NEAR EAST UNIVERSITY

Faculty of Engineering

Department of Biomedical Engineering

Electromagnetic Blood Flow Meter

BME 400/402
GRADUATION PROJECT

Submitted by : Muharrem Ahmetcan YALÇIN
(20090783)

Submitted to : Ali IŞIN

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CONTENT

ABSTRACT

This project is Electromagnetic Blood Flow Meter which includes introduction, magnetism, transformers, electromagnetic bloodflow meter, conclusion and references parts.

Introduction part will explain what the bloods and veins are and will give information about embolisms and diagnosis.

Magnetism part is presented more wide constrast to previous one. Magnet,magnetism and how to create basic electromagnet will be presented by using photographs.

Transformers will be carried out briefly also in order to be part of magnetism.

Main part of Project is Electromagnetic Blood Flow Meter(ebfm).Principles, design, types and process of own experiment will be studied. These will be also proved by several figures.

Project will be concluded with conclusion and references parts.

Keywords: Electromagnetic bloof flow meter, electromagnet, blood, vein, vessel, measure of blood.

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LIST OF FIGURES

1.INTRODUCTION

The aim of this project is tomeasuring speed of blood flow by generating electromagnetic field.

1.1.BLOOD

Blood is a bodily fluid in animals that delivers necessary substances such as nutrients and oxygen to the cells and transports metabolic waste products away from those same cells.

Blood is conductive mixture. There are approximately 2 volts of electricity in the human body. This voltage value, some value in the calculation of the body helps us.[1]

1.2.VEINS

In the circulatory system, veins (from the Latin vena) are blood vessels that carry blood toward the heart. Most veins carry deoxygenated blood from the tissues back to the heart; exceptions are the pulmonary and umbilical veins, both of which carry oxygenated blood to the heart. Veins differ from arteries in structure and function. For example, arteries are more muscular than veins, veins are often closer to the skin and contain valves to help keep blood flowing toward the heart, while arteries carry blood away from the heart.[2]

1.2.1.EMBOLISM/ INFARCTION

The most common cause of radial artery disease is atherosclerosis. however, other common causes Buerger's disease, Takayasu's disease, Raynaud's phenomenon, thoracic outlet syndrome, thromboembolism. One this project, we focused leg and arm arterial occlusion.

Vascular disease, leading to the feet and legs of narrowing or blockage of the arteries means. Vascular disease of the legs or arms of the major risk factors; smoking, hypertension, diabetes, high levels of blood cholesterol, age and still be considered a lazy life. Furthermore legs vessel disease more often seen in men. Cardiovascular disease is more common with advancing age.

As a result of vascular disease of the blood flow to the arms and legs as a result of congestion and shortness decreases.[3]

1.3.DIAGNOSIS

Cardiovascular disease is the simplest method to establish the diagnosis with the help of electro magnetic and ultrasonic blood flow meter is to measure blood pressure in the legs and arms. Although this is a simple test is safe and painless.

2. MAGNETISM

Magnetism refers to physical phenomena arising from the force between magnets, objects that produce fields that attract or repel other objects.

All materials experience magnetism, some more strongly than others. Permanent magnets, made from materials such as iron, experience the strongest effects, known as ferromagnetism. This is the only form of magnetism strong enough to be felt by people.

Then there's paramagnetism, in which certain materials are attracted by a magnetic field, and diamagnetism, in which materials are repelled by a magnetic field. Other, more complex, forms include antiferromagnetism, in which the magnetic properties of atoms or molecules align next to each other; and spin glass behavior, which involve both ferromagnetic and antiferromagnetic interactions.

Some materials are called non-magnetic, because their magnetic effects are so small. Magnetism can also vary depending on temperature and other factors.[4]

2.1.MAGNET

A magnet is a material or object that produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, and attracts or repels other magnets.[5]

2.2.MAGNETIC FIELD

A magnetic field is a way of mathematically describing how magnetic materials and electric currents interact. Magnetic fields have both a direction and a magnitude, or strength. Magnets have a "north" pole and a "south" pole. Opposite poles attract each other and alike poles repel each other. These poles are referred to as a magnetic dipole. Magnetic dipoles and electric currents both give rise to magnetic fields.[4]

A magnet is what makes a compass point north — the small magnetic pin in a compass is suspended so that it can spin freely inside its casing and respond to our planet's magnetism. A compass needle aligns itself and points toward the top of Earth's magnetic field.

