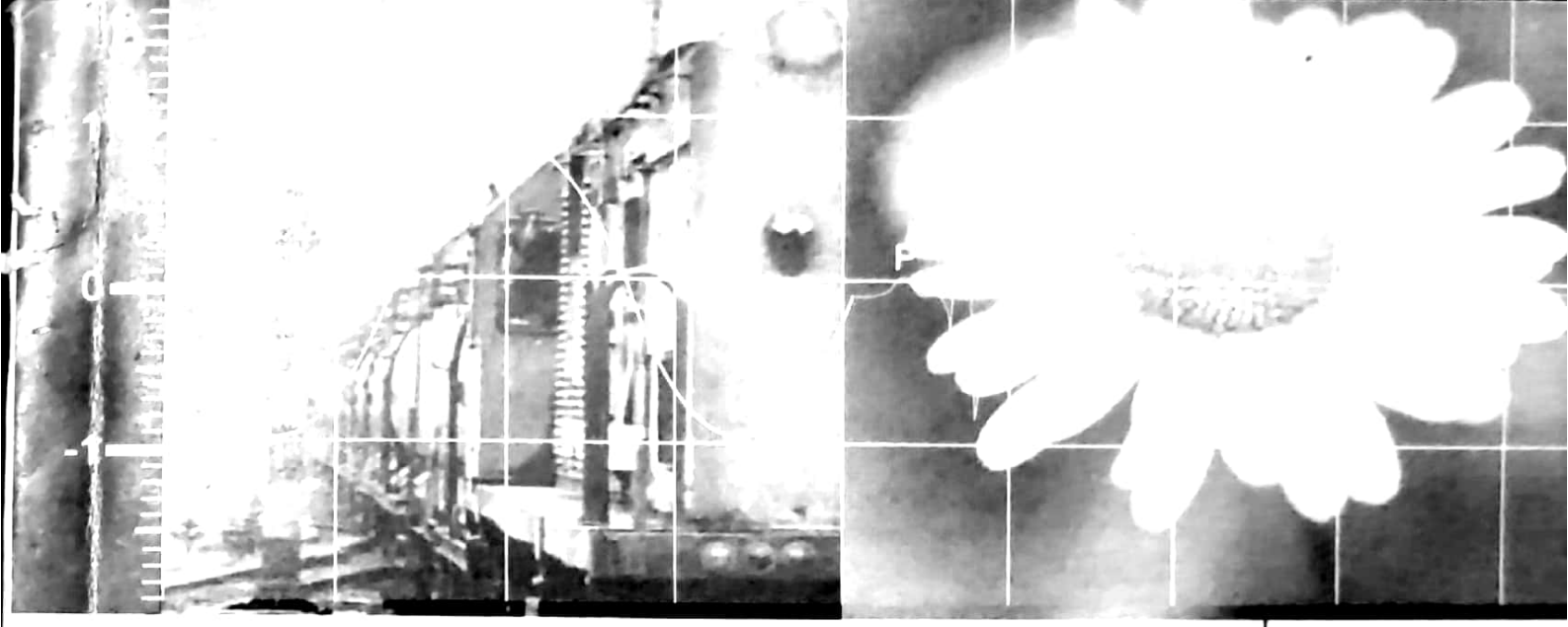

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PHYSICS

PROTOTYPE OF ELECTRON BEAM MACHINE USING ELECTRON SOURCE FROM OSCILLOSCOPE

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Abstract

In this paper, it is described miniaturization of electron beam machine using electron beam source from oscilloscope. A rectangular form of electron beam image was obtained by vertical and horizontal couples of coil supplied with regulated frequency of saw tooth current.

The result show that the maximum area yielded by electron beam sweeping was 0.51 cm^2 held in the frequency and current of 37.31 Hz and 35.1 mA respectively for vertical coil couple, and 57.47 Hz and 45.83 mA respectively for horizontal coil couple. Generally, this miniature was able to descript the principle of operation of electron beam machine.

Keywords: electron beam machine, oscilloscope, oscillator, magnetic field.

