Guide to TREASURE

An Introduction to METAL DETECTORS

by Charles Garrett

Garrett Guide to Treasure

An Introduction to Metal Detectors
By Charles Garrett

Introduction

Treasure Hunting with a metal detector appeals to men and women of all ages. It is an absolutely universal outdoor hobby! Treasure can be hunted with equal intensity anywhere on the face of the earth or under its waters. Each individual decides how much energy is required to excel at the hobby, and the decision can be changed from day to day or even from one minute to the next. The hobbyist can hunt for hours a day or for just a short while; the hunting may be strenuous or involve little exertion. Hidden wealth can be sought with equal vigor and satisfaction at exotic foreign locations or literally in one's own backyard.

Hunting for treasure with a metal detector is an ideal hobby for young people, full of energy and curiosity, with a desire for adventure and excitement. The hobby is perhaps even more suitable for mature men and women—yes, senior citizens—whose health permits (or requires) light outdoor exercise and who have maintained their zest for adventure. Treasure hunting offers the opportunity to satisfy this quest for excitement and mystery without lengthy travel or elaborate equipment.

Truly, seeking lost treasure fascinates everyone, and it is a hobby that offers financial rewards as well as the benefits of healthy exercise and outdoor activity. Finally, nothing can compare with the sheer thrill of discovery—whether it be that first coin…a ring…a gold nugget…an outlaw cache. The joy and excitement enrich both the spirit and the pocketbook.

This *Garrett Guide* provides basic information on the development and operation of equipment designed to detect all forms of metal, but especially treasure. The *Guide* will include simple explanations of scientific principles that govern the process of metal detection. It will also point out various ways in which detection devices are used. Modern detectors manufactured by Garrett Electronics serve as illustrations.

This *Garrett Guide* answers three simple questions:
-How does a metal detector operate?
-How can a metal detector be used to find treasure?
-What are its other uses?

What is a Metal Detector?

A metal detector is an electronic device that detects the presence of metal, primarily through the transmission and reception of radio wave signals.

A metal detector is **not** an instrument (Geiger counter) that detects energy emissions from radioactive materials. It is not an instrument (magnetometer) that measures the intensity of magnetic fields. It does not point to metal; it does not measure the abundance of metal. A metal detector simply detects its *presence* and reports this fact.

Computerized metal detectors such as Garrett's GTI 2500 Pro and Infinium LS with microprocessor controls are as modern as tomorrow, but the metal detector itself scarcely represents a new scientific development. Ancient documents indicate that a Chinese emperor over two thousand years ago developed a metal detecting device using magnets. It was designed to find weapons before they were used to assassinate him.

When President James A. Garfield was shot in 1881, doctors asked Alexander Graham Bell, inventor of the telephone, to help locate the bullets with metal detection equipment. As American industry grew in the early 20th century, detectors were developed to monitor metal tools and products and control their possible theft by employees and visitors to manufacturing plants. Other uses were also found in commerce and industry.

During World War II rapid advances were achieved in the technology of metal detection as new equipment was developed essentially to locate land mines and similar weaponry. In 1945 mine detectors joined countless other items of war surplus in the marketplace…available at a fraction of their cost. Veterans familiar with this equipment were quick to recognize its value in locating buried treasure.

And, a new hobby was born!

Many companies produced, first, bulky instruments using vacuum tubes; then, smaller and lighter detectors with transistorized circuitry. It was not until the late 1960's, however, that real progress began to be made in developing stable and sensitive detectors that featured rudimentary target identification and ground mineral rejection.

The Garrett Company, founded in 1963 by the author and his wife Eleanor, has been and remains a leader in the development of all types of new and advanced metal detection equipment.

During the early years after World War II, use of "mine detectors" by hobbyists was restricted almost entirely to prospecting for precious metals. As technological advances were achieved, however, it became evident that metal detectors could discover far more than nuggets and ore veins. Soon, they were being used to find such other types of treasure as lost coins and jewelry, caches and relics. Metal detectors helped to explore ghost towns and find lost storehouses of treasure. Finally, detectors were developed that could be taken deep under the ocean where successful location of lost treasures worth millions and millions of dollars has brought them widespread notoriety.

