Generation Of Unipolar Field For The Control Of Charges

Barnabas Oluwaseyi Alabi, Daniel Iyanuoluwa Oni

Abstract: Electric charge is the property of a matter that allow for electric and magnetic forces interaction. These charges can be controlled by unipolar electromagnetic field. In this study, such unipolar field that can propagate was generated. This unipolar electromagnetic field was simulated and tested for propagation. To produce a propagating unipolar magnetic field, a time-varying unipolar electric current generator was considered. The model considered was simulated in the National Instrument's Multisim windows application environment. The generated electric voltage waveform was viewed via the output 'grapher' of the application. Various loads were connected to ensure consistency in the unipolar waveform for different load value on the generator. The result obtained showed that a unipolar field which could propagate, can be achievable only when the signal involved was properly rectified. After rectification however, the desired waveform and signal was produced. The test for propagation was done using a core of iron and a small solenoid connected to the rectified output and the field produced was magnetic, this attracted a metal clip 1.0 cm away and a larger core attracted a hammer from around 10.0 cm away. The study concluded that a propagating magnetic field useful for the control of charges can be generated if the signal involved is made to be unipolar in nature.

Index Terms: Electrical Charges, Electromagnetic field, National Instrument's Multisim, Rectification, Unipolar Electromagnetic Field.

1 INTRODUCTION

Electric charge is the property of a matter that allow for electric and magnetic forces and interaction. These charges can be controlled by unipolar electromagnetic field. Unipolar waveform's polarity does not change with time while a bipolar waveform is one which changes polarity with time, i.e. like sine wave, its polarity changes as time changes. The polarity of a unipolar waveform does not cross the zero horizontal line. Metals consists of different elements whose atoms are charged. The property of magnetism and or electricity in them makes them useful for various purposes, as conductors, insulators, electromagnets, deflectors etc. However, to control the charges, a propagating dc magnetic field is needed. Signals generated, propagated and transmitted in the wide electromagnetic spectrum are normally full wave, non-rectified, sinusoidal and usually their waveform is bipolar in nature [1] [2]. Taking a cue from the possibility of creating unipolar DC electric field, this work considered the principle therein, and thus developed a model for the generation of a unipolar Electromagnetic wave signal, simulated an electromagnetic wave generator and tested for the propagation of a unipolar electromagnetic field (DC magnetic field) for the control of charges.

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2 REVIEW OF RELATED CONCEPT

2.1 Concept of Electromagnetic Field

[3] described an electromagnetic field as physical field produced by electrically charged objects and it affects the behavior of charged objects in the vicinity of the field either near or far. The electromagnetic field extends indefinitely throughout space and generally describes the electromagnetic interaction. Electromagnetic field can be viewed as the combination of an electric field and a magnetic field as shown in Figure 1. The electric field can be produced by stationary and moving charges while the magnetic field is a secondary effect produced by moving charges. These two (i.e. the stationary charges and the moving charges) are often described as the sources of the field.

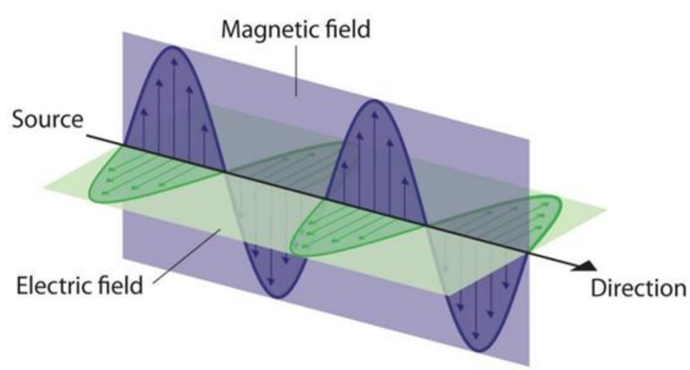

Figure 1. *The Nature of Electromagnetic Radiation [4]*

The way in which charges and currents interact with the electromagnetic field is described by Maxwell's equations and the Lorentz force law. Maxwell found that all electrical signals propagate with an electric field and an associated magnetic field. His Equations in 2.1 to 2.4 shows that a change in the electric field with respect to time causes a change in the magnetic field with respect to distance [5]. This change in magnetic field causes a change in the electric field, and a change in electric field causes a change in magnetic field, this continues in that order, making the wave to propagate [6]. Michael Faraday and Joseph Henry, independently, were the first to discover electrical induction media and lines of force and developed a mathematical relationship between them. This is known as Faraday's law and it is expressed in Equation 2.1. Faraday's law shows that a changing magnetic field induces an electric field proportional to the rate of change and vice versa. Maxwell further developed the ideas of Ampere circuital law and Gauss law to produce two other Equations in 2.2 and 2.3. Ampere's law shows that a current produces a magnetic field proportional to the total current and Gauss' law shows that the total electric flux density from a closed surface equals the total charge enclosed. Maxwell then added another law (as in Equation 2.4) which shows that the magnetic flux density out of a closed surface is zero. These four equations express the basic laws of electricity and magnetism, and are commonly known as Maxwell's equations.

