This report is submitted in partial fulfillment for the Bachelor Degree of Electronic Engineering (Industrial Electronic) is here by approved.

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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : METAL DETECTOR

Sesi Pengajian : 2006/2007

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(HURUF BESAR)
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METAL DETECTOR

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This Report Is Submitted In Partial Fulfillment of Requirements for the Bachelor Degree of Electronic Engineering (Industrial Electronic)

Faculty of Electronic and Computer Engineering
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April 2007

"I here by admit that the paper is my own work except some of the parts which have been cited accordingly."

Signature :.....

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Date : 25/04/2007

I dedicate this book to my parents that give full support to me, also for my beloved friends, Lydiana Angela and Azrina and to my supervisor En. Farid Arafat.

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ABSTRACT

The use of metal detectors to search for archaeological finds is practiced both by archaeologists and hobbyists. The metal detector also can use as security. So for this situation, one device is developing to solve the problem. Metal detector is consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of metal, which is electrically conductive, is close to the coil eddy currents will be induced in the metal, and this produces an alternating magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer) the change in the magnetic field due to the metallic object can be detected. This project is developed to detect metal like iron, coins that lost. This project is based on super heterodyning principle which used the principle of heterodyning (combining two frequencies to create new signals equal to the sum and difference of the original pair).This signal is transmitted to speaker by filter and amplifier.

ABSTRAK

Metal detector digunakan untuk bidand arkeologi, yang diamalkan oleh ahli arkeologi dan sebagai hobi. Pengesan logam boleh juga digunakan sebagai keselamatan. Untuk situasi ini, sati peralatan telah dicipta untuk mengatasi masalah diatas. Pengesan logam mempunyai oscillator yang menghasilkan arus elektrik yang melalui gegelung dah menghasilkan medan magnet. Jika kerulan logam dimana adalah konduktif kepada elektrik, ia lebih dekat kepada gegelung , arus eddy yang mendorong kepada logam dan menghasilkan medan magnetnye sendiri. Jika gegelung lain digunakan untuk mengukur medan magnet, perubahan dalam medan magnet bergantung kepada logam yang dikesan. Projek ini berdasarkan prinsip 'Superheterodyning' dimana prinsip ini adalah gabungan dua frequency untuk menghasilkan satu signal baru yang bersamaan dengan hasil tambah dan perbezaan pasangan asli. Signal ini dihantar kepada speaker melalui filter dan amplifier.

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CHAPTER 1

INTRODUCTION

In this chapter will explain the detail about the project introduction, objective project, scope of work, and problem statement also methodology about this project.

1.1 INTRODUCTION

With the advanced technology, metal detector always upgrade depends on customer wants. Every moment the metal detector will change and upgrade to give the easy way to customers. To give the easy way to customer, the metal detector with super heterodyning principle was developed to give the good way for detect the metal just use the coil. With use super heterodyning principle, the circuit can produced the electromagnetic current with use the Beat frequency Oscillator.

1.2 OBJECTIVES OF THE PROJECT

The objectives of this project are:

1. To design a device which can use to detect metal;
2. To detect metal using coil as an oscillator;
3. To study how to developed the system of metal detect
4. To know about the Beat Frequency Oscillator theory;
5. To study super heterodyning principle.

1.3 SCOPE OF THE PROJECT

For this project, the scopes of the project are:

1) This project is about the device that can detect the metal by using:
   -Super heterodyning principle.
   -Beat Frequency Oscillator.

2) For this project, this metal detector can detect metal object like coins, nails and other metal.

3) This metal detector uses 25 turn coil to detect the metal.

1.4 PROBLEM STATEMENT

1) To implement the theory of super heterodyning to built the metal detector.
2) To combine the two different signal together.
3) To produce the audio when the metal is detect.
4) To use BFO oscillator in the circuit
5) To make the layout using Proteus 6 professional.

CHAPTER 2

LITERATURE REVIEW

2.1 BRIEF HISTORY OF METAL DETECTOR

2.1.1 INTRODUCTION

A metal detector is a portable electronic device which penetrates the ground magnetically in order to find traces of metal. This metal could either be discarded pieces of aluminum or valuable coins, jewelry and other buried treasures. Part of the appeal of metal detecting is this unknown factor, keeping amateurs and professionals on a constant scan for new sources of metal and more promising locations. These devices can usually penetrate sand, soil, wood and other non-metallic substances, making most areas fair game for treasure hunters.