How Does a Detector Operate?

Just as knowledge of an internal combustion engine is not required for driving a car, it is not necessary to understand the scientific principles of metal detection to use a detector to find coins or lost jewelry—or to detect hidden weapons in a school or airport.

Similarly, just as knowledge of a gasoline engine makes one a better *operator* of a motor vehicle, understanding the how and why of metal detection results in a better *treasure hunter*. As its name indicates, this *Garrett Guide* explains these basic principles.

Metal is detected essentially by the transmission and reception of radio wave signals. This is true of any device designed for that purpose. What distinguishes quality metal detectors such as those manufactured by Garrett from those of lesser quality are the methods by which signals are transmitted and the sophistication with which they are received and interpreted.

When a radio signal is produced in the searchcoil of a metal detector, an electromagnetic field is generated that flows out into the surrounding medium, whether it be earth, rock, water, wood, air or any other material. Electromagnetic field lines penetrate metal whenever it comes within the detection path. Extent of this pattern depends upon the power used to transmit the signal and the resistance of the medium into which the signal is transmitted.

The electromagnetic field generated by transmission from the searchcoil causes *eddy currents* to flow on the surface of metal detected by this field. Generating these currents on the metal causes loss of power in the electromagnetic field and this loss of power can be sensed by the detector's circuitry.

Electromagnetic field lines passing through metal and generating eddy currents further disturb the normal electromagnetic field.

These currents and their resulting distortion of the electromagnetic field are sensed by a metal detector. Simultaneously, a secondary electromagnetic field is generated by the eddy currents into the surrounding medium. A receiver in the searchcoil detects these signals at the same time the loss of generating power is being detected. Circuitry of the metal detector interprets all these sensations and generates appropriate audible and/or visible signals.

The detection device instantly reports to the treasure hunter usually by an audio sound relayed to the detector "speaker".

Eddy currents flow on the surface of any metal object (or mineral) having the ability to conduct electricity. Precious metals such as silver, copper and gold have higher conductivities and appropriately, more flow of eddy current than iron, foil, tin or other less desirable minerals. Since metal detectors can "measure" the amount of power that is used to generate eddy currents, the detector can "tell" which metals are serving as the conductors.

Quite simply, the quality of these signals generated, received and interpreted by the metal detector and the ability of the treasure hunter to act upon them determines the difference between "digging junk" and finding treasure.

Oh, that it could be that simple!

Penetration of the electromagnetic field into the "search matrix" (that area over which a metal detector scans) is described as "coupling." Such coupling can be "perfect" into air, fresh water, wood, glass and certain non-mineralized earth.

Unfortunately, life is seldom perfect. The search matrix which a metal detector "illuminates" (through transmission and reception of signals) contains many elements and minerals…some detectable and some not…some desirable and some not. A metal detector's electronic response at any given instant is caused by *all* conductive metals and minerals and ferrous non-conductive minerals that are being illuminated (detected) in the search matrix by the electromagnetic field.

Detection of minerals is, in most cases, undesirable. Two of the most undesirable are also two of the most common…

- Natural iron (ferrous minerals) found in most of the earth's soil;
- Wetted salt found in much of the earth's water.

Not only do these minerals produce detection signals, but they inhibit the ability of instruments to detect metal.

When iron minerals are present or near the search matrix, the electromagnetic field is upset by them, and signals are distorted. Iron mineral detection, therefore, presents a major problem both to manufacturers and users of metal detectors. Although detection of such minerals may be desirable when a prospector is seeking ferrous magnetite that could contain gold or silver, it is a nuisance to the hobbyist searching for coins, relics or jewelry.

A primary design criterion of any detector, therefore, must be to filter or eliminate responses from undesirable elements, permitting the treasure hunter to be informed only of those responses from desirable objects. This is accomplished in a variety of ways, depending upon the type of metal detector.

The words *ground balance* and *discrimination* have become accepted as those terms to describe the ability of a detector to seek out only desirable targets.