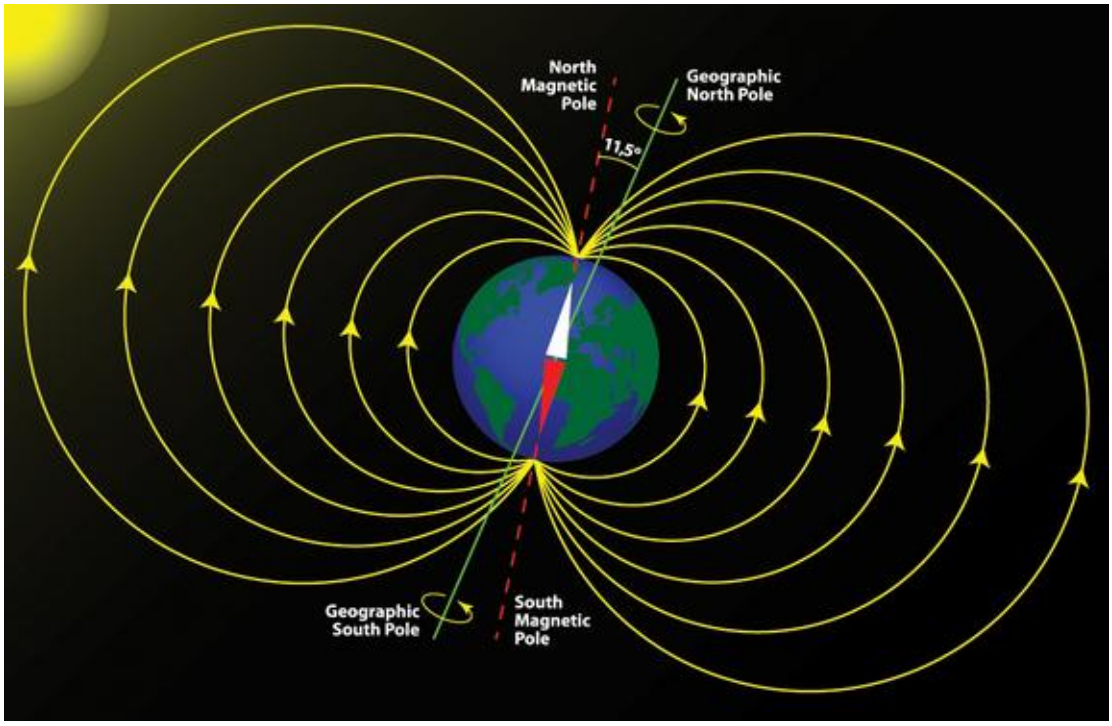

Figure1: The Earth's Magnetic Field, Magnetic Poles and Geographic Poles. [4]

2.3.ELECTROMAGNET

An electromagnet is a type of magnet in which the magnetic field is produced by electric current. The magnetic field disappears when the current is turned off. Electromagnets are widely used as components of other electrical devices, such as motors, generators, relays, loudspeakers, hard disks, MRI machines, scientific instruments, and magnetic separation equipment, as well as being employed as industrial lifting electromagnets for picking up and moving heavy iron objects like scrap iron.

An electric current flowing in a wire creates a magnetic field around the wire, due to Ampere's law (see drawing below). To concentrate the magnetic field, in an electromagnet the wire is wound into a coil with many turns of wire lying side by side. The magnetic field of all the turns of wire passes through the center of the coil, creating a strong magnetic field there. A coil forming the shape of a straight tube (a helix) is called a solenoid. Much stronger magnetic fields can be produced if a "core" of ferromagnetic material, such as soft iron, is placed inside the coil. The ferromagnetic core increases the magnetic field to thousands of

times the strength of the field of the coil alone, due to the high magnetic permeability μ of the ferromagnetic material. This is called a ferromagnetic-core or iron-core electromagnet.

The direction of the magnetic field through a coil of wire can be found from a form of the right-hand rule. If the fingers of the right hand are curled around the coil in the direction of current flow (conventional current, flow of positive charge) through the windings, the thumb points in the direction of the field inside the coil. The side of the magnet that the field lines emerge from is defined to be the north pole.

