Electromagnetic Shoot

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Introduction

The *Electromagnetic Shoot*, described in this paper, is a device built for science fair events. It was used for the first time in *Robótica 2006* festival (Figure 1).

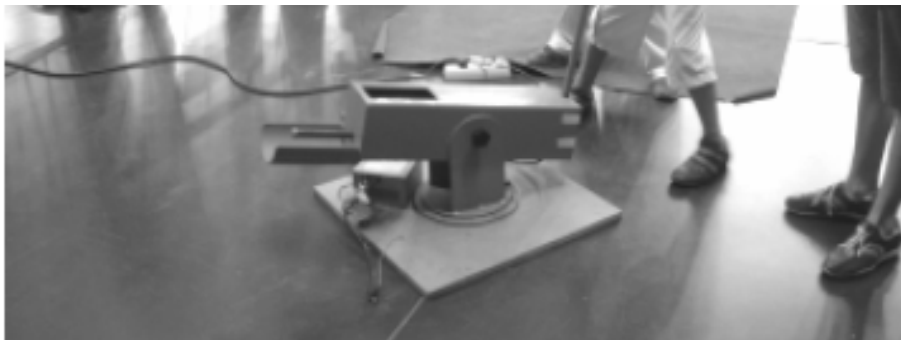

Figure 1. Electromagnetic Shoot at Robótica 2006 festival

The device was a success, in part because it is related with football, which attracts specially the younger ones. A ball is placed in a ball holder. When a button is pressed, the device shoots the ball at a distance of several meters.
The shooting mechanism, shown in Figure 2, was originally developed by João Sena Esteves for *Minho Team* soccer robots and it has been successfully used for several years.

Materials used

The *Electromagnetic Shoot* uses the following materials: Diode bridge; capacitor; button; coil (solenoid); two-piece rod made of iron and nylon (Figure 3); contactor with timer.

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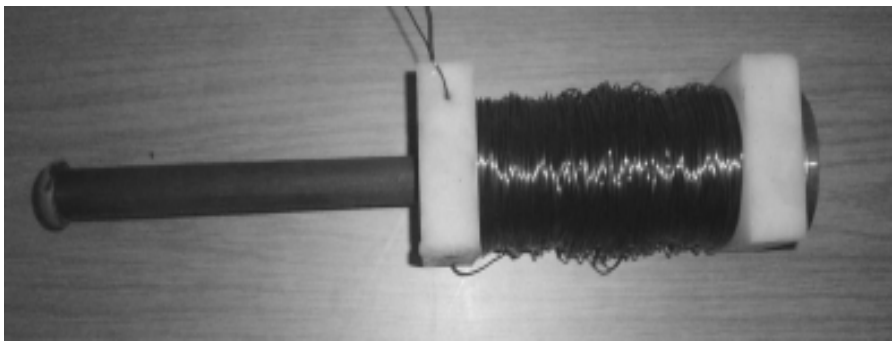

Figure 2. Shooting mechanism

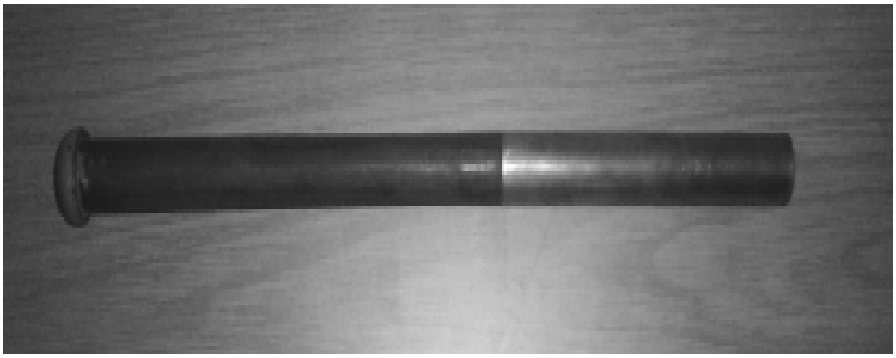

Figure 3. Two-piece rod made of iron and nylon

Device operation

This device operation is based on Electromagnetism laws. When a button is pressed, a current passes through a coil, creating a magnetic field whose direction is given by the right hand rule (Figure 4). The field attracts the iron part of a two-piece rod made of iron and nylon, whose displacement causes the shooting of the ball (Figure 5). The circuit used to produce a current on the coil is shown on Figure 6. The 220V/50Hz mains voltage (Figure 7) is rectified (Figure 8) in order to produce a stronger current and, therefore, a stronger shooting force. A diode bridge is used to rectify the mains voltage. At its output, the voltage is not constant, yet. To accomplish this, a capacitor is added to the circuit. The described circuit is switched on when a button (not shown in Figure 6) is pressed.

