GARRETT Writes on the New VLF's!

This was an article, published in Volume 5, Number 4, of the National Treasure Hunters League issue, in 1977. The National Treasure Hunters League, was owned by Ray Smith, who died from cancer. I was one of his metal detector dealers, and this was taken from printed sales literature material given to me, by Ray Smith, and it does not bear any copyrights, so it does not violate any copyrights.

I will comment in **blue type**, to explain and clarify something, but other than that, it is word for word the published article. I have however, taken some libertys with the size of the original paragraphs, breaking them into smaller paragraphs, so not to lose the reader's interest.

I will stick in the diagram examples, that went with the article. Then at the conclusion, I will include an advertising sheet of each metal detector, that Charles Garrett was speaking of in 1977. This is so you have an "all-inclusive" view and knowledge, so you can really appreciate the entire article. It was the beginning of the fantastic Garrett VLF metal detectors! This text is not photocopied, it was written by me, on my computer. **Melbeta**

The new VLF (Very Low Frequency) ground canceling detectors are here to stay! In a very short time, they have taken their place right alongside the popular BFO and TR detectors. Let's take a look at the new VLF's so that we can have a better understanding of them and their real capabilities!

Will the VLF types "zero out" the ground as the manufacturers claim? Are they more sensitive than other types? If so, what makes them more sensitive? Can these instruments be made to discriminate? Does the Treasure Hunter still have need for the TR and BFO types? Are the new twin circuit VLF/TR types as good as reported? Many questions such as these are beginning asked about the new instruments and since they are becoming very popular, let's take a close look at them.

The instruments are known by various name descriptions: VLF (Very Low Frequency, VLF/TR (Twin Circuit VLF and TR Discrimination), GEB (Ground Exclusion Balance), MF (Mineral Free), GCD (Ground Canceling Detector), Magnum, and others. From where is the main VLF classification derived? Let's see.

All electrical or electronic equipment operates at signal frequencies from zero frequency (direct current -- DC) up to many, many millions of hertz (cycles) per second. The entire range of electrical frequencies is classified into many frequency bands or "groups" of frequencies.

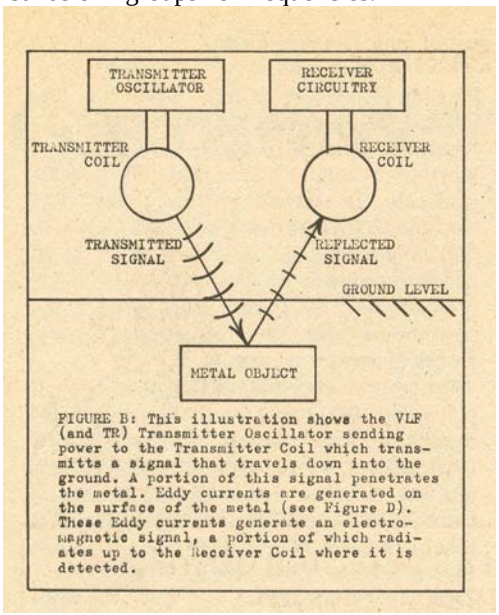


FIGURE B: This illustration shows the VLF (and TR) Transmitter Oscillator sending power to the Transmitter Coil which transmitts a signal that travels down into the ground. A portion of this signal penetrates the metal. Eddy currents are generated on the surface of the metal (see Figure D). These Eddy currents generate an electromagnetic signal, a portion of which radiates up to the Receiver Coil where it is detected.

For instance (See Photo 1 above), we hear frequency sounds in the 20 hertz to 20,000 hertz (.20KHz to 20KHz) band. You will notice that within this audio band there are three smaller band classifications. The ELF (Extremely Low Frequency) band includes all frequencies from 30 hertzs to 300 hertz (.03KHz to .3KHz). The VF band (Voice Frequency -- does not include the very low and very high music frequencies) includes all frequencies from 300 hertz to 3000 hertz (.30KHz to 3KHz). The VLF (Very Low Frequency) band includes all frequencies from 3000 hertz to 30,000 hertz (3KHz to 30KHz).

