FINAL PROJECT REPORT

METAL DETECTORS

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FALL 2020

EE 314

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ACKNOWLEDGEMENT

I would like to thank Dr. Mani Mina for providing us the platform to study more about several topics in electrical like electromagnetism, Theory of relativity, Quantum computing, Quantum Entanglement, Quantum Mechanics, Modern Physics, Black body radiation, Einstein's life and his theories.

I would like to thank Iowa State University for providing us the opportunity to take this class and make the class environment suitable.

Even during these uncertain circumstances, the classes have gone smoothly and efficiently.

I would also like to thank my family without whom I wouldn't be here. Therefore, I am thankful for this platform.

Sincerely,

Priyanka Kadaganchi

ABSTRACT

The idea of this project with the help of the sensors it can detect any kind of metal. Whenever some kind of metal material is near the sensor there will be a sound letting us know that there is something that has metals and whenever the metal is removed the sound is turned off.

I thought of this project as it is a very interesting phenomena of detecting things. Metal Detectors work on the principle of transmitting a magnetic field and analyzing a return signal from the target and environment. The magnetic flux passes through some objects such as Plastics, clothes, handbags, back packs and detect any metal objects.

INTRODUCTION

HISTORY

Many scientists and engineers were trying to make a devise or a machine that would pinpoint metal. And Early machines were mostly crude and used a lot of battery power. In 1874, Gustave Trouve developed a handheld device for locating and extracting metal objects such as bullets from human patients. This inspired Graham bell and in 1881, Alexander Graham Bell was the first who created the metal detector and Fisher issued the original patent on one while many made many advances on it later in the year. Bell invented this to save President James Garfield who laid dying of an assassin's bullet. Bell hurriedly invented a crude metal detector in an unsuccessful effort to find the shell.

Metal detectors were first used extensively in 1960s for mineral prospecting and other industrial applications.

About Alexander Graham Bell

Alexander Graham Bell was a Scottish-born inventor, scientist, and engineer who is credited with inventing and patenting the first practical telephone. He was born in Edinburg, United Kingdom. He also co-founded the American Telephone and Telegraph Company in 1885. Fun

fact: His daughter's name was Margaret Hello and those were his first words when he called through the telephone he had made.

DEFINITION

A metal detector is an electronic instrument that detects the presence of metal nearby.
Metal detectors measure metal by using electromagnetic induction. Uses include demining (land mine detection), the detection of weapons such as knives and weapons, Geophysical prospecting, archaeology and treasure searching, especially at airports. About Metal Detectors are also used in the food industry and in the building industry to track foreign bodies. Detect steel retention bars that are buried in walls and floors in asphalt and pipes and cables.

PURPOSE

Metal detectors are useful for finding metal inclusions hidden within objects or buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone or a needle moving as an indicator.

Another common type is "walk through" metal detectors used in airports, or entry in malls, or some large gathering, prison, courthouses. This is to check of the person is carrying or hiding something dangerous or concealed metal weapons on a person's body.

MODERN DEVELOPMENT and PHYSICS

In the 1930s, the industrial invention of the metal detector began. Gerhard Fisher also developed a radio direction-finding system that was to be used for precise navigation. The framework

performed exceptionally well but in areas where the landscape included ore-bearing rocks, Fisher found that there were irregularities. He proposed that if metal could distort a radio beam, then a computer that would detect metal using a search coil resonating at a radio frequency should be built. He filed for, and won, the first patent for a metal detector in 1937. However, during the early years of World War II, it was Lieutenant Josef Stanislaw Kosacki, a Polish officer attached to a unit stationed in St Andrews, Fife, Scotland, who refined the concept into a practical detector. They were large, they operated on vacuum tubes, and separate battery packs were needed.

During the Second battle of El Alamein, when 500 units were transported to Field Marshal Montgomery to clear the minefields of the retreating Germans and later used during the allied version of Sicily and the allied invasion of Italy and invasion of Normandy – the design created by Stanislaw was widely used during the clearing of the minefields that were set up by the Germans. The understanding that Stanislaw developed the first practical metal detector was kept secret for over 50 years, since it was a wartime research operation to develop and refine the nature of the detector. There were tons of surplus mine detectors on the market after the war; they were purchased for fun and benefit by relic hunters who used them. This helped to turn metal identification into a hobby.

Now let's talk about some physics - The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically through a coil producing an alternating magnetic field. If a piece of electronically conductive metal is close to the coil, eddy current will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field due to the metallic object can be detected.