A. Introduction

In the industrial field, Electron Beam Machine (EBM) is most useful instrument including welding, hardening, alloyization of the metallic material in the vacuous middle and suited to the welding of abnormal material welding. For welding, there are several advantages i.e.: maximum amount of weld penetration with the least amount of heat input reduces distortion. Repeatability is achieved through electrical control systems. The electron beam machine's vacuum environment eliminates atmospheric contaminates in the weld. Exotic alloys and dissimilar materials can be welded.

The principle operating of EBM is turning the electron path on the horizontal and vertical direction, thereby resulted spraying electron until the desired area. Commonly, the main component of EBM consist of electron source, acceleration tube, High Voltage, optical system, direction system, screening system and conveyor system (Sumaryadi, *et al.*, 2001; Djoko S. P., 1998). Generally, conveyor system is needed on the applied EBM in the industrial field. Sudjatmoko (1999) has design the electron beam machine 500 KeV / 10 mA, and find out that electron source system is designed from heated chatode. Tutik Sujiati (2003) has reach the effect of the magnetic coil to the distibution of magnetic field on the both horizontal and axial direction of electron beam screened trough oscilloscope, that is intensity of magnetic field on the middle area of scrren is higher compared with others.

On the laboratories scale, it is probable to produce a prototype of EBM by using oscilloscope equipment. For resulting electron beam sweeping which able to display a rectangular form, it is used two AC magnetic field deflector that are horizontal and vertical magnetic field deflectors (Chattopadhyay, *et al.*, 1989). Each of that completed with frequency

regulator. Oscillator was able for regulating frequency. In this paper it is conducted a prototype of electron beam machine in the laboratory scale using oscilloscope.

B. Instrument

The instruments required for operating this experiment include:

1. A set of oscilloscope in the CRO (Cathode Ray Oscilloscope) experiment produced by BATAN mode of BI 764. This instrument was supplied by 4000 volt DC of power
2. Wire with diameter of 0.4 mm was formed as coil with inner diameter of 2.165 cm, outer diameter of 5.93 cm, and length of 2.65 cm.
3. Oscillator that supply the continues sawtooth wave to the coils.
4. Multimaster for measuring the current flowing on the coil.
5. Gaussmeter for obtaining magnetic field intensity produced by coils. That gaussmeter specified by GM 04 mark, 212-714 series, produced by Hirst Magnetic Instrument Ltd.
6. Digital oscilloscope for displaying the wave form outputing by oscillators and for obtaining it frequencies. This instrument was connected with personal computer (PC) to produce the picture and saved in the file.

C. Design for experiment Instrument

The instrument used in this experiment is schemed in the Fig. 1.

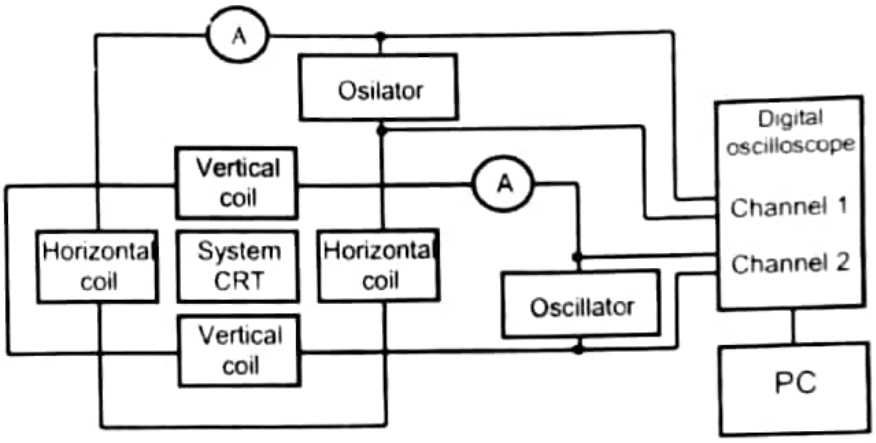

Fig. 1 Block diagram of instrument

As shown in Fig. 1, it is appear that CRT (Chatode Ray Tube) system is arrounded by couples of horizontal and vertical coils. The two coils is connected with their oscillators and the their current can viewed in amperemeter. Frequency regulation can be obtained by rotary potensiometer. Output voltage from horizontal coil is connected with chanal 1 oscilloscope, while output voltage from vertical coil is connected with channel 2 oscilloscope. For assisting the viewing the output voltage from the two coils, it is used the softview software, thereby the results can be viewed or recorded.