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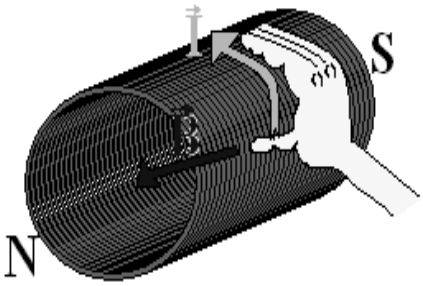
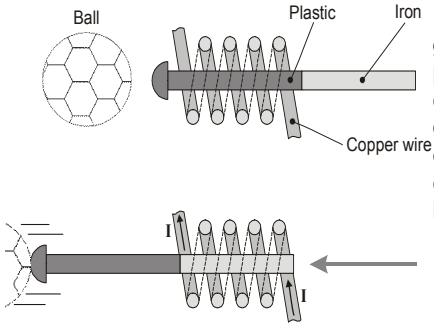


A coil (solenoid) is made of a large number of series-connected wire loops. When a current flows in a coil, it generates a magnetic field whose direction is given by the right hand rule. With your right hand, extend the thumb and curl the other fingers around the coil, in the direction of the current. The thumb points to the north of the magnetic field [1, 2].

Figure 4. Solenoid



Iron has orbital electrons that are organized in small groups called domains. The domains are randomly positioned. When an electrical current flows in the coil it produces a field, which will order the magnetic dipoles of the iron. This alignment of the orbital electrons will push the iron part of the rod into the centre of the coil, making the nylon part shoot the ball.

Figure 5. Shooting mechanism operation

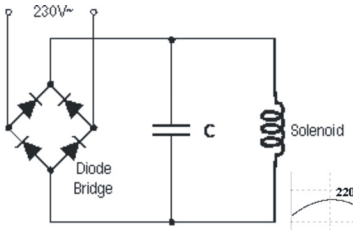


Figure 6. Electric circuit

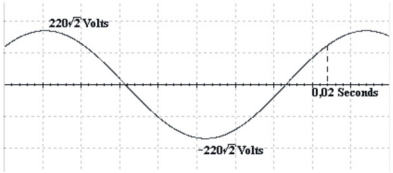


Figure 7. Mains voltage waveform

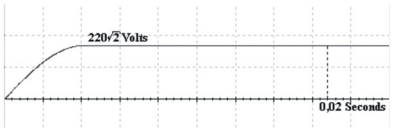


Figure 8. Rectified wave

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A temporized contactor was added to the circuit. This contactor prevents overheating of the coil, since it switches power off automatically – after a predetermined time – even if the power button is kept pressed. The shooting mechanism was fastened inside an iron case mounted on a turning base (Figure 9), which was developed to allow shooting the ball in any direction within a 90º angle.

Conclusions

An electromagnetic shooting mechanism, originally developed for soccer robots and capable of shooting a miniature soccer ball at a distance of several meters, has been presented in a science fair version. The device includes a slewing iron case and overheat protections.

The *Electromagnetic Shoot* is a fun experiment because it's related with sports, more precisely with soccer. But it also is educational, since it illustrates Electromagnetism laws. Its operation principle is the same used in other electromagnetic devices like relays and contactors.

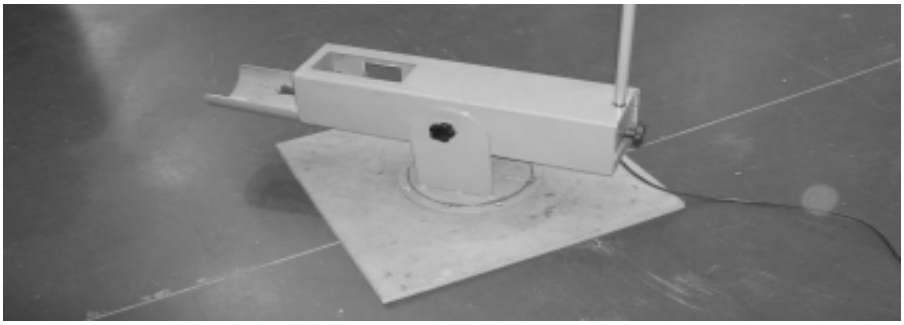

Figure 9. The Electromagnetic Shoot has an iron case mounted on a turning base

The device has been a success as a science fair attraction. Building it was exciting. It was an opportunity to learn a lot and gain experience, too.

References

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