CONSTRUCTION OF A HOMEMADE METAL DETECTOR USING LOW COST MATERIALS

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ABSTRACT:
This work aimed to describe step by step how a homemade metal detector construction is performed, such as describing its characteristics and functioning and how it can be produced by anyone who has basic knowledge about electronics or even lay in the subject. The work was carried out in the Materials Science course, to promote student interaction with subject arising from electromagnetism.

KEYWORDS: construction; metal detector; characters; operation.

INTRODUCTION

New teaching-learning strategies have been gaining ground in university, especially in engineering education. In this scenario, large parts of brazilian educational institutions begin to interact as these new concepts, moving in two directions: insertion of smoother transformations in the teaching-learning process and others that opt for more severe transformations in the pedagogical project of the institution. In the smoother way, they maintain the predominant disciplinary curricular model, but they prioritize the greater involvement of the student, with active methodologies, such as teaching by projects in a more interdisciplinary way, hybrid teaching and the inverted classroom. Other institutions propose more innovative, non-disciplinary models that redesign the project, physical spaces and methodologies based on activities, challenges, problems and games, and in which each student learns at their own pace and according to their need, in addition to learn from other students in groups and projects, under the supervision of teachers (Adapted from CHRISTENSEN, 2014 and BACICH, et al, 2015).

In this context, the objective of this works is the description of the technical-professional experience report of a student of Electrical Engineering – the construction of this first prototype: a homemade metal detector. The idea arose from the need of finding for metallic objects both for historical purposes (where a percentage of relics then concentrated on the seabed) and for other areas such as industry or military. Furthermore, was emerging a new type of audience in which only aimed the fun of finding this kind of material on the shores of the coast or in the backyard of your home.

With the advancement of electronics and study related to magnetism was developing devices capable of detecting metallic objects at great distances and by means of obstacles, such as in different types of wall, human body, etc. Moreover, be a military aid to detect underground bombs or even inside airports and border areas preventing gun traffic, among others. The purpose of this article is to describe, systematically, the construction of a homemade (low amplitude) metal detector, functioning and a priori consisting of materials of low financial cost, since the others available in the market have a high price.

MATERIAL AND METHODS

The present research is characterized as theoretical-experimental. In the theoretical phase, a survey of similar existing projects was carried out, through the consultation on the World Wide Web and consultation of several works done in Brazil. After this stage, the product was sketched and the material listed. The next step was to purchase the material and the physical assembly. After the detector (prototype) was shaped, the product validation tests were started. In this step, when it is verified that some problem has been remedied and the changes in the base design have been registered. The next step was to prepare an experiment guide for the teacher and the students, in order to reproduce the product in laboratory activities by other classes. Finally, the last stage consisted in the elaboration of technical and academic indicators: project report, articles for congresses and exhibition in IFPE and in higher education institutions of northeast Pernambuco.

The team used ideas management techniques and the best proposal to be developed in agreement with the Project Coordinator (professor from subject). For the development, the designer showed the prototype working and, in case of approval, should develop the printed circuit board and the environment model (home, garden, sensor). The final prototype was calibrated and validated initially in the laboratory, then it was used in an experimental workshop to be used by

students and professor of IFPE and institutions of the region. All the materials and equipment needed for the development of the project were acquired throughout the execution of the project as the demand arose.

Table 1 – Detailed estimate of the homemade metal detector.

Description	**Quantitative**	**Price (R$)**
Universal Circuit Board	01	R$ 22,00
Resistor of 47kΩ	01	R$ 0,10
Electrolytic Capacitorof 2.2 µF	02	R$ 0,50
Electrolytic Capacitor of 10 µF	01	R$ 0,50
Integrated Circuit NE555P	01	R$ 1,00
Speaker	01	R$ 1,34
Battery – 9 V_{CC}	01	R$ 9,00
Battery Connector	01	R$ 2,60
Monopolar Switch	01	R$ 1,80
Enameled Copper Wire	01	R$12,00
Pipe ¾’	01	R$7,75
Total cost = R$ 59,00		

The list of materials and detailed budget is illustrated in Table 1, most of the components presents affordable prices, except the universal circuit board, which was chosen because it has the input of the components and thus facilitate the welding of the same. The second stage of making the prototype consists of the schematic diagram of the circuit (Figure 1), to guide the student, where each component would be positioned and welded, thus reducing possible future errors. In this way the construction of the electric circuit can be started according to the schematic of Figure 1, using soldering iron to weld the components, it is available in the IFPE –Garanhuns Campus.