Future detectors

Modern top models are fully computerized, using microchip technology to allow the user to set sensitivity, discrimination, track speed, threshold volume, notch filters, etc., and hold these parameters in memory for future use. Compared to just a decade ago, detectors are lighter, deeper seeking, use less battery power, and discriminate better. New genres of metal detector have made their appearance. BB (Beat Balance) and CCO (Coil Coupled Operation) were unveiled by the electronics press in 2004. Both were invented by electronics writer and designer Thomas Scarborough and combine unprecedented simplicity with good sensitivity.

Discriminators

Technological developments were also increasingly taking place, and very few of the smaller businesses were able to survive in contact with the major outfits. The production of hobby machines has been discontinued by GOLDAK, METROTECH, IGWT, TEC and very recently, ARADO. Some metal detecting devotees still treasure their Arado machines, which were considered to be hard to set up but reputed to be the deepest-seeking hobby detectors ever made. The invention of the induction-balance system, where two coils are set up in an electrical equilibrium to create a 'empty' or negative balance, was the most critical technological improvement in detectors. Introducing metal to the proximity of the coils caused them to unbalance, causing a shift in sound in the speaker of the unit. Scientists have long understood that any metal, by alternating current, has a particular response to stimulation. In its induced current, each metal creates a time lag or 'step angle'.

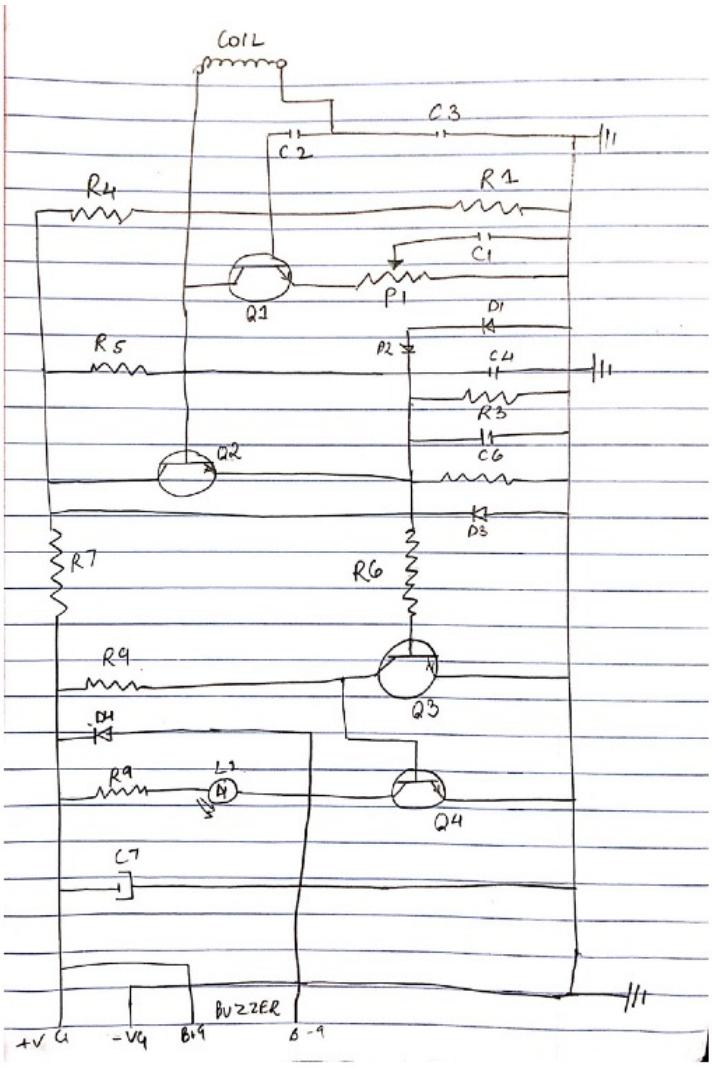
This meant that it was now possible to set up detectors to disregard undesirable phase angles and react only to preferred metals positively. But the creation of the 'discriminator' detectors had a drawback as well. The implementation of discrimination often had the impact of lowering the sensitivity of the system, because it was less capable of identifying deep objects. In addition, there was the fact that the region of undesirable metals such as copper, was very similar to other desirable metals. In the overall continuum, gold, particularly in alloy type, was very similar to tinfoil, so the discrimination control had to be used carefully. The price to be charged for setting up a detector to disregard iron and tinfoil was the risk of the customer searching over and missing a desirable discovery sooner or later-maybe a diamond engagement ring on a beach.

