



Global Academy of Technology

Department Of Electronics and Communication Engineering



Report On

FIELD THEORY

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TITLE: METAL DETECTOR

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ABSTRACT:

- The concept behind this project of “Metal Detector” is to ensure avoiding any illegal or unauthorized entry of metallic objects, bombs, knives, guns within the luggage bags of the person carrying them in public places like theatres, shopping malls, parks, airports, hotels, railway stations etc.
- It is a low-cost metal detector using a transistor circuit.
- It is a in simple words A Colpitts oscillator working in the medium band frequency.
- This project gives an overview of metal detector working principle and applications.

CONTENTS:

- 1) Introduction
- 2) Principle of Operation
- 3) Block Diagram
- 4) List of Components
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INTRODUCTION:

What is Metal Detector?

A metal detector is an electronic device.

- An oscillator which produces AC current that passes through a coil producing an alternating magnetic field.
- A part of the metal is near to the coil; eddy current will be induced in the metal. This produces a magnetic field of its own.
- If an extra coil is used to measure the magnetic field, the magnetic field can be changed and sensed due to the metal object.



PRINCIPLE OF OPERATION:

The operation of metal detectors is based upon the principles of electromagnetic induction.

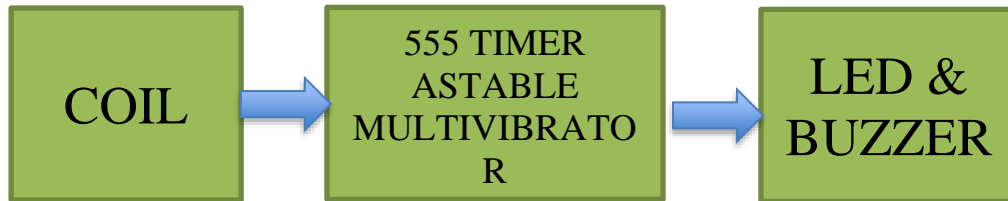
Metal detectors contain one or more inductor coils that are used to interact with metallic elements on the ground.

A pulsing current is applied to the coil, which then induces a magnetic field.

When the magnetic field of the coil moves across metal, the field induces electric currents (called eddy currents) in the metal.

The eddy currents induce their own magnetic field, which generates an opposite current in the coil, which induces and a signal indicates the presence of metal.

BLOCK DIAGRAM:



- First the search head or the coil is made to interact with the metal and then the oscillator fails to maintain the frequency, hence the metal is detected.
- Then the signal is amplified and given to LED and Buzzer to indicate the presence of a metal.
- Only those metal can be detected which can change the frequency to RF range

LIST OF COMPONENTS:

1. RESISTOR

$R=47k\Omega$

2. CAPACITOR

$C1= C2= 2.2\mu F$

$C3=10 \mu F$

3. DETECTOR COIL

- The electromagnetic field can be transferred by the search coil of the detector into the ground & receives the electromagnetic field return from a metal object.

4. BUZZER

- When the metal detector detects the metal object, then it generates an audible sound like a beep.
- A siren, horn, or bell may also be used.
- Other commonly used alarm devices are buzzers; flag drop markers