The main advantage of an electromagnet over a permanent magnet is that the magnetic field can be rapidly manipulated over a wide range by controlling the amount of electric current. However, a continuous supply of electrical energy is required to maintain the field.[6]

2.3.1.HOW TO CREATE BASIC ELECTROMAGNET

2.3.1.1.REMOVE SOME INSULATION

Some of the copper wire needs to be exposed so that the battery can make a good electrical connection. Use a pair of wire strippers to remove a few centimeters of insulation from each end of the wire..[7]

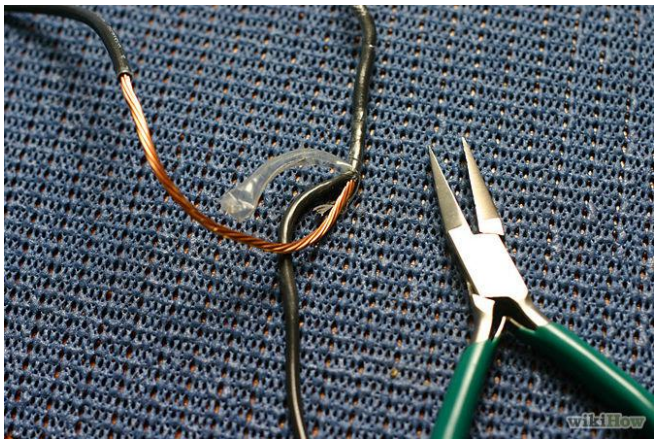

Figure2: Copper Wire [7]

2.3.1.2.WRAP THE WIRE AROUND THE NAIL

Neatly wrap the wire around the nail. The more wire you wrap around the nail, the stronger your electromagnet will be. Make certain that you leave enough of the wire unwound so that you can attach the battery.When you wrap the wirearound the nail, make certain that you wrap the wire all in one direction. You need to do this because the direction of a magnet field

depends on the direction of the electric current creating it. The movement of electric charges creates a magnetic field. If you could see the magnetic field around a wire that has electricity flowing through it, it would look like a series of circles around the wire. If an electric current is flowing directly towards you, the magnetic field created by it circles around the wire in a counter-clockwise direction. If the direction of the electric current is reversed, the magnetic field reverses also and circles the wire in a clockwise direction. If you wrap some of the wire around the nail in one direction and some of the wire in the other direction, the magnetic fields from the different sections fight each other and cancel out, reducing the strength of your magnet.[7]

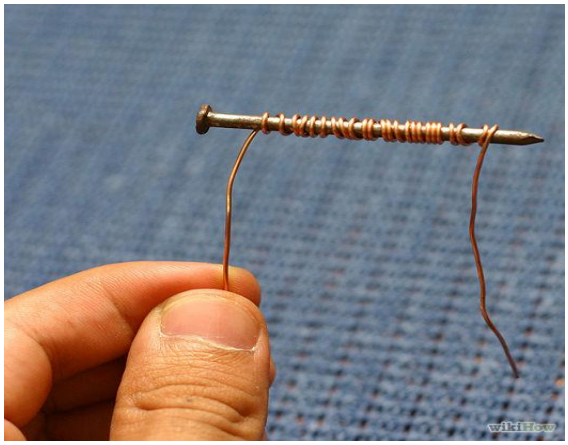

Figure3: Basic Coil[7]

2.3.1.3.CONNECT BATTERY

Attach one end of the wire to the positive terminal of the battery and the other end of the wire to the negative terminal of the battery. If all has gone well, your electromagnet is now working![7]

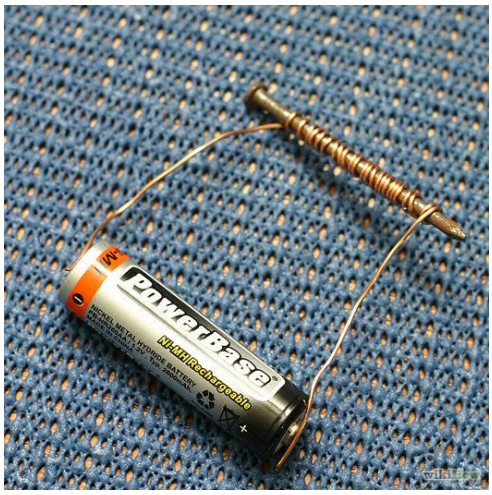

Figure4: Basic Electromagnet[7]

3.TRANSFORMERS

A transformer is an electrical device that transfers energy between two or more circuits through electromagnetic induction.