The majority of today's VLF detectors operate at a frequency somewhere between 5000 hertz and 20,000 hertz (5KHz to 20KHz) which obviously, places them within the VLF frequency band as described in the previous paragraph. For this reason they are named VLF type instruments.

Actually the VLF type instruments are Transmitter Receiver (TR) detectors because they transmit a signal into the ground and then receive a portion of that energy back. It would have resulted in confusion, however, had these instruments been called TR's. When the time came in 1975 for me to name and classify our first ground canceling detector (The Master Hunter VLF) I spent several weeks thinking about it. I considered such classifications as MPD (Magnetic Phase Detection), G2C (Ground Canceling Circuitry), and others like MFO (Mineral Free Operation) and GCD (Ground Canceling Detector). I selected VLF because that classification was broader in scope than the other possible designations. There were also other reasons. I know that it would e easier for everyone to understand and remember and it tied in well with the designations TR and BFO. Since that time, four other manufacturers have acknowledged VLF operation ... so the VLF is here to stay!

Basically what we have said so far is that these new VLF's are actually Very Low Frequency Transmitter-Receiver detectors. Let's get right to the heart of the matter and discuss why they are different from the standard TR. Standard TR's are the type of TR detectors that have been around for several decades. Most of them operate within the frequency range of 50,000 hertz (50KHz) up to 100,000 hertz (100KHz). (Now at this point of time, I want to mention that the famous Compass Yukon Induction Balance detectors, which was a variation of the TR detector, operated at 100khz.)

You can see that this is quite a bit higher than the VLF range of 3000 to 30,000 (3KHz to 30KHz)! The difference between these two types is more involved than just the frequency. For simplicity's sake, let's say that standard TR's transmit a signal into the ground and receive 100% of the signal that is reflected back from a metal target. VLF's on the other hand, transmit a signal into the ground, but they receive only a portion of the signal that is reflected from a metal target. (I understand they use filter circuits, to eliminate unwanted portions of the signals, thus they are "trapping out" some of the unwanted signals.)

In order for us to understand fully how the VLF types work, it is necessary to take a brief look at how a signal is transmitted into the ground and how then a portion of that signal is reflected from the target to be received by the detector. Almost all types of meal detectors are designed with oscillator circuits. These oscillator circuits take direct current (DC) battery power and convert it into alternating current (AC) power.

The design determines at which frequency the oscillator is to "run." In the case of our latest Master Hunter VLF/TR Deep Seeker (the 5.5KHz model), we decided the frequency should be 5500 hertz. This would give us the best depth capability in the ground canceling mode.

In the case of the Master Hunter VLF/TR Feather-weight (Groundhog), we decided that the frequency should be 15,500 hertz (15.5KHz which is better for gold detection). This would give us the best capability of selecting (with a control panel knob) a wide range of optimum settings where various targets (iron pots, relics, and precious metals, such as coins) could best be detected. VLF depth is sacrificed somewhat in the Groundhog, but TR discrimination operation is greatly improved.

When an engineer determines an oscillator frequency, he then designs the searchcoil for the best operation at that frequency. The searchhead is constructed with one or more transmitter coils and one or more receiver coils. The AC oscillator power is fed into the transmitter coil(s). The coil then generates an

invisible electromagnetic field (Photo 2) that radiates from the coil in all directions. If this field could be seen, it would look like a gigantic doughnut with the searchcoil embedded right in the middle of it.

