# SOUNDS from the GROUND

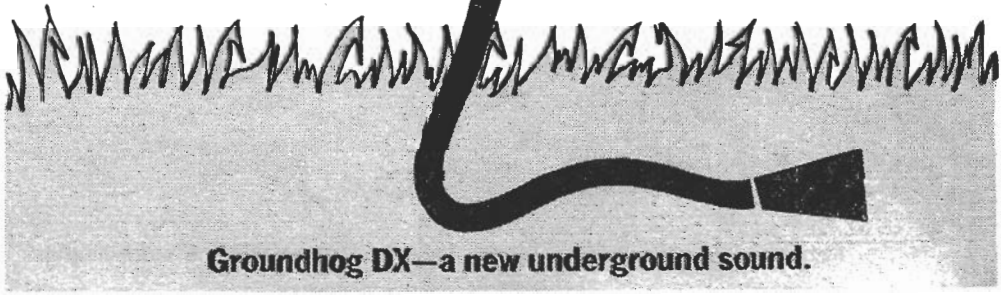
by Mike Centore III

NO MATTER HOW LONG you've been a radio listener, no matter how sophisticated your receiver may be, chances are you're missing out on an entire spectrum of communications and broadcasting stations. Where are the signals from these unheard stations? They circulate in the earth beneath your feet!

It all started more than two-hundred years ago when Ben Franklin and others found that electrical impulses could be sent from one place to another by using the earth itself as the conductor. Later, Samuel Morse succeeded in sending code through the ground. Early in the 1900's, Nathan Stubblefield devised a method of sending audio many miles through the earth's water table. This sparked the interest of many and was the principle behind the first wireless field phones.

The use of underground *radio* dates back to World War II. Our Army, Navy, and Air Force used it in situations where conventional radio was useless (because of enemy jamming, etc.). Ham operators, forced off the air because of the war, tried underground radio as a secondary system of communications. While the system was found to be less efficient than above-ground radio, some surprising contacts were made.

**Backyard Propagation.** To get a basic idea of how an underground communications systems works, look at Fig. 1. As you can see, the signal to be transmitted (be it radio or otherwise) is fed directly into the earth by way of an underground antenna. Since the earth is a mixture of water and minerals, the soil is a



Groundhog DX—a new underground sound.

a highly conductive medium known as a chemical *electrolyte*. The signal propagates through the ground just as it would travel in a large, low value resistor. But, unlike a resistor, the resistance of the earth is not the same in all places. This is due to variations in chemical make-up, water content, and temperature. Because of this, the signal is distributed unevenly, with maximum signal in the areas of lowest resistance. Fig. 1 shows the high concentration of signal in the wet earth surrounding a body of water. Also shown in Fig. 1 is the all-important *water table*. This is the upper extreme of the earth's *zone of saturation*, where the space between each grain of soil is completely filled with water. At this point, usually eight feet below the surface, the resistance of the soil is at its lowest, making signal conditions excellent. In fact, the water table is just as important to underground communications as the ionosphere is to above-ground radio. The major requirement for the underground transmitting antenna is that it be buried deep enough to make good contact with the water table.

**Putting Your Ear to Ground.** It's just as easy to receive underground radio signals as it is to hear the normal variety. In fact, all you need to do is bury your present above-ground antenna! This is absurd, but in theory it would work fine. A more practical approach is to use an "antenna" like the one illustrated in Fig. 2. Here, a metal pipe (or rod) is driven into the ground as deep as possible. While the pipe should be long enough to reach the water table, I have had satisfactory results using pipes as short as three feet. The pipe can be of copper, bronze, galvanized steel, or any relatively non-corrosive metal. The surface of the pipe should be bare metal—free from paint or grease. The diameter is not of great importance. On top of the pipe, some type of wire clamp should be mounted. This may be a regular ground clamp or a large self-tapping metal screw.

The success of your underground reception depends a great deal on the location of your underground antenna. To be effective, the antenna should be driven into an area of high signal concentration. As you know, the mud around a pond or other moist area is an excellent antenna site. But even if there is no such condition around your yard, there are other factors to consider. For example, it has been found that certain types of soil make better electrolytes than others. Soil containing large amounts of refuse material (ashes, cinders, etc.) is the most conductive type. Next best is soil containing adobe, clay, shale, or loam. The least conductive soils are composed mainly of sand and gravel. One final note about the location of your antenna: do *not* drive your underground antenna into an area which is closer than ten feet from any other ground rod or water pipe. Read on and you'll see why.

**Dirt Cheap Receivers.** Well, now that you have your underground antenna set up, it's time to start thinking about the receiver. The first thing that comes to mind is to use a standard shortwave radio. But unless your receiver tunes down to around ten or twelve kHz (that's *kilo*hertz), you will be missing out on most of the underground action.