Electronic engineers accomplish this through various methods of circuitry which properly manage the normal electrical phase relationship among resistive, inductive and conductive voltage. Phase shifting is a phenomenon basic to the understanding of electricity. Management of it to enable a specific metal detector to "balance out" iron mineralization or "discriminate" against undesirable targets involves highly proprietary knowledge and circuitry protected by U.S. patents. The author and other Garrett engineers, incidentally, hold many of these patents, including a number that are primary in the manufacture of metal detectors.

Treasure Hunting Metal Detectors

Metal detectors designed primarily for treasure hunting come in a wide range of sizes and shapes. They can also vary in price by hundreds of dollars with some models sold very inexpensively. It has been said, however, that a "cheap" detector has difficulty locating a penny lying on a vinyl floor. This *Guide*, therefore will be concerned only with "capable" detectors…those with quality and the ability to find treasure.

Incidentally, "capability" should never be confused with "versatility," which will be discussed. A capable detector can be depended upon to perform the tasks for which it was designed—as long as the detector is operated properly.

What should a "capable" metal detector, one that will find treasure, cost? Answering a question with a question, one might respond, "What should a car cost?" The answers to both questions are the same. The price will depend on the quality of the detector (car) purchased and the features (options) it offers.

Most metal detectors are designed to find coins because the vast majority of treasure hunters seek coins and jewelry. Some instruments, therefore, are designed principally for coins, and others are specifically designed for different hunting tasks. Some are made to operate in or under the water; others are primarily for cache hunting (jars of coins – cans filled with coins) or prospecting for gold. *Versatile* describes a most popular type of detector such as the Garrett GTI series. This is the *universal*, or all-purpose, detector designed to fulfill any treasure hunting function on land. And, submersible searchcoils such as those that are standard with Garrett detectors permit the Master Hunter instruments to be used for underwater hunting as well.

Detector Configurations

Let's examine the basic features of a treasure hunting metal detector.

***Standard*:** The basic configuration of most detectors features a control housing attached to the handle and stem with a cable wound around the stem to the searchcoil. This configuration is often called a "wrist action" model. Balance and weight are important in the selection of a standard configuration detector. Lightweight models can be used for long periods without causing much fatigue. Balance is defined as the ease with which a detector rests in the hand when held in normal operating position. Little effort should be required to hold the searchcoil in the air at operating height. Lightweight and good balance will result in minimal fatigue experienced both during and after treasure hunting.

Pistol-Grip: This type of detector (GTI Series), essentially a variation on the standard configuration, usually features a built-in extension arm rest. Excellent balance and lightweight generally make it an instrument that a hobbyist can use for hours without tiring. With the detector as an "extension" of the arm and hand, its searchcoil stem lies along the same line as the forearm. Motion is accomplished without thinking since operation is almost as simple as "pointing a finger."

Hip-Mount: This configuration features the control housing on a belt around the waist or slung over the shoulder with the searchcoil on an adjustable-length stem. An armrest is also usually supplied. This configuration to which most standard detectors can be converted is designed to relieve the arm of weight and to protect the control housing in some surf-hunting models. Conversion are often available for use with standard detectors. The Infinium LS features built-in convertibility.

Underwater Designs: The Garrett Sea Hunter Mark II and Infinium LS are the world's most famous for use in shallow or deep water (up to 200 feet). Designed for efficient land, surf and underwater hunting, these detectors are built in the hip-mount configuration but the control housing can also be mounted on the shaft.

Searchcoils

In considering searchcoils, the automobile analogy can be continued. Searchcoils have the same function as wheels on a car. Wheels take power from the motor and interface between the automobile and the ground. They roll along, take bumps and shocks to permit the car to perform its function of getting to a destination. Search-coils take power from the control housing. Wheels take power from the motor and interface between the automobile and the ground. They roll along, take bumps and shocks to permit the car t o perform its function of getting to a destination. Searchcoils take power from the control housing via the searchcoil cable. They are the interface between the metal detector and the ground. They take bumps and shocks as they scan to permit the detector to perform its function of finding targets.

A metal detector simply would not function without a searchcoil. Most searchcoils have transmitter and receiver antennas embedded within them. They come in many shapes and sizes. Roughly speaking the smaller the searchcoil, the smaller the object that can be detected. Larger searchcoils detect deeper and larger objects.