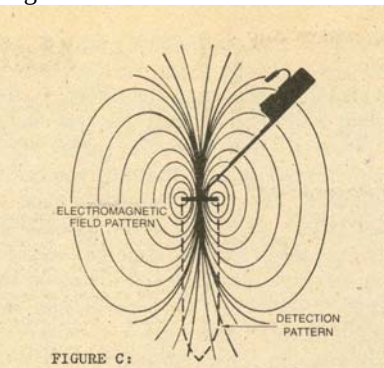
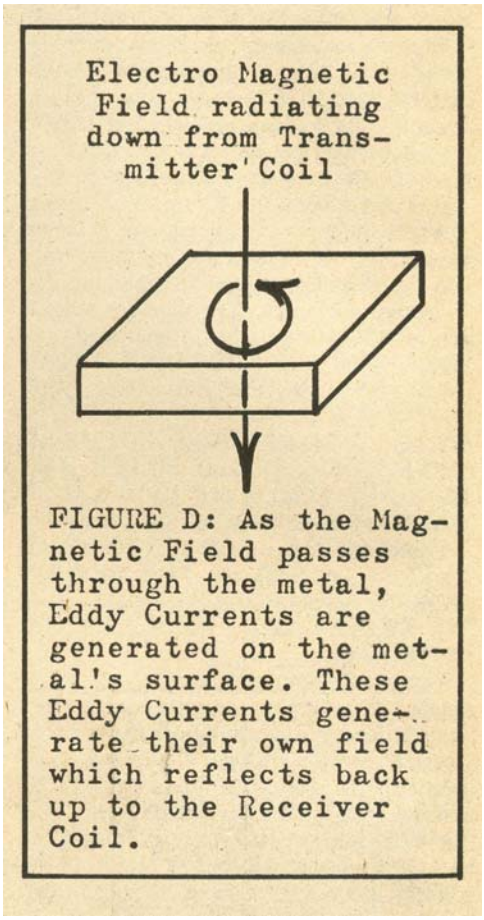


FIGURE C:

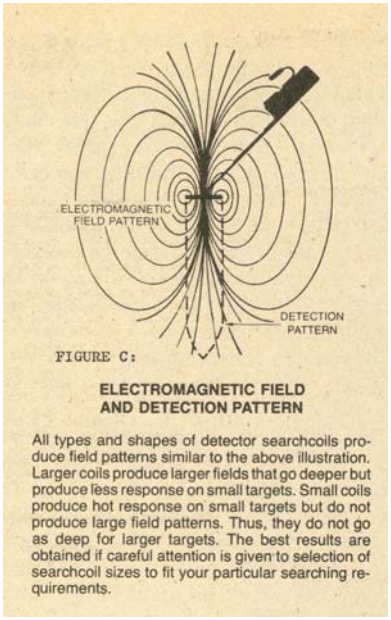
ELECTROMAGNETIC FIELD AND DETECTION PATTERN

All types and shapes of detector searchcoils produce field patterns similar to the above illustration. Larger coils produce larger fields that go deeper but produce less response on small targets. Small coils produce hot response on small targets but do not produce large field patterns. Thus, they do not go as deep for larger targets. The best results are obtained if careful attention is given to selection of searchcoil sizes to fit your particular searching requirements.

The downward portion of the field penetrates the ground. If there is metal buried in the ground, the field also penetrates the metal. This is the point where detection begins to take place. When this field passes through the surface of the metal, very tiny, circular AC currents are caused to flow on the surface of the metal. (Okay, I assume when the metal becomes “electro-ized”, that is why I have noticed, that a target tone discriminator will change its identification, right after you have swung the coil, over the target, back and forth a few times. It is this AC current, that is “now” upon the metal, that creates a “new” target detection, for my metal detector. I am sure many of you have noticed “this change” in the target?). See Photo 4



These currents, called “eddy currents”, generate their own electromagnetic field the same did the coil when it got its current from the oscillator. This “eddy current” field radiates out in all directions the same as did the coil’s field. A portion of the “eddy current” field is radiated upward and reaches the detector’s receiver coil where it is “picked up” or its presence is detected. See Photo 2.



Then, with suitable electronic circuits, the operator is alerted to the presence of the buried metal.

