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Model of electric car alternative charging

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***Abstract* — The paper describes the design and realization of a test facility as well as a conducted experiment using the remote-controlled metal car mini Bugatti. The aim of the experiment was to find whether is possible to charge electric cars by permanent magnets.**

***Keywords* — electromagnetic induction, permanent magnet**

I. INTRODUCTION

Michael Faraday (1791-1867) was an English scientist who discovered electromagnetic induction in 1831. He pointed to the fact that by changing a magnetic field an electric field is generated [1].

Magnetic field is manifested by force action on moving electric charges or a conductor [2].

If a conductor is occurred in magnetic field and moves in certain velocity, free charge carriers (electrons) make relative motion in magnetic field, for that reason the force that puts them into motion will be started to effect on them. If the conductor is enclosed in electric circuit, induced electric current starts to flow through it and we get induced electric voltage on the conductor terminals (1)

$$u_i = -\frac{d\Phi}{dt} = -\frac{N \cdot \Delta B \cdot S}{\Delta t} = -\frac{N \cdot \left(B_{\max +} - B_{\max -}\right) \cdot S}{\Delta t} \qquad (1)$$

where Φ is induction flux, N is number of coil windings, B is magnetic induction and S is surface coil made by conductor.

Magnetic induction is described by magnetic induction lines, i.e. directed closed graphics in which a tangent has the direction of the vector of magnetic induction in every point [3].

II. EXPERIMENT

The experiment consist of the remote-controlled metal car mini Bugatti RC. Its construction had been adjusted so that the wheels were blocked, i.e. they were steered to the right and embedded by hot air gun in order to stop their movement. Also the remote control was adjusted. The buttons on the left and on the right were disconnected and instead of them a new switch was welded that enabled the start of the car in position 1 and stop in position 2. The remote control is powered by three pieces of battery type AAA with total voltage 4,5V.

The car was put in the flat surface where by the wheeling radius was measured. The trajectory diameter reached 360 mm. On the basis of it the track was constructed with the same diameter. It consists of two parts: the bottom part with diameter 360 mm and thickness 10 mm serves for fixation of the permanent magnets. These are fixed firmly by screws. 12 pieces of chosen magnets were fixed along 30°. The upper part is used for measuring.

From the circuit board with the dimensions (96x38) mm was etched a coil with 26 windings at which it was found out that this coil had few windings that would enable the achievement of the demanded voltage and so it was designed a coil with the dimensions (105x20) mm and 100 windings

that was fixed on the car chassis.

III. RESULTS AND DISCUSSION

The basis of the experiment is a moving car along the upper part of the track. Under the car there was a coil with 100 windings at which on the bottom part of the track there were fixed 12 permanent magnets placed along 30° as the figure 1 shows.

Fig.1 Position of the permanent magnets in the bottom part of the track.

Using the simulating program Quickfield it was simulated the influence of a magnet to the track and they were obtained data of allocation of a magnetic field above the particular magnets (Fig. 2). After the substitution the data obtained by the simulation in the equation (1) it is possible to calculate the output voltage in this realization.