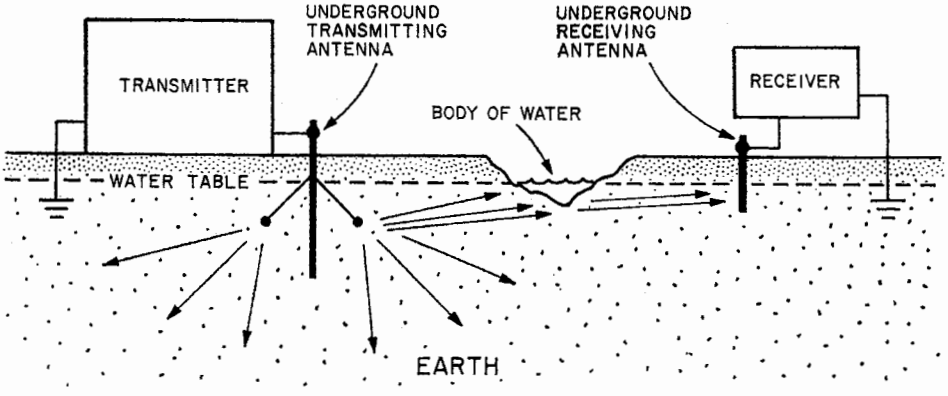



**Fig. 1. Transmitter is either radio or audio type. Practical receiver is shown right.**

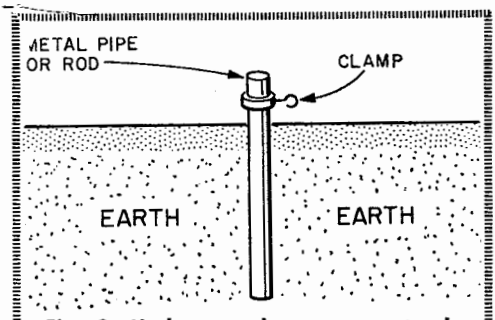



**Fig. 2. Underground antenna extends into water table for best results.**

Also, the input impedance of most receivers can't be varied enough to stay matched to widely changing ground conditions.

For the past few years, I have been using the simple "receiver" shown in Fig. 3 with very good results. When connected to the underground antenna and a good earth ground, the circuit is capable of receiving signals on *any* frequency, including audio. As shown pictorially, the entire receiver can be built around the connecting lugs on the potentiometer. The sensitivity of the circuit is surprisingly good. Best results have been obtained using a high impedance crystal earphone (Lafayette 99—25512 or equivalent), although a headset with an impedance of 20,000 ohms or more may be used.

**Double-Ground Hookup.** For proper operation, the circuit must be connected to a good earth ground (cold water pipe, ground rod, etc.) as well as the clamp on the undreground antenna. Any signal which is received has developed a voltage between the receiving antenna and the electrode used as earth ground. This explains why the underground antenna must be separated by at least ten feet from the grounding electrode—otherwise, the incoming signal would be short-circuited by the low resistance of a small patch of earth between them.

If it is desired to have the receiver located far from the underground antenna or grounding electrode, you may run long interconnecting wires. However, if the wires are made longer than fifty feet or so, they will begin to act as above-ground antennas, causing you to pick up local broadcast station interference.

**What You Will Hear.** With everything connected properly, while listening to the earphone, "tune" R1 through its range until you hear something. Fig. 3 shows which direction to rotate the shaft on the potentiometer to select either radio or audio signals. If you hear two stations at once, the potentiometer may be adjusted to bring in one over the other to some degree.

Most of the stations you hear will be operating on the Very Low Frequency range and below. All modes of operation are used ranging from CW (code) to AM (voice), including many types of "radiolocation" beacons. Some of what you hear, including most of the beacons, are not intentionally transmitted underground. The extensive antenna grounding methods employed at these low frequencies set up a strong underground signal that travels many miles. One such station to listen for is the Navy's two-million watter operating from Cutler, Maine. The station sends CW on 14.8 kHz. The CW is received as a loud low-pitched hum.

Through the years, I have heard everything from CW and beacons to hard rock on my underground receiver. You must understand that some of what is transmitted under ground was sent this way to obtain some degree of privacy. I found this out one hot summer day (when conditions are best) as

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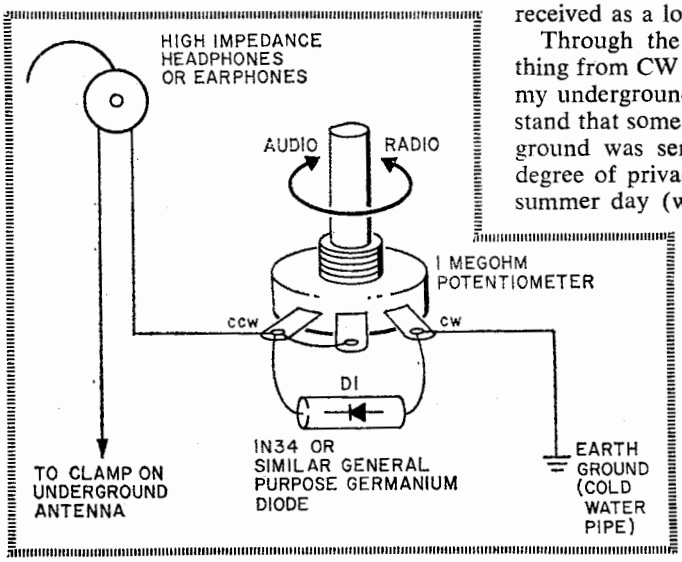


**Fig. 3. Circuit uses 3 parts. Use this simple circuit to pick up both AF and RF signals from the ground.**

# Sounds from the Ground

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I casually tuned across a weak signal that seemed to be a three-way telephone call! Well, you'll just have to listen for yourself. . .

**Audio? Why Audio?** You may be wondering why the underground receiver was designed to receive audio signals. It seems that there's a new fad among electronics minded Hippies. Recently, they have been feeding their high-power guitar amplifiers into the earth! They tell their local friends to drive a pole into the ground, connect it to the input of their own guitar amplifier (along with a good earth ground), and listen to the speaker! ■

# Heathkit DVMM