Now that we know how a transmitter-receiver system works, we can proceed to discuss the difference between TR and VLF instruments. This discussion, please remember, is greatly simplified, but it will serve quite well to help you to understand how the different types work.

In this life it takes time for everything to happen. Time does not stand still so that everything happens at once. It takes time for an electromagnetic field to be transmitted into the ground. It takes about the same length of time for the return signal to reach the detector's receiver coil. (This tells us, to swing the coil slower, and not to move too fast metal detecting, and to give the metal detector time to "see" the target, time to "analyze" the target signal, and time to "respond", both with the audio signal in the speaker, and with the meter response. If we move too fast, we could move right over a deep coin, and the metal detector did not have time to tell us the deep coin was there, and we are off and beyond the target location.).

Let's say that you have a super-fast stop watch. You set the hand to "zero" at the vertical or 12 o'clock position. At the instant the electromagnetic field leaves the transmitter coil and starts its journey into the ground, you start the watch. Let's say, further, that the hand reaches the 3 o'clock (15 micro-seconds) position at the same time the field reaches the buried metal target. The eddy currents are set into motion on the surface of the metal and they generate their own field which starts traveling back toward the detector. Assume the watch hand reaches the 6 o'clock (30 micro-seconds) position when the return field reaches the detector's receiver coil. Remember that all this is happening in only tine fractions of a second, but we are slowing it down mentally so that we can understand it better.

Next, we discuss a vital thing that happens to the return field that makes VLF operation possible. THE SPEED AT WHICH THE RETURN FIELD IS GENERATED IS NOT THE SAME IN ALL METALS AND MINERALS. For the sake of simplicity, let's say that gold, silver, and refined solid iron generate their fields the fastest and those fields reach the receiver coil when the hand is at 6 o'clock. Natural iron that is present in the soil generates its field more slowly and its field does not reach the receiver coil until, for example, the hand has reached 9 o'clock.

It is at this point that the TR and VLF differ. The TR "waits" for all signals to come back. Then all signals are combined into one signal which is then fed into suitable electronic circuitry. The speaker sounds off, indicating the presence of EVERYTHING IN THE GROUND THAT CAN BE AFFECTED BY THE DETECTOR'S ELECTROMAGNETIC FIELD. THIS INCLUDES NOT ONLY METAL SUCH AS GOLD, SILVER, AND IRON BUT **ALSO SOME IRON EARTH MATERIALS!** Thus, what you hear when a TR sounds off is a COMBINED SIGNAL, THAT IS CAUSED BY THE RETURN SIGNALS FROM BOTH SOLID METALS, AS WELL AS IRON EARTH MATERIALS.

You should now realize why your TR is more difficult to operate over iron mineralized ground than over ground that does not contain iron earth minerals. The detector is actually "detecting" the natural iron in the ground! This is where the VLF comes into action. Its electronic circuits can be made to be "blind" to the signals that return from the "slower" earth's natural iron minerals.

Remember that we said that the field from the solid metal reaches the receiver coil when the hand is at 6 o'clock. THE VLF "TAKES" THESE SIGNALS BUT THEN "TURNS OFF ITS RECEIVER CIRCUITRY" SO THAT THE DETECTOR DOES NOT "SEE" THE SLOWER SIGNALS THAT COME BACK FROM IRON EARTH MATERIALS. NOW, YOU SHOULD BE ABLE TO UNDERSTAND BETTER WHY THE VLF DETECTS METAL BUT DOES NOT DETECT IRON EARTH MINERALS! The detector simply looks for the first return signals and then it closes its electronic "eye" so that it won't see any more signals until the next cycle of signals start coming back up from the buried metal.

You might be asking why the standard higher frequency detectors cannot be made to cancel iron earth minerals. Actually, they can, but their sensitivity (how deeply they will detect) is very poor. At the very low frequencies sensitivity becomes fantastically good. That is, in itself, a long detailed story so we will not discuss it here.