$$\vec{\nabla}\wedge\vec{E} = -\frac{\partial\vec{B}}{\partial t} - \vec{M} \qquad (2.1)$$

$$\vec{\nabla}\wedge\vec{H} = \frac{\partial\vec{D}}{\partial t} + \vec{J} \qquad (2.2)$$

$$\vec{\nabla}.\vec{D} = \rho \qquad (2.3)$$

$$\vec{\nabla}.\vec{B} = 0 \qquad (2.4)$$

2.2 General Sinusoidal Waveform

In electronics, there may be a need to produce signals working at different frequencies, and with different waveform/shape. These signals could take the form of square waves, rectangular waves, triangular waves, saw-toothed waves and other variety of pulses. Electrical waveforms are basically visual representations of the variation of a voltage, current or any other electrical quantity over time. There are many various types of electrical waveforms available but generally they can all be grouped into two on the basis of their direction; unidirectional waveforms and bidirectional waveforms [7]. The unipolar signal is an example of a unidirectional waveform. The waveform is as shown in Figure 2.

2.3 Unipolar Electric Signals, Rectification and Diodes

Rectification is the conversion of alternating current (AC) to direct current (DC). In DC supply voltage, to reduce the ripple or voltage variations, capacitors are connected across the load resistance. This method may be suitable for low power applications, it is unsuitable when a "steady and smooth" DC supply voltage is needed. One method to improve on this is to use every half-cycle of the input voltage instead of every other half-cycle. The circuit which allows this is called a Full Wave Rectifier [8].

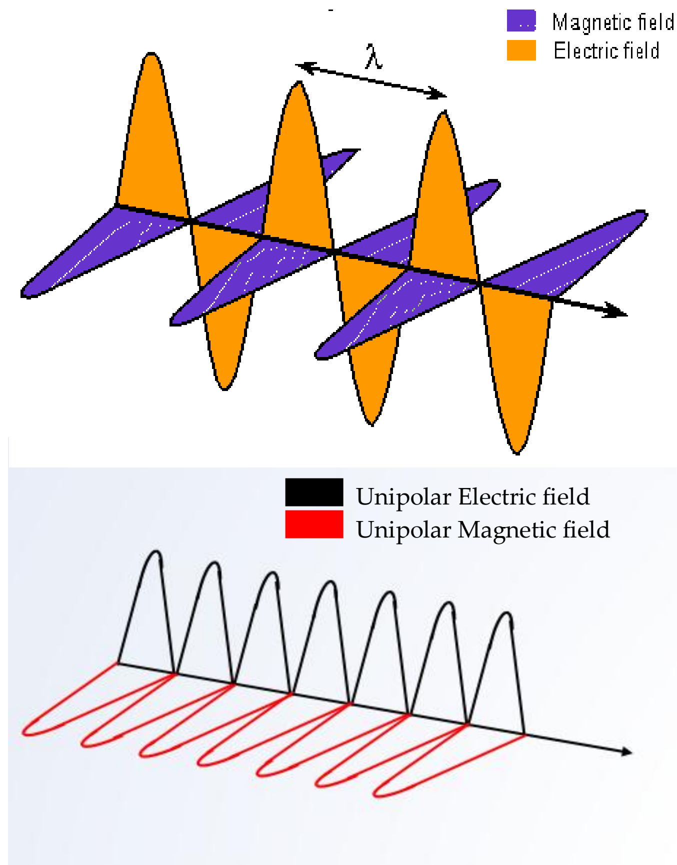

Figure 2. *Figure showing EM sinusoidal waveform and the desired unipolar waveform respectively.*

Diodes are used in rectification of signals, and the type of diode useable largely depends on the frequency at which the circuit is operating. While the 1N4000 series PN junction diode works well at low frequencies, the PIN, Schottky or Varactor diodes are preferable at higher frequencies. After rectification the signal is unipolar in nature as shown in Figure 2.