New coil designs:

Coil designers also tried out innovative designs. The original Induction Balance coil system consisted of two identical coils placed on top of one another. Compass Electronics produced a new design; the two coils were made in a D shape and were mounted back-to-back to form a circle. This system was widely used in the 1970s, and both concentric and D type (or Wide scan as they became known) had their fans. Another development was the invention of detectors, which could cancel out mineralization in the ground. This gave greater depth but was a non-discriminate mode. It worked best at lower frequencies than those used before, and frequencies of 3 to 20 kHz were found to produce the best results. Many detectors in the 1970s had a switch that enabled the user to switch between the discriminate mode and the non-discriminate mode. Later developments switched electronically between both modes. The induction balance detector development would ultimately result in the Motion detector, which frequently checked and balanced the background mineralization.

METAL DETECTOR

Circuit diagram of Metal detector:



This is the circuit diagram of the concept that will work as a metal detector. It consists of resistors, transistors, buzzer which is a loud speaker, LED, diodes, oscillators, inductors, capacitors, PCB – Printed circuit board, TDA 2822. These components will be used to complete this project. I have explained later about these components in more detail.

Working:

Now we will focus on the working of the circuit diagram that was mentioned above. It is quite a straightforward circuit to understand. It works on the principle of super Heterodyne. It consists of two oscillators. One is Colpitts oscillator, and the other has a ceramic filter, which is commonly used in the intermediate frequency sound section on TV. Both frequencies combine to mixer [transistor (T2)] and from the transistor T2 of the collector is taken out and given the two diodes known as detector stage and then to the filter and then to IC (TDA 2822) which is a stereo amplifier which amplifies to the loudspeaker.

The first oscillator is fixed at 5.5Mhz, and the other oscillator is known as Colpitts trimmer. Then the capacitance is changed by varying the capacitance called trimmer. The capacitance is then altered by varying the capacitance of the capacitor before varying to see that no metal is in contact with the inductor. After changing the capacitance, the two frequencies are equal; hence there is no sound. When any metal is bought under the contact of the frequency (Colpitts oscillator) changes hence the difference of the frequency is taken, and therefore, there is an output. This output is amplified and given to the speaker.

Different characteristics:

1. Resistor

It is defined as the opposition to the flow of current.

Resistance is the property of a resistor which opposes the flow of electrons through it.

It is measured in Ohms and is indicated by letter R.

2. Diode

It is an semiconductor device which allows the flow of current in one direction and opposes in the other direction.

3. Semi-conductor Diode:

A semiconductor diode allows current to flow easily in one direction but not in the other. It's resistance is low conducting direction but very high in the opposite direction. A diode has two terminals, the anode and the cathode.

4. Transistor

Transistor is three terminal semi-conductor devices consist of emitter, base and collector. Transistor has two junctions namely:

a. Emitter base junction- it is forward bias
b. Collector base junction – it is reverse bias

Transistor has two diodes that are connected back to back. One is transistor N- type and P-type. Biasing of the transistor happens for an active mode.

I. Transistor application:

1. It is widely used as an amplifier.
2. Transistor is used as a buffered to match high impedance to low impedance.
3. It is also used as a switch.
4. It is used in clipping and clamping circuits.
5. It is used in active filters

6. It is used in digital circuits.
7. It is used in square wave generation circuits called multivibrators.
8. They are also used in oscillators like Colpitts (which have been used in this project), Hartley, wein bridge and phase shift oscillators.

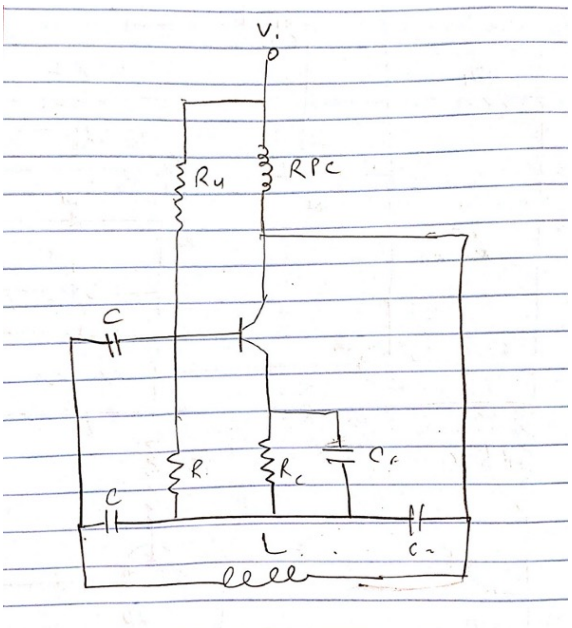
5. Oscillators

Many electronic devices require a source of energy at specific frequency which may range from a few Hz to several MHz. This is achieved by an electronic device called an oscillator. Although it generates a frequency, it should be noted that it doesn't create energy.
Oscillators are extensively used in electronic equipment. For example, in radio and TV receivers' oximeters are used to generate higher frequency wave called carrier wave. Audio frequency and radio frequency signals are required for the repair of radio, TV and electronic equipment. Oscillators are also widely used in radar, computers and other electronic devices.