D. Experiment Methode

1. The instruments are arranged as showed in Fig. 1.
2. Setting the power supplay on the on position until appear the point of electron beam in the fluorescene screen.
3. Connecting oscillator with vertical coil couple, until appear the image of electron in the horizontal line form. After the vertical coil was off, in the same way, is done on the couple of horizontal coil for finding the vertical line of electron beam.
4. Vertical coil was connected with oscillator and so horizontal ones, and then choicing the sawtooth wave mode.
5. Regulating frequencies of two osilators for getting a distribution of electron beam in the rectanguler form. The larger, the sharper and the more homogen the rectanguler area the better the image. After achieving this condition, we measure the lenght and wide of rectanguler for obtaining the area of electron beam.
6. The next step is recording the rectanguler image in the screen with digital camera and recording the voltage wave with softview software and saving it.

E. Results and Discussion

1. Characterization of magnetic field in the coil

In Fig. 2 displayed curve correlating the electric current with magnetic field generated by coil.

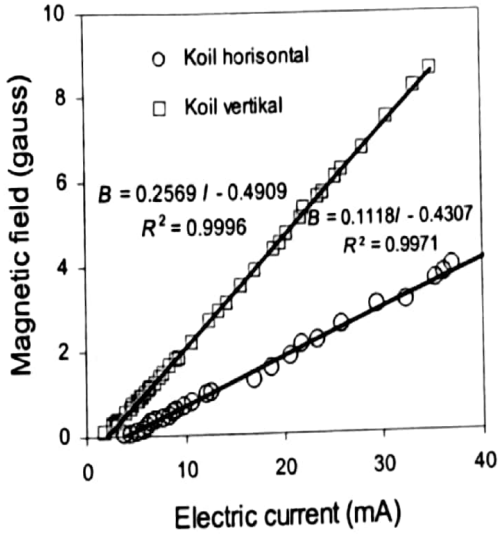

Fig. 2 Curve that correlating the electric current and magnetic field for vertical coil (□), and for horizontal coil (o). The two coil couples are filled with iron core.

From Fig. 2, it is appear that the intensity of magnetic field (B) is proportional to the electric current (I). The well proportionality of two parameters can be view from each of correlation coefficient between B and I, which are not less then 99%.

2. Image of electron beam

In Fig. 3, it is displayed images of electron beam on the oscilloscope for couples of vertical coil (a) and horizontal coil (b). The maximum length of image is 3.0 cm held in the frequency and current of 37.31 Hz and 34.72 mA respectively. While maximum wide is 1.7 cm held on the frequency and current of 57.47 Hz and 44.07 mA respectively. Form Fig. 3(b), it is appear that the intensity of image at the end of bottom of beam line is higher than it at another parts. It is due to inhomogenity of intensity of magnetic field raised by the horizontal couple of coil.