2.4 Effect of Magnetic Field on Charges

Magnetic fields can cause particles to move in three ways; spiral, bounce or drift motion. All cases of magnetism is due to charged particles in motion whether moving along a straight line or spinning about an axis. It takes a moving or spinning charged particle to create a magnetic field, and it also takes another moving or spinning charged particle to "feel" that magnetic field. Magnetic interaction depends on the state of motion of the charged particles [9]. The motion of charged particles might be the origin of all magnetism as evident in the fact that no magnetic interaction occurs between a bar-magnet and a stationary charged particle or between two stationary charged particles. [10] developed laboratory experiments that investigated the effect of magnetic field on charged water vapour. He conducted the experiments at room temperature and in calorimetric cupboard heated to about 100ºC. The water vapours used for the experiments were charged using induction effects of Zn-Cu and Al-Cu electrodes. The magnetic field utilized were sourced from solenoid systems and permanent magnet. The interactions between the magnetic fields and charged water vapours produced shows that the water vapour charged by line transformer circuit using spiral

Al-Cu electrodes had significant mobility effects during interaction with magnetic fields. The result generated serves as a framework for shifting atmospheric rain cloud with magnetic field. To consolidate the result generated, the research also carried out the simulation of the interaction between charged atmospheric rain clouds with varied magnetic fields so as to predict the movement of rain cloud. The generated signal however, cannot propagate.

2.5 Properties and Uses of Unipolar Waves

Unipolar fields have been found to be useful in different areas ranging from medicine, to engineering, to industrial usage. In the medical field, [11] during a research work on the morphology of single unipolar electrograms during Atrial Fibrillation (AF), reflected the occurrence of various specific patterns of conduction. These patterns were used to differentiate between different types of AF, and to identify regions with structural conduction disturbances involved in perpetuation of chronic AF way better than all other configurations of electrograms. Electrograms recorded with a multi-electrode catheter using the unipolar mapping principle were found to be better. [12] analyzed trains of regular unipolar microsecond-scale magnetic field pulses produced by intracloud lightning discharges. Waveforms of the magnetic field pulses were measured using a broadband analyzer with a sampling interval of 12.5 ns. The observed trains contained several tens of pulses, and the time interval between neighboring pulses typically varied between 1 and 10 µs. This was found to be better than the bipolar equivalent. The research proposed a possible generation mechanism based on the hypothesis that periodical charge structures are present in the thundercloud. The unipolar principle was employed in [13] work on unipolar field charging of particles by electrical discharge which highlighted the effect of particle shape with merits. Similarly, unipolar light emitting devices based on III-nitride semiconductor super-lattices were used to create the analogue n–p junction between two n-type super-lattices with a shallow and a deep sub band [14]. In all of these works they highlighted the merits in the use of unipolar fields and unipolar properties in different contexts and field of studies.

2.6 Control Mechanism of Charges and Charged Cloud Particles in Particular

Considering the far distance of the different clouds to the ground and the possibility of controlling the cloud if charged, there is a need to propagate a field. The magnetic field that can be used for the control of charge from such distance will not be sufficient if it is not made to propagate and travel the distance. Electromagnets and superconductors have been used to generate magnetic field for the control or usage in one circumstance or the other, however, none has been found to propagate magnetic field over a long distance. The size of these previous scientific discoveries limits them from being taken to a near distance or made to be in proximity or within close range of the formed charged cloud. This is probably with a view of launching it into space so as to move close to the cloud from where it can then be used to control such charged cloud particles. It is expected that the magnetic field (moving the charged cloud particles) must be able to reach a distance which is that far up. In some cases, the negative effects of uncontrolled precipitation i.e. drought, flooding, famine etc as stated by [15] and [16] and the need to reduce or even bring to an end these effects makes it imperative to find a way of controlling these charged moisture waiting to precipitate. Over the years, various methods have been employed, with varying degrees of effectiveness and reliability. Some have been engaged for laboratory use, others in a small scale, and a few others on a large scale. [17] simulated an interaction between charged atmospheric rain clouds with varied magnetic field, he discovered that this helped to easily predict the movement of rain cloud.