Oscillators can provide sinusoidal or no sinusoidal waves. An amplifier has to satisfy the barkhausen criterion so as to walk as an oscillator.

Colpitts's Oscillator

It is also an LC oscillator used to generate RF signals.



LC OSCILLATORS are used in:

1. Radio and TV receivers as load oscillator.
2. For induction and dielectric heating purposes.
3. For high frequency applications.

6. MICRO PHONES

Micro phone here used are transducers for converting sound energy into electrical energy. They serve two purposes they are used to convert speech signals into electrical signals and serve as measuring instruments converting sound signals into electrical current with accurate indicating meters.

7. Loud speakers

A loud speaker is an electro magnetic transducer for converting electrical signals into sounds. There are two types in one the vibrating surface called diaphragm radiates sound directly into air and the second in which a horn is interposed between diaphragm and the air.

8. Inductor

The relation between electricity and magnetism was discovered by Oersted in 1824. An inductor in a coil of wire with core of either air or magnetic material such as iron. The inductors oppose currents are said to have inductance.

The behavior of an inductor can be observed by the following example:

Inductive behavior:

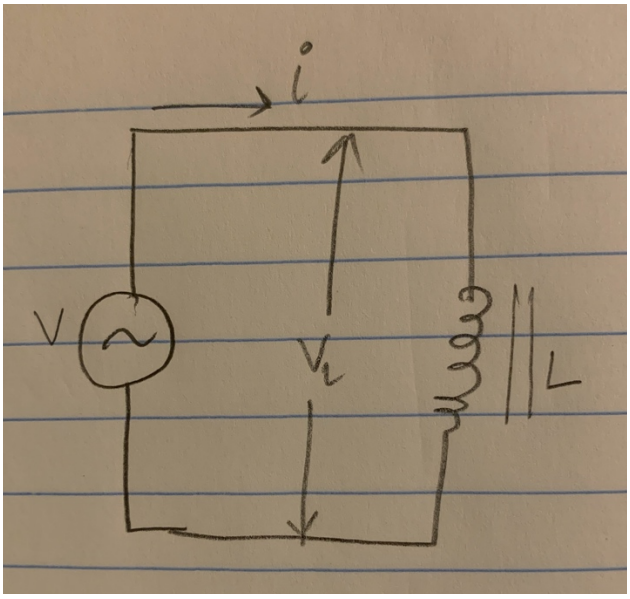
The rheostat is first adjusted so that the lamps reach the same brightness when the switch is on DC, the resistance are of the rheostat then equals the resistance of the inductors. If the switch is opened and closed again, the lamp L1 one lights up a second or two after the L2 to the inductor which is in series with the L delays the rise of the DC to study value because of its inductance.

If 3 V battery is replaced by a 3 V AC supply the lamp and never lights up because the current is charging all the time. However, it does light if the inductance is ready used by removing the iron core.

To sum up, and inductor allows DC to flow but opposes AC it has the opposite effect to a capacitor. In order to understand how an inductor walks we need to understand when a conductor is in a charging magnetic field of a voltage is produced in it. This phenomenon can be done by pushing and withdrawing the magnet to the inside of the coil, the magnetic field is changed hands of voltage is induced. The ability of this is known as coil inductance. It can be explained into two ways that is self inductance and mutual inductance.

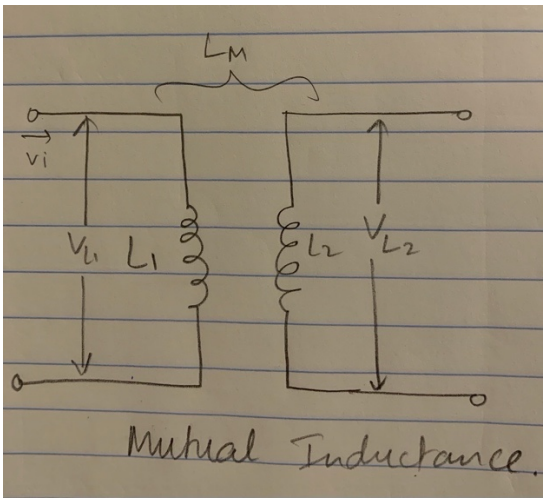
Self Inductance:

It is the ability of a conductor to induce voltage in itself when current changes. It is denoted by a L the self induced voltage V_L across an inductor is shown in the figure.