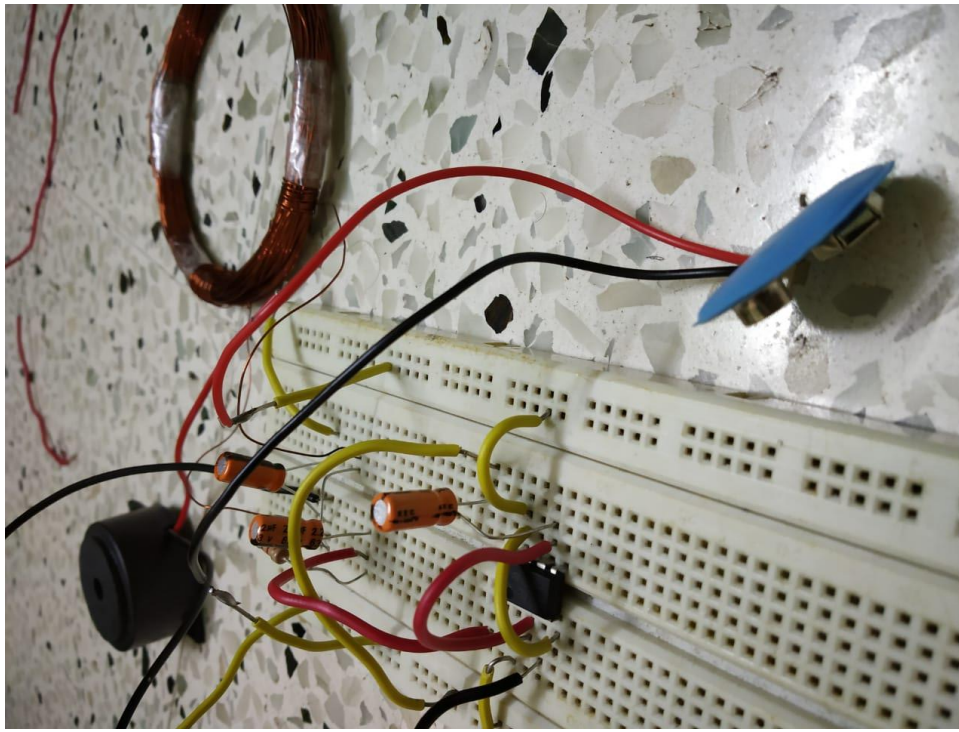
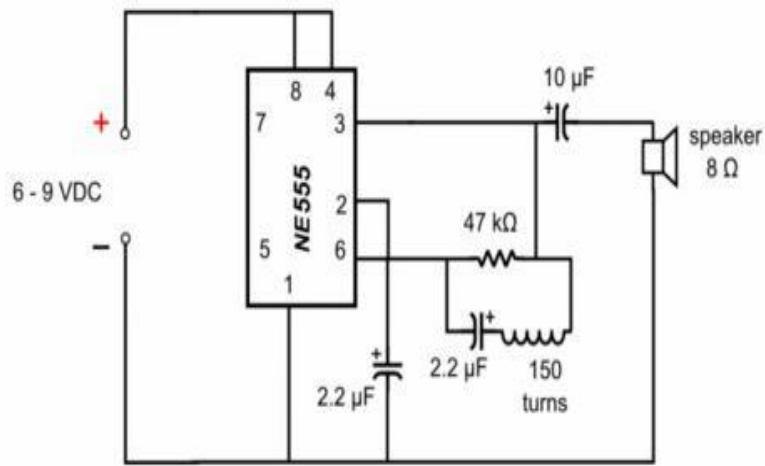
5. POWER SUPPLY

- The main purpose of the battery is to provide the power to the detector / Circuit.

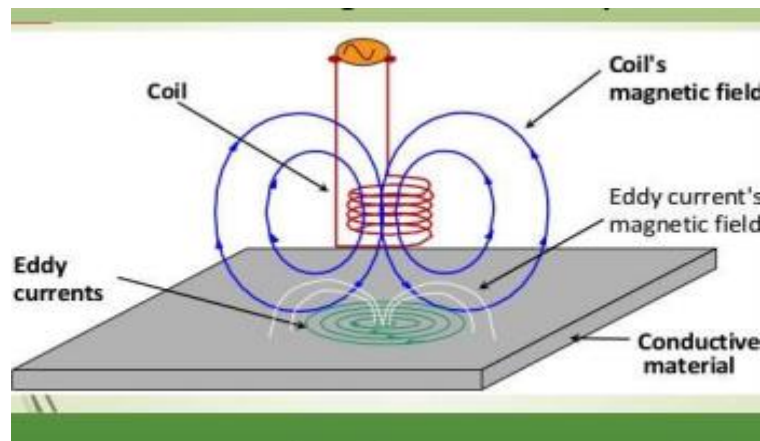
6. 555 Timer

- The **555 timer IC** is an integrated circuit (chip) used in a variety of **timer**, delay, pulse generation, and oscillator applications

