal objects in any kind of soil, even in ground submerged under two feet of water.

Built-in speaker provides clear signals

Pushbutton tuning and ON-OFF volume control

Headphone jack

Toggle switch selects Discrimination or Ground Balance modes

Battery test switch to monitor condition

Easy-grip handle for fatigue-free use

Easy-to-read meter installs for right- or left-handed users

- Find valuable objects where conventional locators are almost useless
- On/off with volume, meter, speaker, phonejack, discrimination, ground balance, tuning controls, battery test, charging jack and mode switch
- Uses 6 AA cells

Telescoping shaft collapses to 22"

Search head folds flat for easy storage, waterproof and submersible to 2 feet.

Reading controlled by discrimination setting. Needle deflects upscale and sound increases when object is within search field. Downscale deflection indicates a ferrous object.

\$219⁹⁵

Fully Adjustable Discrimination Circuit filters background signals—screening out pulltabs, metal foil, bottle caps, ferrous and alloyed items. The Groundtrack can be used in high "junk" locations where the use of other locators is all but impossible. Have the sensitive pushbutton tuning of our best metal locator at a price far below the competition.

A Ground Balance Mode pinpoints treasures even in high-mineral soil. A Very-Low-Frequency induction balance system provides silent operation until that coin or artifact enters the 6-inch diameter search head field of detection. Then a clear tone sounds that grows louder as you approach vertical center.

Use the Groundtrack anywhere. It's lightweight and portable, with a telescoping shaft that collapses for storage. Operates on 6 AA cells (not included) or the optional Rechargeable Battery Pack, which includes AC outlet and DC lighter socket chargers for use at home or in-the-field.

Kit GD-1290, Shpg. wt. 5 lbs. **219.95**
GDA-1190-1, AC/DC Rechargeable Battery Pack, Shpg. wt. 2 lbs. **24.95**
GDA-1190-2, Superex Headphones, Shpg. wt. 2 lbs. **14.95**

GD-1290 SPECIFICATIONS: Sensitivity: Locates dime at 4" to 6" typical, may be less depending on soil conditions, mode of operation and amount of discrimination selected. Method of Detection: Induction-balance circuit. Detector Output: Meter, speaker, phone jack. Power Requirement: Six AA cells or Rechargeable Battery Pack. Dimensions: Extended height, 45½". Net Weight: 3.4 lbs.

until it was put away for another day. Ken's second complaint is one that probably most metal locator owners, who go looking for coins or treasure, have. The GD-48 has a poor ROI.

For those of you who don't know the phrase ROI, it is a business term that stands for *Return on Investment!* Ken's ROI was nominal. Maybe if aluminum recycling was in affect in the seventies, he might have been able to return all the can tabs he found. But alas, Ken never mentioned gold coins nor pieces-of-eight he located under the search head during his explorations.

I personally know of one dime he did find. I hid it under the carpet when we were checking his GD-48 out one afternoon.

When I asked Ken what happened to his metal locator, he said the swivel broke between the sense-head and the arm and he finally abandoned it. However he said it gave him good service for many years.

Acknowledgements:
 I'd like to thank Ken - W6HHC for saving and passing along his GD-48 manual after his unit broke beyond repair. He also provided the GD-348 manual that he acquired from a friend.

