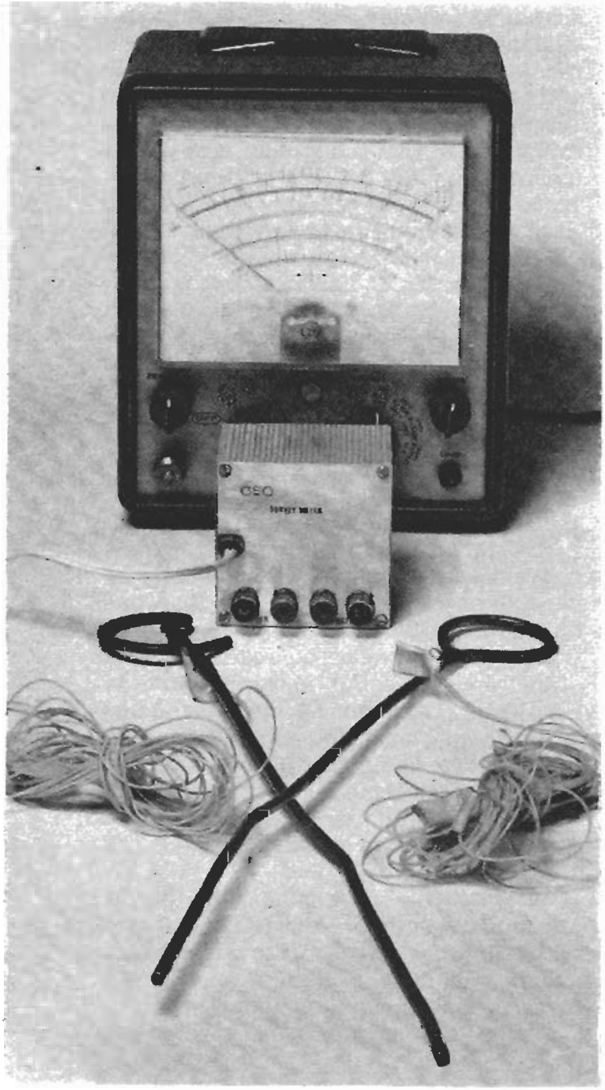


An Underground SURVEY METER and Metal Locator

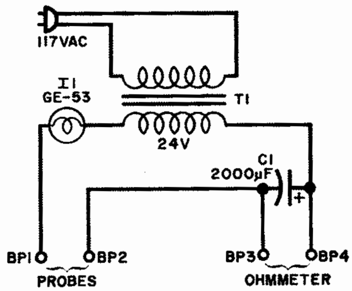
LOCATE WATER LEVELS OR BURIED TREASURE—
AT DEPTHS OF MANY FEET

BY HAROLD PALLATZ

AT SOME TIME or other, you have undoubtedly read about or built and used an underground metal locator. Most of them work well when locating objects of a fairly good size that are not buried too far below the surface. Did you ever wonder what you would do if you wanted to find something that was really far down (say 100 feet) and perhaps nonmetallic? How for instance, do geologists locate large ore deposits, underground water sources, and oil pockets buried in the earth?

Any one of several different methods can be used—seismic shock, self potential, or resistivity profile. Obviously, each of these approaches operates in a different fashion but they are all quite capable of deep subterranian penetration.

In the seismic shock method, a series of transducers is positioned around an area and an underground shock wave is



Simple survey meter circuit can be easily assembled in a utility chasis.

initiated by conventional explosives. The transducers pick up both the original shock wave and the echoes from any underground strata having a different refraction index.

The self-potential method uses the potentials generated electrochemically in the earth to outline an ore body. A sensitive galvanometer—in conjunction with a set of conducting earth probes—measures the voltage gradients. Wooden stakes are driven into the ground at points of similar potential to outline the position of the ore body. A ground fault shows up as a sharp cutoff, or flat side, in such a pattern.

In the resistivity method, current is passed through the earth by inserting metal electrodes a known distance apart and variations in resistance are noted. The resistance can be related to the type of material existing at a certain depth (which is related to the spacing between electrodes). Water, as well as large metal pipes and ore bodies, have a low resistance, while oil has a high resistance.

Commercial geophysical equipment operating on the resistivity principle has been used to survey down to many hundreds of feet. With such equipment, four metal probes are stuck in the ground, equally spaced along a straight line and an electric current is passed between the rods. It can be shown that if two metal probes are spaced 100 feet apart, the current is a function of the average resistance 50 feet down at the center point between the two. Knowing the voltage and the current, the resistance at that point can be determined.