It was also visualized that in series with the capacitor of 2.2 µF is to the detector coil (phenomenon of electromagnetic induction), this is made of enameled copper wire AWG34. The PVC pipe to be used can be of any gauge, preferably 60 cm or more. Three hundred turns must be given with the enameled copper wire, in order to construct a coil with a detection area (diameter of 20 cm). It must be similar to the coil shown in Figure 2. When starting the coiling of the copper wire in the pipe leave a free bridge with a length of 10 cm and at the end also, so that these are welded to the circuit of Figure 1. After welding of the components, the positive and negative wires of the battery adapter were soldered to the positive and negative terminals of the circuit.

Installation of the switch was done by welding it to the positive and negative terminals on the battery by welding them on the first and last legs. Finally, components duly welded and organized in a way that does not compromise the performance of the circuit, when any kind of damage (external weathering) occurs to the operation of the metal detector, has been inserted inside the PVC pipe.

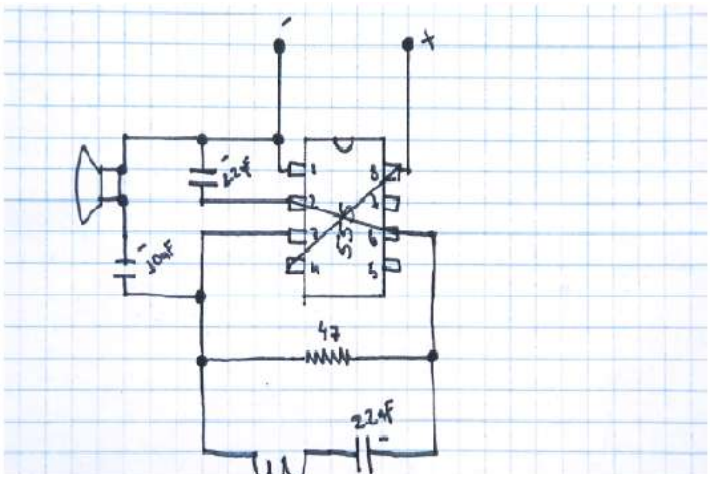


Figure1 – Electrical circuit of the homemade metal detector.

Figure 2 – Detection Coil Illustration.