3.0 METHODOLOGY

3.1 Unipolar Field Generation Methodology

The motivation behind the research was from [10] where it opined that if every other charge can be moved, then rain clouds can also be moved since rain cloud is made up of charged water particles. In the work, an attempt was made to use magnetic field to move charged particles with some interesting results derived. However, the magnetic field could not be felt from a long range because dc fields cannot propagate. There is therefore a need to generate a propagating dc field if the movement of rain cloud is to be made possible. This thus led to rectification of a sinusoidal signal to produce a propagating unipolar electromagnetic equivalent. An existing laboratory experiment on the control of charges was adopted, and equally an existing model for the generation and propagation of EM waves was adopted. The two models were adapted to suit the possibility of accommodating the use of a bridge rectifier and eventually develop a new model for the generation of a unipolar electromagnetic field. [10] worked on a means of using dc magnetic field to move charges. The aim of the research was that if charges can be moved, then rain cloud can also be moved. The research attempted to use dc magnetic field to move charged cloud in the laboratory. From the analysis however it was noticed that magnetic field could not be felt from a long range because dc fields could not propagate. Various models, and designs have also been made to generate and propagate EM signals. These varied from different frequencies across the EM spectrum. One of such models by [18] was adopted. An experiment was done to test for the effectiveness of a rectified signal in the case of electromagnets i.e. the work was carried out to know if rectification will give a stronger magnetic field in an already established condition. The circuit was simulated in the National Instrument (NI's) Multisim environment as shown in Figure 3.

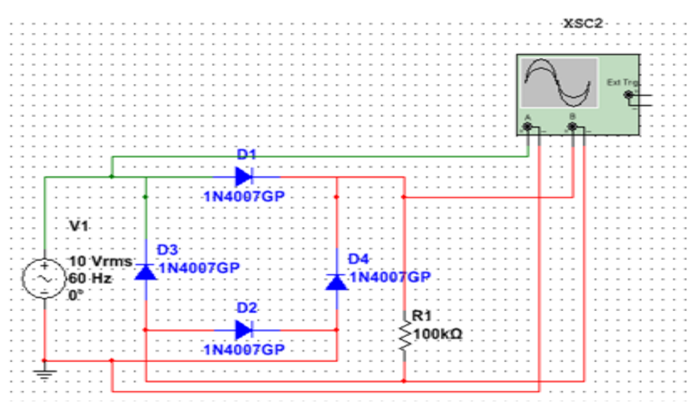

Figure 3. *Figure showing the simulated electromagnet model as designed on the platform*

An overview of the method for the generation of unipolar field for charge control is hereby highlighted below:

- First, establish the fact that a normal sinusoidal electromagnetic field cannot propagate.
- The field will however propagate if its waveform is made unipolar in nature. This means that either only the above zero line (positive cycle) or below zero horizontal line (negative cycle) is possible. This type of waveform was obtained by rectification of the electromagnetic signal adopted from an existing work.
- Experiment was carried out to compare the effect of generated magnetic field in an electromagnet whose source is either a sinusoidal signal or a rectified unipolar signal. The later produced much stronger magnetic field.
- A bridge rectifying circuit was added to the first model to help produce the desired unipolar signal. The rectified signal was applied to a solenoid, and it was found that the field produced was a pure dc magnetic field useful for the control of charges owing to the two experiments done.
- The conclusion came on the backdrop of the field generated being able to attract iron/metals (which contains charged particles) even from a distance
- It is believed that if the field generated is made stronger, this source could be used to move a charge particle or substance from a point to another.

The block diagram of the newly developed model is as shown in Figure 4. The new model was transferred to the National Instrument's application software, and used for the simulation of the full circuit as shown in Figure 5. Other analyses were also made. The circuit model desired for the generation of unipolar signal is a multistage circuit. The basic building block of the circuit are; crystal controlled oscillator, filter network, multiplier, amplifier and the rectifier.

