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Implementation of Caliper Device of Density of Magnetic Flux of Low Cost in the Western Amazonia

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ABSTRACT: This article presents a prototype projected to calibrate sensors that measure the density of the magnetic flux. Based in the Coil of Helmholtz, the prototype will be used to check the density sensors of uniform magnetic flux of low intensity, around its center of symmetry. Implemented with embedded technology, when measuring the circulating flowing and with the parameters of the structure it can determinate the level of the density of the magnetic flux produced. It presents an error 28,22% in the length of operation of 0 to 2000 uT and a low cost in its implementation.

KEYWORDS*:* Coil of Helmholtz, Magnetic Flux, Electronic.

I. INTRODUCTION

To the implementation of a monitoring network of the density of the magnetic flux throughout a transition line of high voltage, one of the first equipments that must be available is a caliper of high density of magnetic flux, known as Coil of Helmholtz. In the Western Amazonia it cannot be naturally found this type of device, what causes a high cost to itself. In a research done in international websites it was possible to obtain values around 2400 to 8000 dollars, without considering the taxes, fees and expenses to send it to Brazil.

It was used a coil idealized by Hermann Ludwig Ferdinand Von Helmholtz (1821-1894), to do the calibration of the sensors of the density of the magnetic flux, that works with the continuous or alternated flowing, formed by two coils rounded and calibrated, each one containing N spirals, where the feeding chains can be continuous or alternated, flowing in the same direction and creating an uniform magnetic camp. The distance between the coils are equal to the ray R common to both them, as well as it is organized in picture (1).

If the currents in the coils are in the opposite direction, the magnetic field created by them will have opposite sides. This configuration creates a field gradient that is used to the calculus of the strength against a material sample, which is a fact normally used in scales of susceptibility. However, in this study, the coils will be energized with an electrical flowing of same sense that create a magnetic camp inside the geometry of the pair of coils. A magnetic camp (B) created by a coil of Helmhotz, is given by the product of the constants (4=53=5), magnetic permeability of the free space (tO) with the values of the electric flowing (I), number of whorls (n) and divided by the ray of the coil (R), forming the equation (1)

$$B = \left(\frac{4}{5}\right)^{3/5} \frac{\mu_0 n I}{R}$$

(a)

Equation (1) (a).

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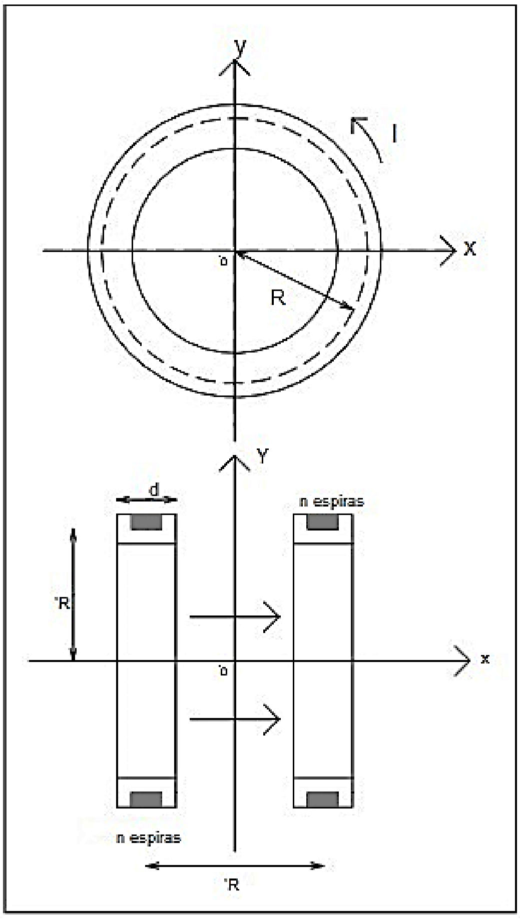

(a)

Fig. 1. Helmholtz's Coil Scheme (a).

The project had the objective of develop a calibrator of low cost to be used in developing sensors of density of magnetic flux.

Consequently, the article was organized in the following way: in section 2 it presents the methodology with the detailed description of the creation, in section 3 the measurements of the performance and finally in the section 4 the conclusions of the work.

II. METHODOLOGY

It was first set the value of the desired magnetic field, resulting in approximate values of 1000μT. Then we used the equation (1) (a) of the Helmholtz coil to set the number of turns. The distance was determined at 21.5 cm, because this way the coil would not have a large size and does not lose its pattern of predetermined magnetic field values. By the formula it was possible to obtain the coil current, and to support the same, we used a copper wire of 20 AWG.