CIRCUIT DIAGRAM:



WORKING OF CIRCUIT



- Initially the circuit is tuned to a fixed resonating frequency decided by the combination of capacitance (C_1 & C_2) and Inductance (L) value.
- A metal detector consists of a NE555 which is configured as an astable multivibrator this is the configuration which is an alternative to COLPITTS OSCILLATOR which produces current in the copper coil & hence a magnetic field is produced around it. (BLUE LINES)
- When the metal detector circuit is placed near to a metal object, these rapidly changing magnetic field lines (due to current flowing in the coil) penetrate through metal's surface & produces circulating currents called "Eddy currents" on the metal surface. (GREEN LINES)
- This eddy currents will create its "own new magnetic field" that affects the original one. (WHITE LINES)
- Metal detectors can contain 1 or more, Inductor coils (Copper coils) used to interact with metallic elements.
- Now the two frequency will be different & thus the oscillator fails to maintain the original resonating frequency.
- This Reverse magnetic energy is absorbed back changes the Inductance of the copper coil and so do the frequency of oscillations.
- Then the pulse width of the signal is decreased, hence the Buzzer starts beeping faster than usual.

EXAMPLE: DETECTION OF A COIN

- A pulsing current is applied to the coil, which then induces a magnetic field shown in blue.
- When the magnetic field of the coil moves across metal, the field induces electric currents in the coin.
- These eddy currents induce their own magnetic field (RED LINES) which generates an opposite current in the coil, which induces a signal indicating the presence of metal.
- The portion of the reverse magnetic field (RED LINES) that intersects the detector coil winding (BLUE LINES) causes a detection signal to occur in that winding. Thus, the detector alerts the operator that metal has been detected.

TYPES OF METALS

- The Sensitivity of a metal detector is NOT the same for all types of metal.
- **Ferrous:**
 - 1) Metal that can easily be attracted to a magnet comes in this field.
 - 2) Easiest metal to detect.
 - 3) E.g. Steel, iron, etc.
- **Non-Ferrous:**
 - 1) Highly conductive non-magnetic metals.
 - 2) Moderate to detect and are very good conductors.
 - 3) E.g. copper, aluminum, brass, etc.
- **Non-Magnetic Stainless Steel:**
 - 1) Most difficult metals to detect.
 - 2) Poor electrical conductivity
 - 3) Low magnetic permeability
 - 4) E.g. Wood, Rubber

APPLICATIONS:

- Airport and Building Security.

To check whether guns, knives, or other weapons are being transported.

- In Civil Engineering

Metal detector are used to locate “Rebar” (strengthen steel used as rod in concrete).
Detectors can only locate metallic objects below the surface.

- Land mine detector

Military has used metal detector to pinpoint buried land mines since world war 1.

- In Construction industry

To detect steel reinforcing bars in Wires, Concrete, Pipes buried inside floors and walls.

In Geological research. & Archaeological exploration

To find: -

- 1) Coins
- 2) Rings,
- 3) Jewelry,
- 4) Gold
- 5) Small buried caches and even deep treasures



ADVANTAGES:

- (1) Circuit diagram is very simple.
- (2) We can easily measure the oscillation Resonant frequency of this circuit.
- (3) Instead of fixed capacitor value, we can also use variable capacitor for tuning purposes.

DISADVANTAGES:

- (1) It has less sensitivity
- (2) Even the detectors with good coil compensation could not always detect the smaller target to the required depth

Bibliography:

- YouTube
- Goggle
- Wikipedia
- Field theory text book

CONCLUSION:

- This project has been developed considering the need for low cost.
- The equipment is compact, simple in design and can be used practically anywhere needs.
- This circuit may also be constructed by using chip CS209A or 555 Timer

*Thank
you*