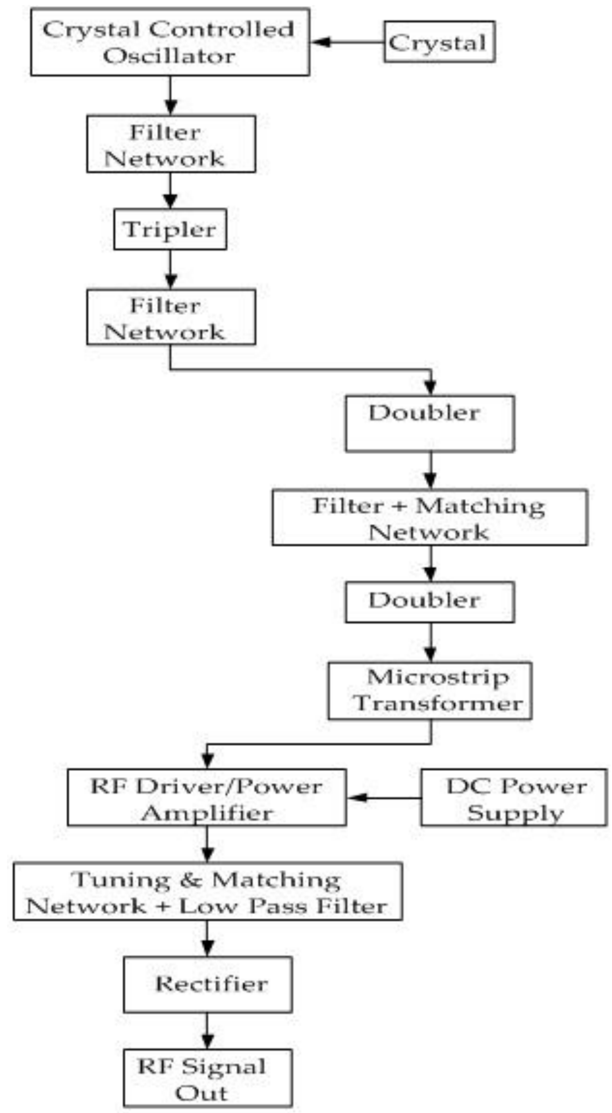

***Figure 4**: The block diagram of the new model and different stages in a generator used for propagating unipolar EM field*

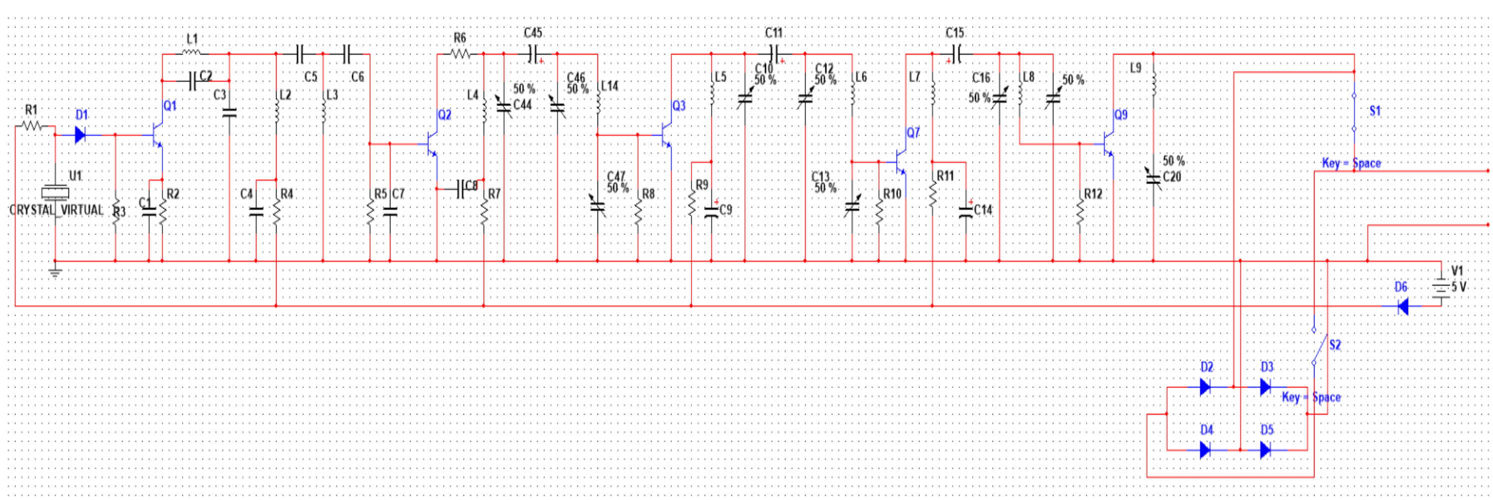

***Figure 5**: Designed Prototype circuit in NI's Multisim environment*

4.0 SIMULATION RESULT

The simulation done was observed via the Multisim® application's 'grapher'. The output waveform derived has a form that is a full sine wave signal establishing the known theory. This is so because the probe of the oscilloscope on the simulator was connected to a point at which the rectification stage was not yet involved. This was done to ascertain that the initial signal was sinusoidal before adding the rectification stage. The main circuit was then simulated again, now with the rectification staged involved as initially designed and the waveform produced is shown in Figure 6.