After all defined parameters, began the production of the coil parallel with the acquisition of the variable autotransformer TDGC2-0,5KVA = 2AMP voltage regulator as shown (2) (a): first the copper wire was wound into a makeshift frame with 21,5 cm of radius containing 300 turns in the two coils, they were removed from the frame and performed successive operation tests with the variable autotransformer.

Among the tests, annotations were made of the values of the variations of magnetic flux density in relation to the current variation with the aid of a magnetic flux meter.

After, were made the definitive fiberglass structures for support of the coil's spirals and fixed with nylon's plastic strap, with the coils already fabricated was realized the installation of connectors where were made the first tests with the autotransformer in the final structure, soon after, was implemented a current sensor for magnetic field and made your calibration.

In the figure(2) (b), it’s possible to see the winding of the spiral coils in its initial structure, taken as basis, just to model the circumference in the moment of the winding, in the size of the desired radius.
Then, was realized the elaboration of its definitive physical structure, that will serve as support for the coils. This structure was made of fiber glass, totally made with low cost as shown in the figure(2) (c).
To accomplish the measure of current that means the electromagnetic field, was used one current sensor that accomplish the measures and works this way: through of the current sensor that accomplish current measures, the values are calculus by ATMega that measures the size of field.
Thus, the structure with coils, was finalized as shown in Figure (2) (d).

(a) (b) (c) (d)
Fig. 2. Variable Autotransformer (a) Spiral Coils (b) Physical Structure (c) Final Physical Structure (d).

III.RESULTS

All tests behave as expected corresponding to the defined parameters, ie the Helmholtz coil in the western Amazônia, reached the variation of the magnetic field of 1000? Tesla initially defined for its creation, showing that even being a low-cost coil has the reliability and efficiency as calibration device for magnetic flux density sensors. Can be used as a device to assist in calibration of sensors for reading magnetic field.

It was observed that the higher the current the magnetic field increases their value continuously. To express the measurement of the magnetic field by the current of the Helmholtz coil, was elaborated a graph (3) (a) which resulted in a non-linear line.

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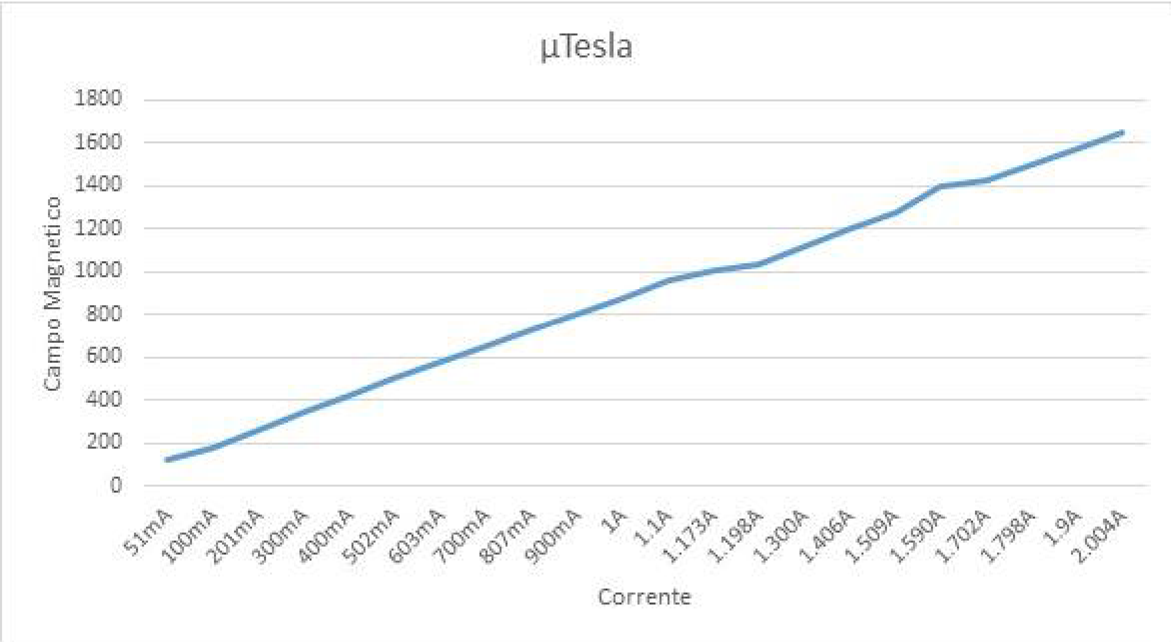

(a)

Fig. 3. Magnetic Flux Density (a).