Effective searchcoils must have electronic shielding, and they should be waterproof. Even if a hobbyist doesn't intend to hunt in shallow water, searchcoils should be able to resist moisture that will occasionally be encountered. As a matter of fact, all Garrett searchcoils not only ""resist moisture," they can be submerged in water to the connector without damage. A good searchcoil is vital to the success of a metal detector. No hobbyist should seek a "bargain" in purchasing a searchcoil!

Standard size: This is a misnomer because there is no "standard" size searchcoil. The coil that operates ideally in a park may be next-to-useless on a junk-filled beach. The searchcoil that finds coins would rarely be used to search for a cache. Searchcoils come in a wide range of sizes:

Diameter of seven to nine inches: This size searchcoil is furnished with most detectors, which is proper because this is the best general-purpose size. They are usually lightweight, have good scanning width and are sensitive to a wide range of targets. Small objects can be detected, and good ground coverage can be obtained. Shallow scanning width is approximately equal to the diameter of the searchcoil. Depth of detection is satisfactory for most targets with a searchcoil of this size.

Three to four inches: This size searchcoil is generally referred to as a Super Sniper. Its intense electromagnetic field gives good detection of small objects, and its narrow pattern permits excellent target isolation and precise pinpointing. Depth of detection is not as great as that of larger sizes. Remember, however, that a searchcoil illuminates everything in the search matrix. In high junk areas it is possible to find targets with a Super Sniper that would be masked by junk signals if a larger coil were used.

Ten to twelve inches: Searchcoils of this size while able to detect coin-size objects at great depths are also classified as the smallest searchcoils to be used for cache and relic hunting. Precise pinpointing is obviously more difficult with the larger sizes, and their increased weight usually necessitates the use of an arm rest of hip-mounted control housing, especially when the detector is used for long periods.

Elliptical searchcoils: Originally developed by Garrett for use by prospectors in rocky or otherwise restricted areas where circular coils could not be used, a new 2d design for windings has greatly expanded the abilities of coils in this shape. They offer many of the same features of the Super Snipers since their search area is so confined. They offer a much deeper detection pattern because of the new winding design, and their effective scanning width is larger than that of small circular coils.

Depth Multiplier Attachment: This special attachment, which Garrett calls the "Treasure Hound Depth Multiplier," multiplies the depth that an instrument can detect. Larger searchcoil sizes can increase depth multiplication factors on the order of two to three times. For example, if a large cannon or safe can be detected to a depth of seven feet with a 12-inch searchcoil, the Bloodhound can locate it to perhaps twice that depth.

Headphones

For maximum success a treasure hunter should use headphones whenever searching with a metal detector. They are essential in noisy areas, such as the beach, parks, playgrounds, and near traffic. They enhance audio perception by bringing the sound directly into one's ears while masking outside noise interference.

Most persons can hear weaker sounds and detect deeper targets when quality headphones are used. They come in several sizes and configurations, the most popular being stereo types that cover the ears. For those detectors without volume controls, headphones can offer the control that allows a wide degree of loudness adjustment without degrading the sound quality.

Reducing sound volume to silent on a detector is accompanied by loss of detection depth and sensitivity. Detectors should always be operated with the audio control adjusted so that just a faint sound (threshold) comes from the speaker. Headphones allow this threshold to be set even lower, giving improved performance.

Discrimination

Most modern metal detectors have controls that allow an operator to eliminate detection of certain classes of targets. This is called *discrimination*. With various targets placed on the dial in the order of their conductivity the operator sets his controls to indicate which targets the detector should accept and which it should reject.

The GTI and GTP's feature *notch discrimination*, which enables an operator to set the detector so that it can isolate any one target to seek out…or any one type of junk metal to ignore…regardless of the location of these targets on the conductivity scale.

When a treasure hunter is scanning his searchcoil over the ground or in the water, a detector reports information on targets in three ways:

- Increases or decreases in audible volume (universal on all detectors);
- Meter deflections (types of meters can vary greatly, along with the amount and accuracy of the information they present);
- Graphic information presented on LCD meters (sometimes reported in a numerical "code").