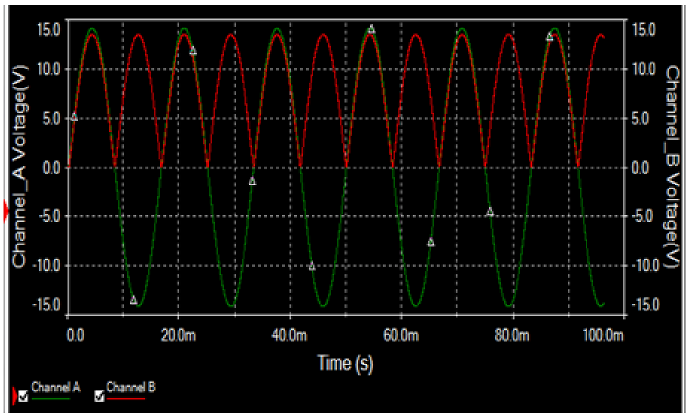

***Figure 6**. Figure showing the simulation's response (channel A is the unrectified output, while the B channel shows the rectified unipolar output)*

4.1 TEST FOR PROPAGATION

To test for propagation in this new model, an improvised solenoid was used with a dc source and a bigger core was used to compare the result with an a.c. source. The rectifying circuit consisting of four 1N4000 series diodes was designed on a bread board. The connection was made and the setup was powered after connection. In the first experiment, where a dc source and a small solenoid was used, the magnetic field produced was felt around 1.0 cm away from the improvised solenoid as shown in Figure 7 for different voltages value. The highlighted part of the figure shows a file clip 1.0 cm away getting attracted to the solenoid by the magnetic field generated from the experimental set-up. This is with a 12v dc source. However, the result obtained in the experiment is in contrast to what is obtainable if a solenoid is connected to an unrectified source. For an unrectified source, no magnetic field was produced, hence no attraction. The second experiment was done for the ac source and a larger core. It produced a stronger magnetic field, strong enough to attract an iron (hammer) around 10.0 cm away as shown in Figure 8.

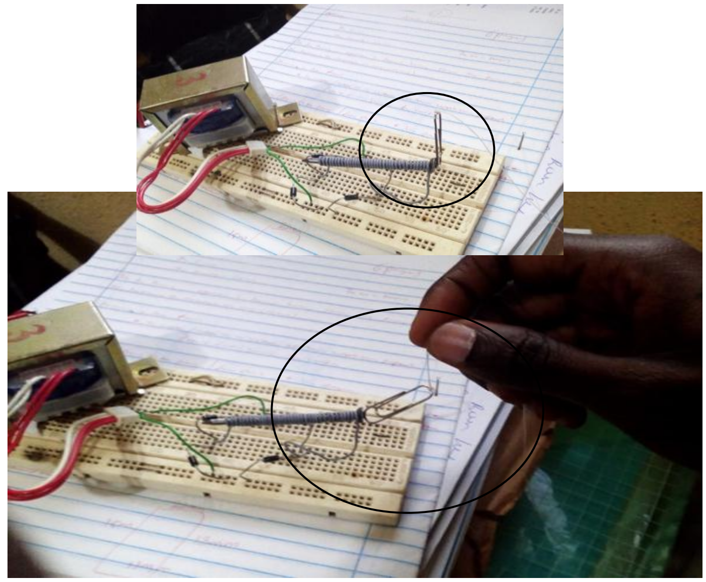

***Figure 7:** Pictures of the design of an electromagnet on a bread board (using a small core). (The circled part shows the file clip attracted by the magnetic field generated from the set up-through the attached solenoid)*

***Figure 8**: Pictures of the design of a rectified electromagnet (using a larger core). (The hammer was attracted to the magnetized core, as the hammer was pulled up and the core was attracted to it due to the strong magnetic field present).*

Conclusion

The research simulated a dc magnetic field (unipolar field) useful for the control of charges in close proximity to the source of the field. This was made possible because charges were found to be controllable when a magnetic field is applied. The National Instrument's Multisim windows application was used for the simulation to generate a unipolar field for the control of charged particles. A unipolar field and a means of generating a strong magnetic field was achieved with the use of diodes arranged in a bridge form to rectify a sinusoidal electric signal. A test setup was made and magnetic field was generated as evident in the attraction of metals around the solenoid and the core. To be able to generate a field strong enough to propagate over a longer distance, such distance as far as the nearest cloud gathering, it is recommended that the circuit used for the simulation in further researches is designed, and made to generate and propagate at a high frequency.

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