IV. DISCUSSION AND CONCLUSIONS

During the construction of the Helmholtz coil, this presented interference because the conditions of measurement of magnetic flux, therefore, were made when the coil was an improvised physical structure, and the flux was measured by a low-quality equipment of the brand ICEL Manaus and EM-800 model shown in figure (4) (a), for these reasons, the error found is considered negligible in value of 28,22%, thus, the magnitude found was satisfactory, since despite the circumstances in the measurements, it has gotten close to the ideal value.

In the graph in Figure (4) (b) you can see the linearity between the applied current and the ideal magnetic flux, based on the formula developed by Helmholtz, for every variation of current, the magnetic flux varied proportionately and with a linear behavior.

The construction of the Helmholtz coil, corresponded to the study of expectations, this happened because the same have successfully reaching the 1000µT predefined in its construction and why be low cost.

Considering that this is not a device easily accessible in the Western Amazonia, and hardly found in Brazil, and only left the international market as an option to acquire this equipment. However, the international coil has a very high economic cost, plus the costs that the consumer will have to have with taxes,fees and shipping costs with the same, thereby hindering access to acquire the same. Therefore, it is possible to observe the effectiveness of the production of this project.

(a)

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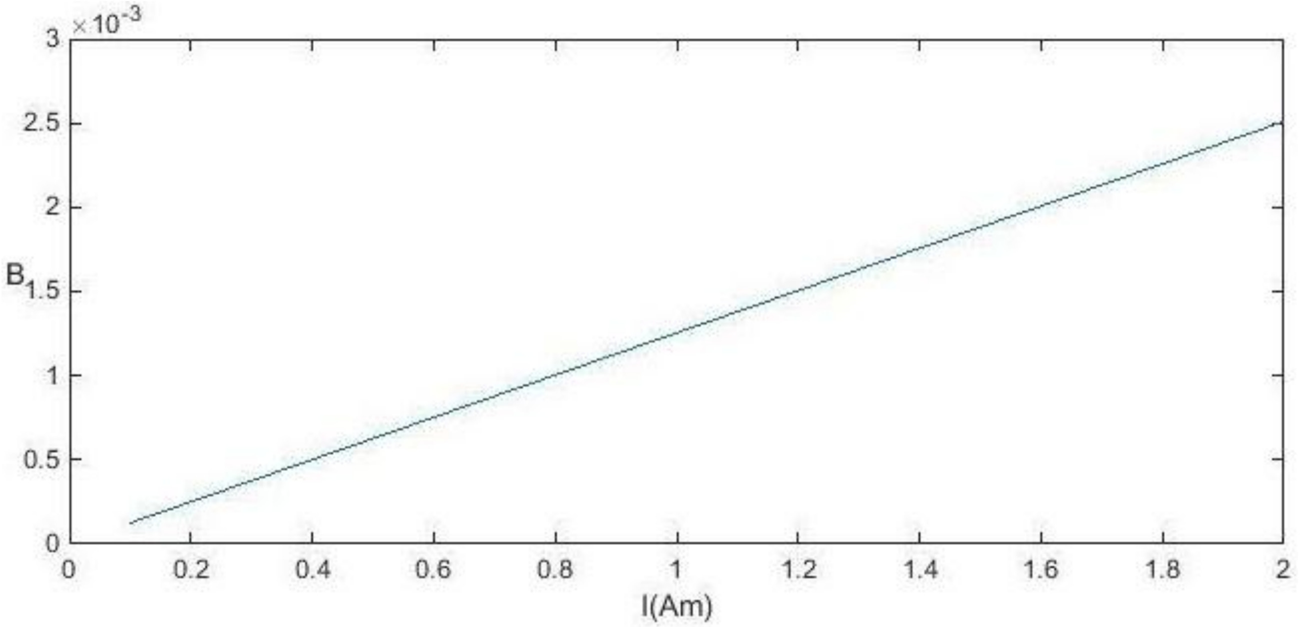

(b)

Fig. 4. Instrument Used For Comparison (a) Magnetic Flux Density Ideal (b).

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