Acceptable objects cause the audio or visual indicators to increase in amplitude; unacceptable objects cause the indicators to decrease. Metered target identification indicators can provide additional information concerning the possible "value" of targets.

The Modern VLF Detector

Metal detectors over the years have been made with various kinds of circuitry to transmit and receive signals. Many of these, though considered obsolete today, still perform capably. Because the Very Low Frequency (VLF) type detector is far and away today's most popular, it is the type that this *Guide* will discuss. The VLF name comes from the operation of this detector in the Very Low (radio) Frequency spectrum of 3 to 30 kilohertz.

Because VLF's can be designed with circuitry that is not bothered by the disturbing effects of iron minerals, circuit gain can be made higher; thus, improving sensitivity (smaller targets can be detected) and greatly increasing detection depth. Operating at a lower radio frequency, the VLF detector generates a greater amount of eddy currents. Since the depth on a metal target to which eddy currents can be generated increases as the frequency of the electromagnetic field source decreases, VLF's cause larger amounts of eddy currents to be generated on targets at all depths. Thus, smaller and deeper targets can be detected.

Automated (Motion)

The motion-type VLF detector with automatic ground balance is probably the most popular model generally used today…especially by coin hunters. First of all, it is easy to use. Added to this are its capabilities for finding coins and jewelry that are almost equal to those of higher priced detectors. This capability becomes particularly apparent when both expensive and average-priced models are in the hands of a novice. Yet, while most models from reputable manufacturers are capable, some will definitely detect coins and treasure deeper than others.

Numerous models of automated detectors are manufactured today. Some offer more features than others, and some are simply better than others. Working with a knowledgeable company will enable you to determine which model is best suited for your needs.

Automated VLF instruments are often referred to as "motion" detectors since they can be hovered over a target for only a few seconds because of their automatic circuitry. Consequently, slight searchcoil motion is always necessary. Certain models, however, can be scanned much more slowly than others. You must learn the capabilities of your instrument through practice.

Another technique you will have to practice is pinpointing, since hovering over a target is not possible. Manual pinpointing will be more difficult for some operators than for others. Electronic pinpointing offered on all the better models overcomes this deficiency. Simply stated, however, pinpointing generally presents no problem for anyone searching for coins because the targets you will be finding can be considered comparatively large.

The automated VLF instrument ranks high among all types of detectors in detection depth. Not only is it capable of reaching to great depths to detect coins, but its extremely sharp and quick response signal is unmistakable when rings, coins and other such valuable metallic objects are detected. In addition, all quality automated VLF detectors will offer some form of trash elimination through discrimination control (s).

Many hobbyists find the automated VLF models satisfactory for types of metal detecting other than coin hunting. This is particularly true of those instruments produced by quality manufacturers. In fact, I've used our automated Sea Hunter model for shallow relic hunting. Some hobbyists even report they have found gold nuggets

with an automated instrument. If you're interested in a detector that will perform satisfactorily in situations other than beach hunting, however, I suggest that you read on about the manual adjust and computerized models.

Manual Adjust (Non- Motion)

Until the development of the automated VLF detector the manual adjust models dominated the treasure hunting field. They represented such an improvement over the old BFO and TR detectors which had but limited (perhaps, *non-existent* would be a better description) ability to eliminate iron earth minerals and wetted salt. Quality manual adjust VLF's are still highly popular instruments capable of performing all coin hunting, treasure hunting and prospecting tasks. They detect very deeply and are offered with an array of desirable features.

Some modern computerized VLF detectors, such as the GTI 2500, include ground balancing that is not only automatic but continuous as well. I believe that in just a few years all quality VLF detectors will provide this continuous ground balance. In fact, ground balance will be an aspect of metal detecting that hobbyists will finally be able to take for granted! What an improvement this truly is…especially after all the problems that veteran THers have experienced over the years with ground balance.

I especially recommend this type of detector to the individual who is interested in hunting for coins but already has an "itch" to try out the other types of metal detecting. As noted above, many hobbyists use motion-type automated VLF detectors for tasks other than hunting for coins and jewelry. The simple truth of the matter is, however, that manual adjust non-motion models will generally detect deeper than motion models.