RESULTS AND DISCUSSION

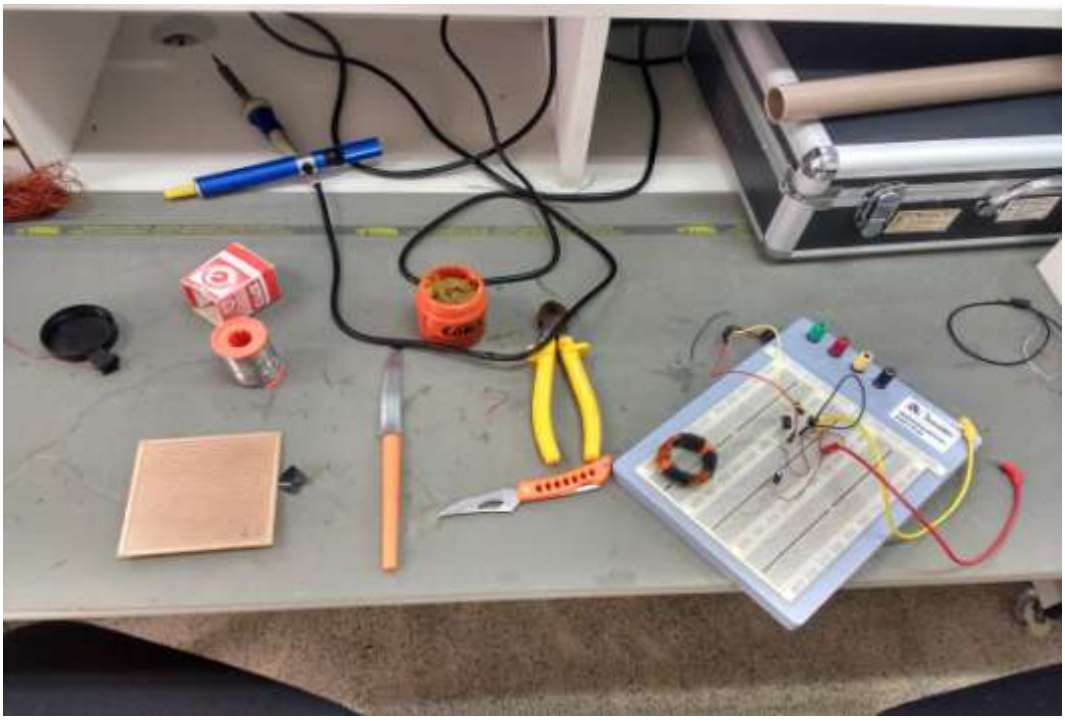
The constructed prototype of the constructed and validated metal detector is illustrated in Figure 3. Several tests were performed: electrical continuity, detection area, type of material to be detected and disturbances external to the circuit.

According to IBERÊ (2017) the role of the metal in the circuit is to change the inductance of the coil, simplifying, if we put electric current in the coil (make electrons pass inside the coil) it will create an electromagnetic field, functioning as an electromagnet. However, when we approach a metal in the coil, we change the electromagnetic field that is being created by the coil. Finally, the role of the electric circuit is to measure the electric current passing through the coil, thus emitting a sound, so if we change the current of electrons passing through the coil, the sound changes. Approaching the metal, we changed the electromagnetic field thus changing the sound emitted by the speaker.

However, with the completion of the construction of the metal detector and its due validation in which metallic materials were inserted or near the coil, the change in the frequency of sound that the speaker made was notorious. From this the results obtained were the real detection of the same in metallic objects, being able thus to be used for applications of small size like detection of metallic materials in his residence.

(a)

(b)



(c)

Figure 3 – Construction details of the homemade metal detector.

For a better performance of the prototype, it is proposed to increase the diameter of the coil that is located at the tip of the PVC pipe and the pipe itself, because there were difficulties with the size that was proposed and the use of a material of better handling. It is worth mentioning that a professional metal detector used to detect metals on the seabed (gold and silver) costs around R$ 2,200.00, while the built prototype costs R$ 60.00.

An improvement for the V2 metal detector is to implement a larger PVC rod to avoid column problems since the V1 metal detector has a small rod. The second improvement is the

modeling of a larger coil, since the coil of V1 has become very small (even when operating normally). Finally, an improvement in the visual aspect to look like high-value metal detector.

An important information observed in the majority of the students after the end of the course was the motivation of the group to study/know the discipline, when it was assisted by practical activities, when it is taught in the conventional methodology (expository class and written tests). Teaching becomes tiresome and difficult to understand due to the quantitative equations and calculations involved, as well as the level of abstraction. Another positive result concerns the number of students who saw real applications of the discipline (mechanical structures designs with instrumentation), one of the challenges of the reality of the future engineer.

CONCLUSION

In spite of being a work in which it seems simple, it favored the immersion of the student of the Electrical Engineering course, as much in the basic electricity subject as in the electronic area, since the latter will be of great importance during all its course. The acquired knowledge of welding and reading of electrical diagrams will provide a better understanding of future projects. It can be concluded that this simple final project of the discipline was full of new experiences, taking with it a team work and with safety considering the legal prescriptions, reading of manuals, elaboration of projects, the experience when speaking in public, handling of the tool's basic electrical maintenance, learning in the use of electrical equipment manuals, learning in organizing and guarding electrical materials.

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