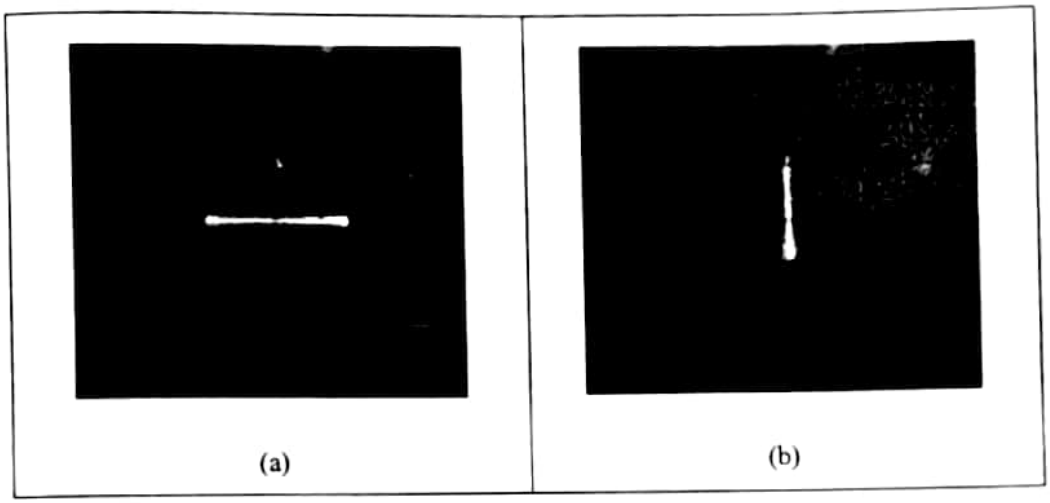

Fig. 3 Image of electron beam for couple of vertical coil (a) and horizontal coil (b).

Inhomogenity of electron beam is caused by not coaxial position of the two coils thereby the raised magnetic force lines distribution is not symmetry. The present of cathode tube between a coil couple is difficult to arrange the two part coils in the center axial position.

If the two coils are connected with their oscillators, we get a rectangular electron beam image [Fig. 4(c)]. This image is formed by combination between voltage from horizontal coil couple at frequency and current of 57.47 Hz and 45.83 mA respectively and vertical coil couples at frequency and current of 37.31 Hz and 35.1 mA respectively. The area can be obtained is about 5.1 cm^2.

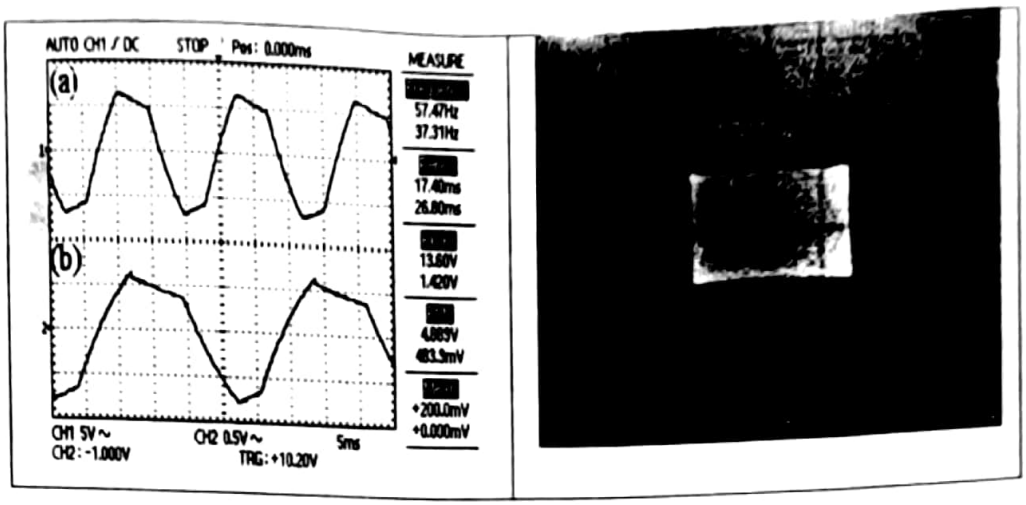

Fig. 4 Profile of voltage for horizontal coil couple (a), vertical coil couple (b), and a rectangular electron beam image with length and wide of 3.0 cm and 1.7 cm (c).

By this image show that, making a prototype of electron beam machine in the laboratories scale by using oscilloscope has succeed though not complete yet. The incompleteness of the achieving image appears from inhomogenity of density of electron beam in the right–bottom side that is higher compared with it in left-up ones. As mentioned above, it is caused by asymmetry distribution of magnetic field from horizontal coil couple. The proposed suggestion for finding the more homogeny image is centering the axial of horizontal coil couple.

F. Summary

From the discussion above we conclude that the designed EBM prototype in the laboratories scale has able to display a rectangular image of electron beam. The achieving maximum area is 0.51 cm^2 held at frequency and current for horizontal coil couple 57.47 Hz and 45.83 mA respectively, and 37.31 Hz and 35.1 mA respectively for vertical coil couple.

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