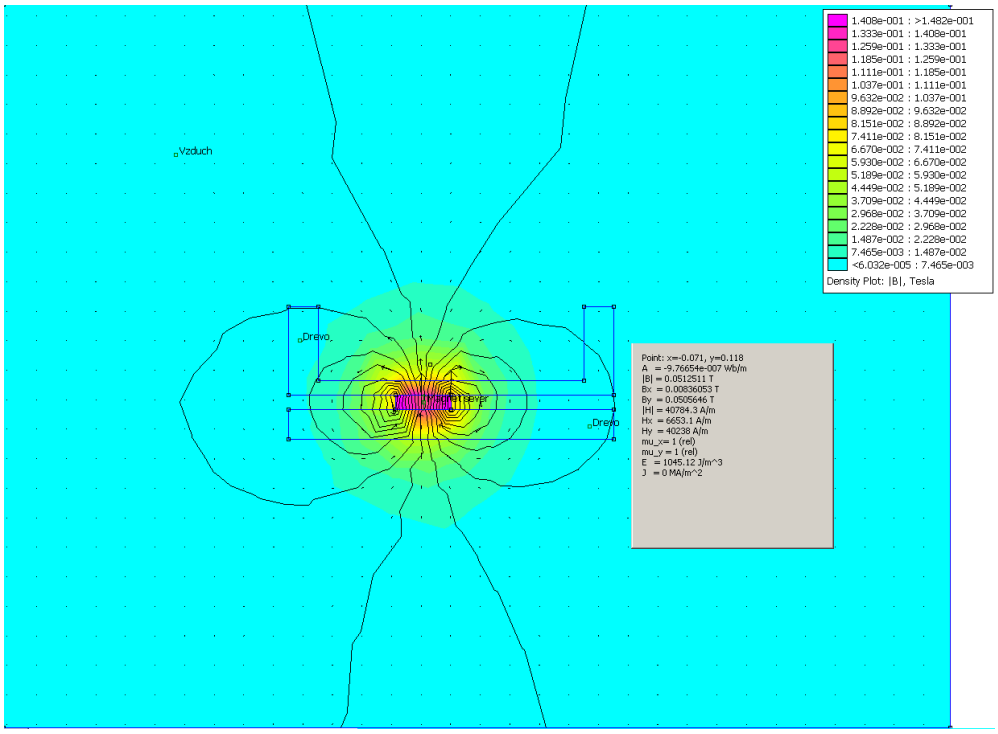

Fig. 2 The results obtained by simulation in program Quickfield

$$u_{iSIM} = \frac{N \cdot \Delta B \cdot S}{\Delta t} = \frac{100 \cdot (51{,}2511 \cdot 10^{-3} - (-51{,}2511 \cdot 10^{-3})) \cdot 2{,}1 \cdot 10^{-3}}{100 \cdot 10^{-3}} = 0{,}21525 \text{ V} \tag{2}$$

Using the analogue measurement device (Fig. 3) the amount of magnetic induction above the particular magnets has been verified. By substitution of the measuring data in the equation (1) we get:

$$u_{iNAM} = \frac{100 \cdot (70 \cdot 10^{-3} - (-70 \cdot 10^{-3})) \cdot 2{,}1 \cdot 10^{-3}}{100 \cdot 10^{-3}} = 0{,}294 \text{ V} \tag{3}$$

Fig. 3. The analogue measurement device for measuring of electromagnetic induction

By connecting the probe of the oscilloscope (Fig. 4) onto the ends of the sensing coil and by moving the coil in a magnetic field the voltage was induced with maximum amplitude 400 mV with the effective voltage 0,282V.

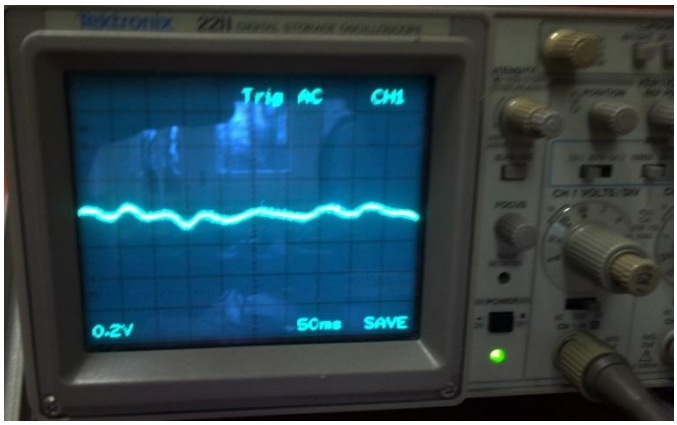

Fig. 4. The oscilloscope showing inducted voltage for the coil with 100 windings

In the graph below there are courses of inducted voltage as a function of the growing number of coil windings. We can see from the graph that for the demanded voltage is needed to choose a coil with 1000 windings and also it is necessary to double the number of magnets, i.e. from actual 12 to 24.

Herewith the time constant will be decreased from previous 100.10^{-3}s to 50.10^{-3}s and herewith the demanded voltage 5,88 V will be reached.

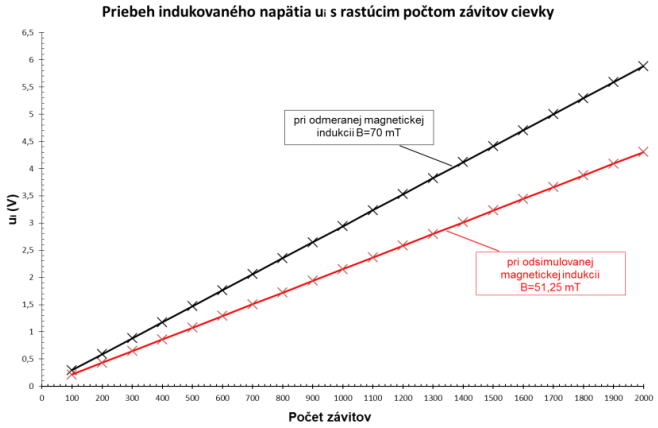

Fig. 5. Inducted voltage versus the number of coil windings for the simulated value of electromagnetic induction (51,25 mT) and for the measured value of electromagnetic induction (70 mT).

IV. Conclusion

The conducted experiment using a remote-controlled metal car has confirmed that at a suitable arrangement designed construction of the experimental circuit it is also possible to consider with its alternative charging by the use of permanent magnets. In the conducted experiment the maximum measuring data of electromagnetic induction was 70 mT and it for the coil with 1000 windings and permanent magnets putting in the range along 15°, provides an alternative of generation inducted voltage 5,88 V.

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