Because of those selfsame "manual" controls from which it gets its name, this type of detector is capable of more precise ground balance. Such precision will rarely be required by the average coin hunter. Not so with relic and cache hunters who seek deep targets or electronic prospectors working over highly mineralized ground. They demand absolute ground balance that will enable them to hear faint signals from faraway or tiny targets.

Any kind of pinpointing technique is possible with the manual adjust VLF detectors since they can be hovered over a target at will. Still, the matter of pinpointing is not especially important since modern, quality instruments all offer precise electronic pinpointing circuitry.

Computerized

The finest metal detectors available today—and, in the foreseeable future—are instruments with computerized circuitry based on microprocessor controls such as those in all Garrett Metal Detectors.

Simply stated, the computerized detector is a *thinking machine*; it performs literally millions of analytical computations almost simultaneously to make circuitry adjustments that were formerly made by hand by the hobbyist. As the searchcoil receives date, it is fed into microprocessor circuitry in digital form and compared with the "mind" of the computer, data that has been stored in the computer at the factory. Thus, knowledge that formerly was required from the operator is now in the computer, which permits it to make adjustments that one required manual action. Not only does the computerized detector make these adjustments automatically, but they are made instantaneously…when they are needed, not when an operator finally notices a need for them.

As the detector is scanned, it continually performs self-tests; that is, it self-adjusts to achieve optimum operating performance for all conditions, including battery condition, temperature changes, ground mineral variations and even the possible aging of electronic components that might cause "values" to change. Target data coming through the detector's searchcoil is compared with the particular requirements selected by the operator (such as discrimination) to produce the proper audio and meter indications. False signals caused by conventional detector "back reading" are eliminated. Even large objects are properly read on the meter with the precise audio tone given.

Garrett engineers have known for years that different ground mineral conditions cause different discriminating performance. Garrett Metal Detectors have various scanning methods stored in their memory banks. As earth mineralization changes while these instruments are being scanned, the detector automatically readjusts itself to use the optimum discrimination method.

Computerized detectors produced by Garrett Metal Detectors permit the ultimate in treasure hunting. No better detectors have ever been devised for the hobby. Greater depth and considerably more discriminating accuracy is possible. Too, a computerized detector maintains circuitry at optimum levels by automatically monitoring every atmospheric and ground condition. But, just as some capabilities that can be achieved with computerized microprocessor-control-led detectors aren't possible with conventional instruments, these added capabilities may not always be required.

It has been said that operator "mistakes" can be virtually eliminated with the new "thinking" detectors. Treasures are already being discovered all over the world that could never have been found before. "Worked-out" areas are producing vast amounts of new discoveries of coins and jewelry.
Because these new finds are ones that were buried more deeply or were masked by trash, they are usually older and more valuable than the objects that had previously been found in the same areas.

Computerized detectors permit professional performance and detection accuracy to be achieved easily by beginners at levels that have tantalized professionals for years. We have truly entered the era of hi-tech metal detector performance. Treasure hunting and all other forms of metal detecting will never be the same again!

Conclusion

Metal detectors, thus, play an important role in the life of almost everyone…whether he or she knows it or not.

The purpose of this *Guide*, however, has been primarily to explain how a detector can improve the *lifestyle* of any individual. We have sought to acquaint the reader with the potential for exercise, pleasure and profit through the hobby of metal detecting.

This booklet serves only as a basic introduction. More extensive information is available in other *Garrett Guides* or many other books.

I certainly hope that you will use your detector to the fullest. Take time to learn about it and to understand how it works. Then, you can join the many thousands of us who now enjoy the hobby. When you do, I hope to…

See you in the field!

If You Would Like to see a Simple Illustration "How Metal Detectors Work" Click Here

Any questions regarding metal detectors can be answered by the professional, experienced staff at Kellyco Metal Detectors, Garrett's official Catalog and Internet Dealer/Distributor. Call them toll free 1-800-898-6673 or 1-800-327-9697. Visit their website at www.kellycodetectors.com – click on Garrett logo to see Garrett's latest metal detectors.

REVISED 11-06