2.1.2 HISTORY

Metal Detector has been around for much longer than most people realize. Towards the end of the 19th century, many scientists and engineers used their growing knowledge of electrical theory in an attempt to devise a machine which would pinpoint metal. The use of such a device to find ore-bearing rocks would give a huge advantage to any miner who employed it. The German physicist Heinrich Wilhelm Dove invented the induction balance system, which was incorporated into metal detectors a hundred years later. Early machines were crude and used a lot of battery power, and only worked to a very limited degree. The Scottish physicist, Alexander Graham Bell, used such a device to attempt to locate a bullet lodged in the back of American President James Garfield in 1881.

2.1.3 DESIGN

For this project, it to analyze the circuit and each component in this circuit.

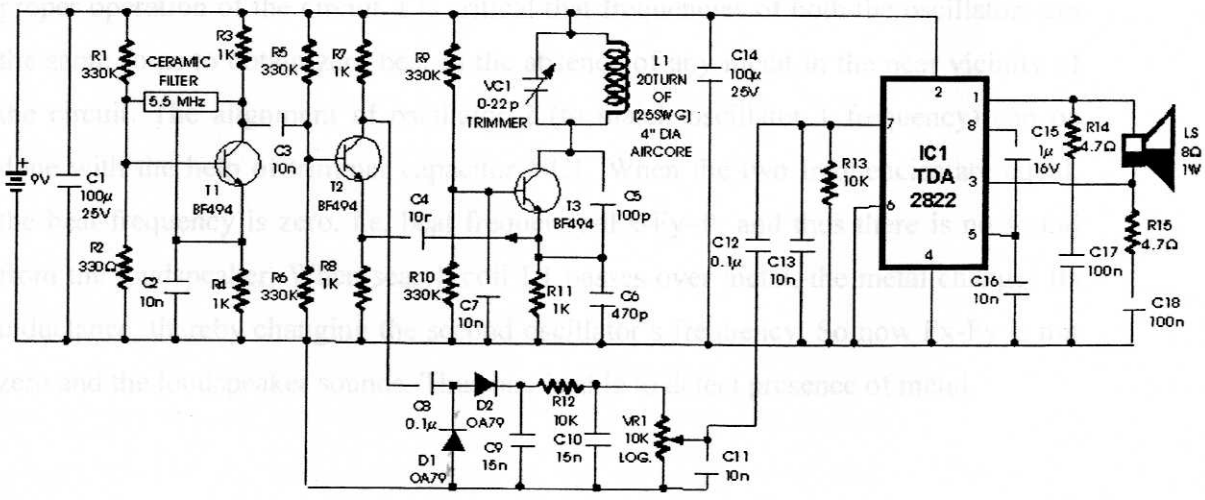

Figure2.1: Metal detector using super heterodyning Principle circuit.

Metal Detector the circuit described here is that of a metal detector. The operation of the circuit is based on super heterodyning principle which is commonly used in superheat receivers. The circuit utilizes two RF oscillators. The frequencies of both oscillators are fixed at 5.5 MHz. The first RF oscillator comprises transistor T1 (BF 494) and a 5.5MHz ceramic filter commonly used in TV sound-IF section. The second oscillator is a Colpitt's oscillator realized with the help of transistor T3 (BF494) and inductor L1 (whose construction details follow) shunted by trimmer capacitor VC1.

These two oscillators' frequencies (say Fx and Fy) are mixed in the mixer transistor T2 (another BF 494) and the difference or the beat frequency (Fx-Fy) output from collector of transistor T2 is connected to detector stage comprising diodes D1 and D2 (both OA 79). The output is a pulsating DC which is passed through a low-pass filter realized with the help of a 10k resistor R12 and two 15nF capacitors C6 and C10. It is then passed to AF amplifier IC1 (2822M) via volume control VR1 and the output is fed to an 8-ohm/1W speaker.