Basically, and quite simply stated, VLF instruments can be made so that they do not “see” the slower return signals that come up from iron earth materials. On all VLF instruments there is provided a “Ground Zero Control” that lets you adjust the detector for best operation over all “strengths” of iron minerals. Some ground contains greater concentrations of iron minerals than others. Because of this varying iron mineral density, an adjustment must be provided.

(Okay, I will go on record here, explaining this ground zero control. What it does, basically, is adjust around the “center” between minerals and metals. It is a center point, or center position, that used to commonly be called the “zero null point or position”. So what he was saying here is that one can have an “additional” discrimination circuit, with a adjustable control, that adjusts the detector into or out of the “zero position”, that is the “separation point” between minerals and metals. Normally if you turn to the left, you adjust from the zero position, “into” mineral tuning. And on the opposite, if you turn to the right, you adjust the zero position “into” the metal tuning. Most discriminators work somewhere “within” the metal range. If you have a detector, that can tune into the “zero position”, then back “slightly positive” into the metal mode, it will have its greatest sensitivy at that location.)

If any of you have carried your VLF to the beach you may have noticed that you could not “zero out” the wetted sands. (Commonly also called wet salts in the wet beach sands). That is because the sands contain salt and when wet the salt solution becomes electrically conductive just like metal. The return signals from the salt solution reach the detector’s receiver coil at the same time as the metal signals. That is why the VLF can “zero out” or cancel ONLY IRON GROUND MINERALIZATION.

You may have asked by now why VLF instruments cannot be made to discriminate. (That was then, they can discriminate today, as they have slightly better designed VLF discrimination circuits). The reason is that return signals from iron travel at approximately the same speed and reach the detector coil at about the same time gold and silver signals reach the coil. They cannot be separated using this particular detecting method. There are ways this can be accomplished but it is extremely difficult to do AND NOT LOSE SENSITIVITY AND A FEW OTHER IMPORTANT FEATURES. A year ago we developed a VLF ground canceling, discriminating detector in the Garrett research laboratory. We know it would reject small pieces of iron.

I took the detector to Idaho and Washington State where some of the “toughest” minerals on earth are to be found, I believe. I tested the detector thoroughly and found that it worked perfectly. It worked perfectly over extremely dense iron earth mineralization. It had super depth on coins and other precious metals. It was not in the least affected by bottlecaps and aluminum pulltabs. It is, however, detect small pieces of iron such as nails. (Now here, I wish to comment on the Compass Coin Magnum. It also did this very same thing, it was able to detect in discriminate mode, as deeply as the all metal mode, but was so sensitive that it detected small iron nails, as deeply as 10 inches. It used a blanking circuit, to blank out the surface trash, thus went deeper in the ground. It also ground canceled iron minerals while it discriminated!).

I made the decision, at that time, not to place the instrument on the market. Even though it had extreme depth detecting capabilities and would reject bottlecaps and aluminum pulltabs perfectly, I believed that further investigation into other methods should continue to determine if a better method might be found.

In the next issue of the National Treasure Hunter’s League Magazine I will continue this discussion of the VLF. Just how good and how sensitive are these new instruments? What are their limitations? Are the TR and BFO instruments till needed? These and other questions we’ll delve into next time.

If you would like a better understanding of all types of detectors, including the VLF’s, I suggest you read this series of articles. It will increase your knowledge of detectors tremendously... and, how can it fail to increase your abilities with detectors? Till next time, God bless you and HAPPY HUNTING!
Charles Garrett
(Note: I received the next issue, but the article was not there. Then my subscription to the magazine seemed to end for some reason, perhaps due to the death of Ray Smith, owner of NTHL. If anyone has a copy of this future article, I really would like a copy of it. Thanks...)

NEW... FROM GARRETT

THE MASTER HUNTER DS VLF/TR Discriminator

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CO-AXIAL
SEARCHCOIL

Twin Circuit DEEPSEEKING DETECTOR

14-inch 4B Faraday-shielded searchcoil.

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