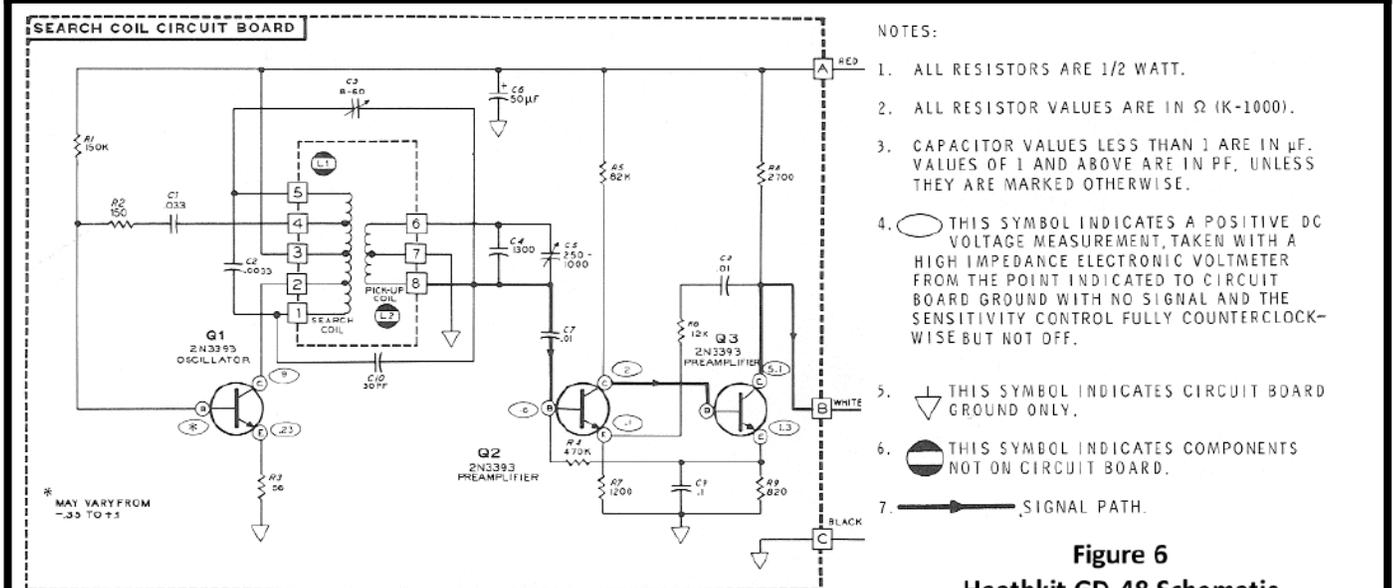
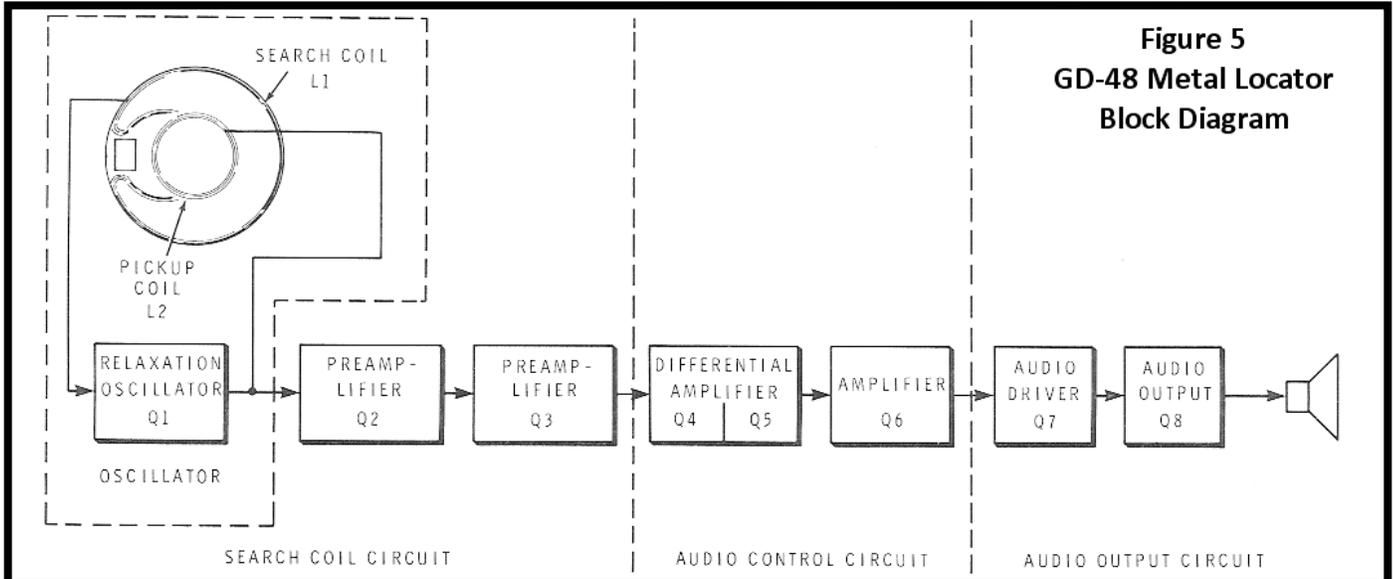
73, from AF6C 

Remember, if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

Thanks - AF6C

This article originally appeared in the February 2014 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.

Figure 4: GD-1290 "GroundTrack". The GD-1190 "CoinTrack" is similar in size and appearance. (From 1984 Catalog)



NOTES:

1. ALL RESISTORS ARE 1/2 WATT.
2. ALL RESISTOR VALUES ARE IN Ω (K-1000).
3. CAPACITOR VALUES LESS THAN 1 ARE IN μF. VALUES OF 1 AND ABOVE ARE IN PF, UNLESS THEY ARE MARKED OTHERWISE.
4. ○ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT, TAKEN WITH A HIGH IMPEDANCE ELECTRONIC VOLTMMETER FROM THE POINT INDICATED TO CIRCUIT BOARD GROUND WITH NO SIGNAL AND THE SENSITIVITY CONTROL FULLY COUNTERCLOCKWISE BUT NOT OFF.
5. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND ONLY.
6. ◐ THIS SYMBOL INDICATES COMPONENTS NOT ON CIRCUIT BOARD.
7. → SIGNAL PATH.