The inductor L1 can be constructed using 15 turns of 25SWG wire on a 10cm (4-inch) diameter air-core former and then cementing it with insulating varnish. For proper operation of the circuit it is critical that frequencies of both the oscillators are the same so as to obtain zero beat in the absence of any metal in the near vicinity of the circuit. The alignment of oscillator 2 (to match oscillator 1 frequency) can be done with the help of trimmer capacitor VC1. When the two frequencies are equal, the beat frequency is zero, i.e. beat frequency=Fx-Fy=0, and thus there is no sound from the loudspeaker. When search coil L1 passes over metal, the metal changes its inductance, thereby changing the second oscillator's frequency. So now Fx-Fy is not zero and the loudspeaker sounds. Thus one is able to detect presence of metal.

2.1.4 Advantages of Using super heterodyning

Now, we easily see that this type of receiver can be constructed, but for what purpose? All we have accomplished is to reduce the frequency to the IF value. We still must process the signal as before. So why are so many receivers using the super heterodyne method? There are three main advantages, depending on the application used for:

- It reduces the signal from very high frequency sources where ordinary components wouldn't work (like in a radar receiver).
- It allows many components to operate at a fixed frequency (IF section) and therefore they can be optimized or made more inexpensively.
- It can be used to improve signal isolation by arithmetic selectivity

2.2 BFO (Beat Frequency Oscillator) Theory

BFO (Beat Frequency Oscillation) - Metal Detectors using BFO technology have two coils of wire, one large coil is located in the search coil of the detector, the other small coil of wire is located within the System Control Pack. Each coil of wire is connected to an oscillator that produces pulses of current. These pulses of current pass through the coils generating radio waves.

A receiver housed within the System Control Pack receives the radio waves and makes a series of tones based upon the frequencies of the radio waves. When the detector search coil passes over a coin or other metal item a magnetic field is created

around the coin or metal item, this magnetic field causes interference with the frequency of the radio waves generated by the search coil and changes the tone produce by the receiver.

Metal Detectors using BFO technology are the ones your likely to get when paying under $100 for, that's right, the cheapies. The BFO technology is the easiest and cheapest to make, thus the prices of the detectors are cheap. The only problem is, BFO technology is very limited when compared to PI and BFO detectors, and the ability to distinguish between junk metals and silver or other coins is very poor.

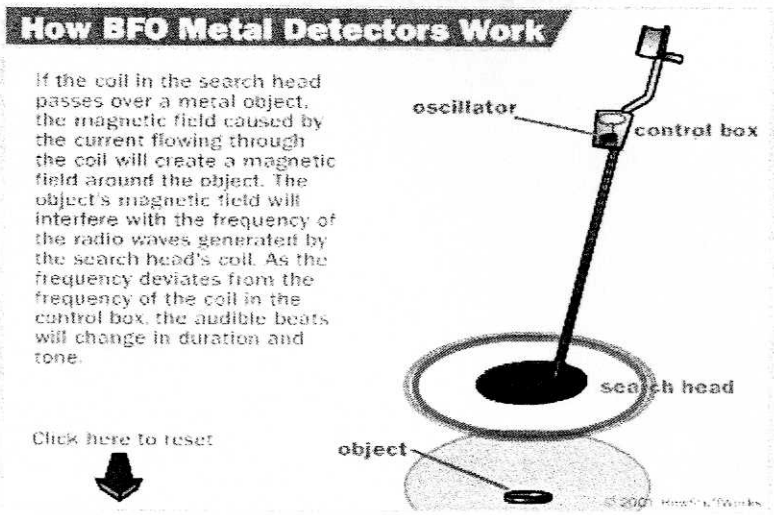

Figure 2.2: BFO theory

2.2.1 Basic System

The basic method of metal location is the BFO principle. (Beat Frequency Oscillator).

It consists of two RF oscillators, usually at about 100 kHz, one of which is fixed in frequency, the other of which employs the search coil as the tuned circuit inductor - so that when a metallic presence affects the inductance of the search coil, that oscillator frequency is slightly altered.

The signals from the search and fixed oscillators are mixed together, to produce sum and difference frequencies in a non-linear device which may be simply a diode, or something more sophisticated.

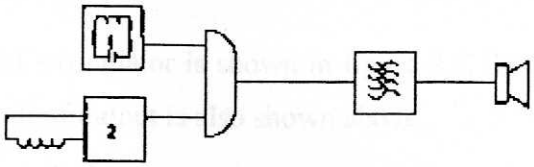

Figure 2.3: Block detail of the BFO system

After mixing, the sum component is filtered out, leaving only the audio component to be amplified and heard by the operator.