The survey meter described here is a simplified version of the commercial equipment. It uses only two probes, but can locate such things as a water table 100 feet below the surface. A schematic diagram of the system is shown at left. It is assumed that the ground probes will maintain a more or less uniform resistance so that any change in resistance during measurements is due to the underground values. To eliminate the effects of polarization, an ac power source is used. However, since ac measurements made in the presence of stray fields can vary widely and are influenced by the capacitance and inductance effects in the earth, a dc metering signal is superimposed on the ac carrier. Although conventional 60-Hz line frequency is used here, any other frequency can be used, but penetration of the earth is better with low frequencies.

Resistance readings are made with a conventional ohmmeter which should be capable of indicating from less than one ohm to about 100,000 ohms. No calibration is required since all readings made at the same place and time are relative to each other. Capacitor *C1* bypasses the ac current and must be of a very low-leakage type. Lamp *I1* is used to limit the short-circuit current to less than two amperes. The 24-volt rms carrier voltage can vary by 25% up or down.

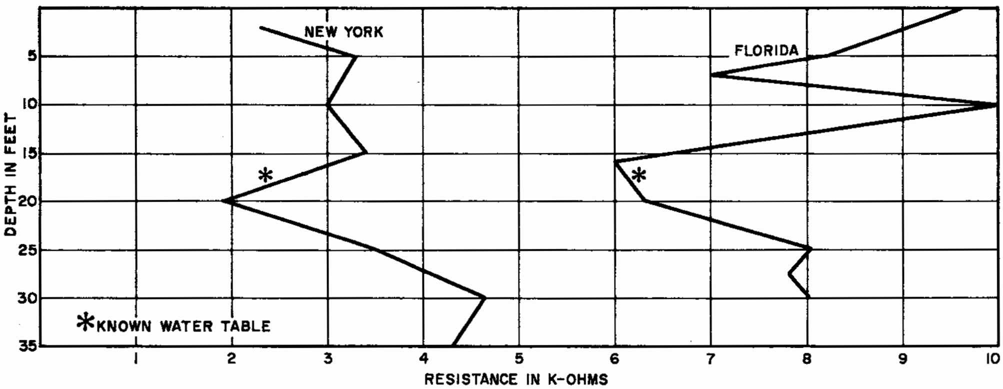
Construction. The components can be assembled in any convenient enclosure with a terminal strip to provide support and tie points. The probes can be iron, brass, copper, or aluminum (both the

EDITOR'S NOTE

Although we had no difficulty in locating a water table 20 feet underground and a water conduit 45 feet down, we did not have the opportunity of determining system "resolution"—how small an object can be detected at various depths. We leave this to the reader who is in better physical shape and handier with a shovel.

For readers in dry areas, the survey meter might be used to verify (or refute) the existence of a usable water table. It might also be valuable (more so than the metal locators that skim the surface) in locating buried treasure.

Try using a battery-powered oscillator to drive the transformer, remembering that the lower the frequency, the better.



Two test recordings made in widely separated localities show striking similarities in that the resistance drops appreciably at depths where known water tables exist.

same) and should be between ¼″ and ½″ in diameter and about 18″ long. One end of each probe should be sharpened to make insertion easier. A length (50 to 100 ft) of #22 insulated (preferably plastic) wire is connected to each probe, with the other end connected to the appropriate binding post. The ohmmeter is connected (polarity not important) to *BP3* and *BP4*.

Operation. With no ac power applied, short the two ground posts together. The ohmmeter should indicate a short circuit. When the posts are separated, the ohmmeter should deflect upscale as the capacitor charges. The maximum resistance is limited by capacitor leakage and must be over 50,000 to 60,000 ohms. Connect a known value of resistance across the ground posts and check that the ohmmeter reading indicates the correct resistance value (within tolerance). Turn on the ac power and note that the same resistance value is indicated. If it differs drastically, the problem is in the capacitor.

Use. Force the ground probes several inches into the earth in the area to be surveyed. You can start with a small separation (10 ft) or a large one (100 ft). With the ohmmeter connected and power on, record the probe spacing and the resistance value. Separate (or bring together) the rods at measured intervals (2 or 3 feet at a time) and record spacing and resistance. When you have sufficient data, plot them on graph paper.

Try to learn something about the area you want to survey. Charts and data are usually available from state or federal agencies concerned with mining and geology. Local well drilling companies also have data on land strata. Make your survey as near as possible to a location of which you have some knowledge. When you have succeeded in obtaining data of your own that checks with known data, you will begin to develop a "feel" for the system and variations in resistance will become meaningful to you. Just remember that dry rock, sand, oil, and gas have high resistance, while water shows up as a sharp low resistance. Two sample charts are shown above. ◈