

# Metal Detectors

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# Types/Applications

## ► Type:

- Very Low Frequency
- Pulse Induction
- Beat Frequency Oscillator

## ► Applications:

- VLF (below 30kHz): is the most popular detection technology at the present time
- Limited in urban areas as PI is unable to reject ferrous (iron) trash
- Ideal under extreme conditions such as salt water beaches and highly mineralized ground
- Good choice for beginning hobbyists or children as they are cheap and easy to make

# Theory

- ▶ According to Faraday's law, the emf induced in the pick-up coil is

$$\varepsilon = - N_p d\Phi/dt$$

- ▶ Magnetic Field at center of field coil is

$$B = N_f \mu_0 I(t)/(2R_f)$$

- ▶ This creates a flux in the pick-up coil:

$$\Phi = ( R_p^2 ) N_f \mu_0 I(t)/(2R_f )$$

# Very Low Frequency (VLF)

- ▶ Uses two coils:
  - -Transmitter coil (search head, antenna)
  - -Receiver coil
- ▶ There is a delay in the received signal compared to the transmitted signal called phase shift
  - -Resistive materials (small phase shift)
  - -Inductive materials (large phase shift)
  - -Ferromagnetic materials (little phase shift)
- ▶ The signal is sent to the control box where it is analyzed by sensors



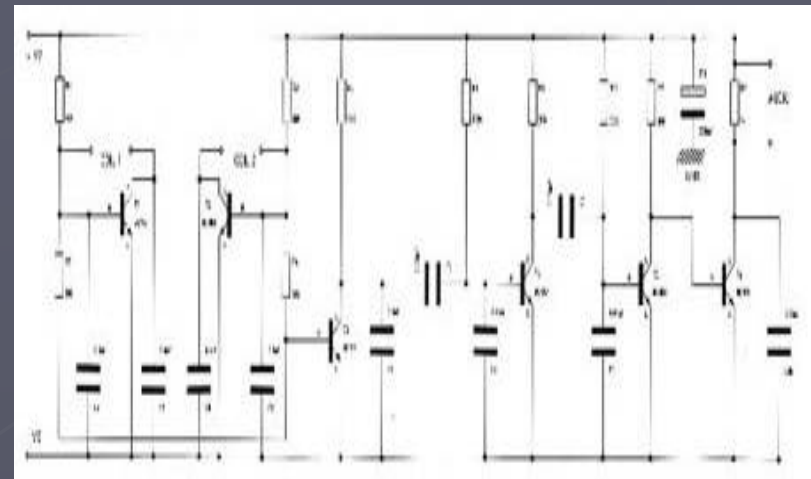
# Pulse Induction (PI)

- ▶ Simple when compared to VLF detectors
- ▶ Advantages/Disadvantages
- ▶ Generates "Pulses" of Current Through Search Coil
  - Magnetic Field Generated:
    - ▶ Pulse reaches its peak and reverses direction, collapsing very suddenly, thus creating a sharp electrical spike.
    - ▶ Pulses continue to be generated from a mere dozen to about a few thousand pulses per second.
  - Detection of Desired Targets:
    - ▶ Reflected portion of signal becomes delayed which is sampled, amplified, and sent to audio circuit to notify user.
    - ▶ Manual vs. Automatic Tuning



# Beat Frequency Oscillator (BFO)

- ▶ Uses two coils and sends a current through each
- ▶ Coils use slightly different frequencies, which produces audible "beats"
- ▶ When passed over metal object, induces a current in object
- ▶ Current causes a magnetic field, which interferes with field produced by detector
- ▶ Interference changes frequency of current in large coil, and thus an audible change in "beats"
- ▶ BFO Metal Detectors are cheap to make, but aren't as accurate or dependable as more expensive types



## How BFO Metal Detectors Work



# References

- ▶ [http://www.mines.edu/~jamcneil/TPT\\_MetaIDetector.pdf](http://www.mines.edu/~jamcneil/TPT_MetaIDetector.pdf)
- ▶ <http://www.gi.alaska.edu/~jesse/treasure/misc/howdetector.html>
- ▶ <http://electronics.howstuffworks.com/metal-detector.htm>