Mutual inductance

When two coils are placed closed in such a way that the flux produced in one coil cuts into the other, then these two coils are said to be magnetically coupled.



9. Capacitor

Capacitor is an electronic component which exhibits the property or capacitance. The electronic components can store electric charge are called capacitor. The property of a capacitance is known as capacitance.

Capacitor characteristics:

Three main characteristics of dielectric medium influence t3he physical form of capacitor.

1. Dielectric constant
2. Dielectric strength
3. Power factor

10. Equalizers (Ceramic Filter)

Electric circuit exhibit non uniform attenuation and phase delay with variation in frequency. It is not desirable in circuits as it amounts to distortion of signals in a working frequency range under ideal conditions the attenuation and phase delay must be the same in the entire frequency range. Equalizers are circuits designed and used to obtain overall uniform response of the total working frequency range.

DISTINCTION BETWEEN SERIES AND SHUNT EQUALIZERS:

The series equalizer is connected in series with the sending or receiving end of the network to be corrected. It is in series with the load also. The Shunt equalizer is connected in shunt with the sending or receiving end of the network to be equalized now.

11. TDA 2822

The TDA 2822 is a versatile dual amplifier that can use any DC supply in the range between 1.8V to 15V, it can be powered from a 3V supply and used to drive headphones ones at 20 mw per 32 ohm channel or from a 9V supply and used to drive 8 ohm speaker at 1 w per channel.

12.Printer Circuit Board – (PCB)

PCB's are the most important element in the fabrication of electronic equipment. PCB's determines many of the limiting properties with respect to fast pulse, high frequency and low-level equipment.

The layout of a PCB has to incorporate all the information on the board before one can go to the preparation. This means that a concept that clearly defines all the details of the circuit also have the final equipment is a prerequisite before the actual layout can start start.

13.Soldering of components:

Pace the components on a PCB properly according to a component layout and solder the components taking proper care.

14. Testing

I am positive if the project was solved in practical it would have worked. With the help of multi meter we can check the conductor track and prepare soldering.

PRECAUTIONS

1. Care should be taken while copying the circuit on to the copper clad.
2. While etching the PCB it should not go on either under etched or over etched.
3. While drawing the PCB layout the original track thickness should be thin. The power supply track should be medium thick, and the ground track should be very thick.
4. The number of tracks and pads should be minimized.
5. Discontinuities should not be there between pad and conducting paths.
6. Usage of jumpers should be minimized.
7. Avoid short circuits.
8. After the unwanted copper is removed the etching process should be stopped.
9. Avoid dry soldering
10. Avoid loose connection.

Results

The project is completed successfully on the paper. Did not get a chance to solve it practically. On placing the metal near the sensor (inductor) sound is produced and sound is stopped when metal is removed.

This is all the theory I could think of and planned how the execution of the project

COMPONENTS LIST

There were the components that were used to make the circuit of the metal detector.

Resistors:

330 Ω (1), 330kΩ (5), 1kΩ (5), 10kΩ (5).

Variable Resistor Log:

10kΩ (1), 4.7Ω (2).

Capacitors

Trimmer 0 – 22 pF (1), 100µf 25V (2), 1µf 16V (1), 10nf (7), 15nF (2), 0.1µf (2), 100nF (2), 100pF (1), 470 pF (1).

Transistors

BF 494 (3)

Diodes

0A79 (2)

Ceramic Filter

5.5MHz (1)

IC

TDA 2822 (1)

Loudspeaker

8Ω , 1w (1)

Inductor 20 turns of (25 SWG) 4" Dia air core (1)

Printed Circuit Board ½ foot square (1)

Conclusion

A metal detector is a device that measures the presence of metal that may not be noticeable because, under garments, bags, etc., it may be concealed. A metal detector's simplest type is an oscillator that creates an alternating current that travels through a coil that induces an alternating magnetic field. A piece of electrically conductive metal is close to the coil; the metal can induce eddy currents, which induces its alternating magnetic field.

Another coil is used to calculate the magnetic field; the magnetic field varies due to the identification of the metallic material.

Constructing a low-cost and accurate metal detector that operates under electromagnetic induction.

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