A varying current in the transformer's primary winding creates a varying magnetic flux in the core and a varying magnetic field impinging on the secondary winding. This varying magnetic field at the secondary induces a varying electromotive force (emf) or voltage in the secondary winding. Making use of Faraday's Law in conjunction with high magnetic permeability core properties, transformers can thus be designed to efficiently change AC voltages from one voltage level to another within power networks.[8]

4.ELECTROMAGNETIC BLOOD FLOW METER

Measures instantaneous flow of blood. Works based on the principle of electromagnetic induction. The voltage induced in a conductor moving in a magnetic field is proportional to the velocity of the conductor. The conductive blood is the moving conductor.

4.1.PRINCIPLE OF ELECTROMAGNETIC BLOOD FLOW METER

A permanent magnet or electromagnet positioned around the blood vessel generates a magnetic field perpendicular to the direction of the flow of the blood.
Voltage induced in the moving blood column is measured with stationary electrodes located on opposite sides of the blood vessel and perpendicular to the direction of the magnetic field.

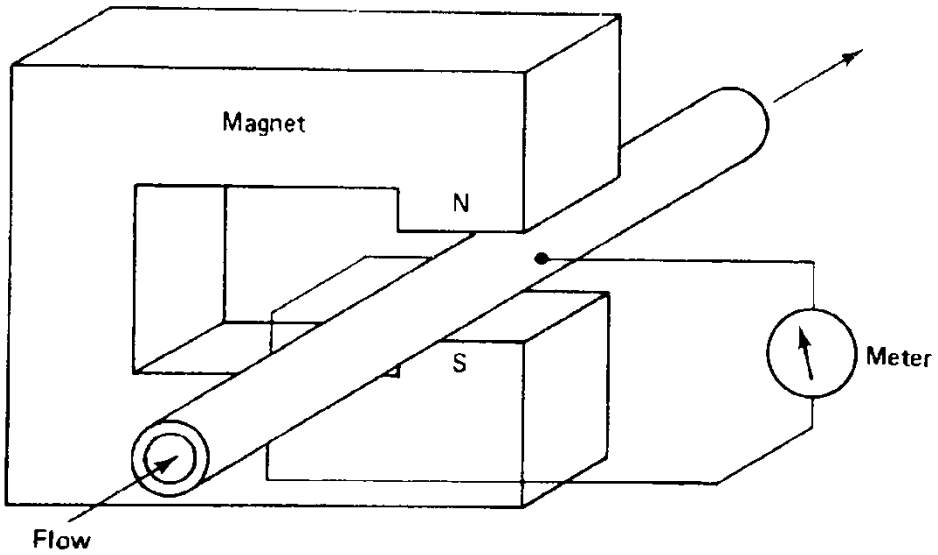

Figure5: Desing of machine [10]

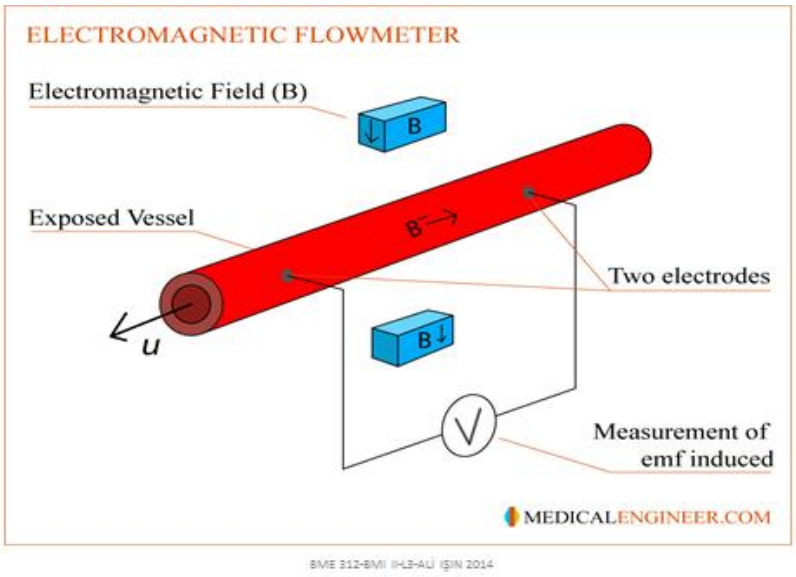

Figure6: Another type of desing [9]

This method requires that the blood vessel be exposed so that the flow head or the measuring probe can be put across it.

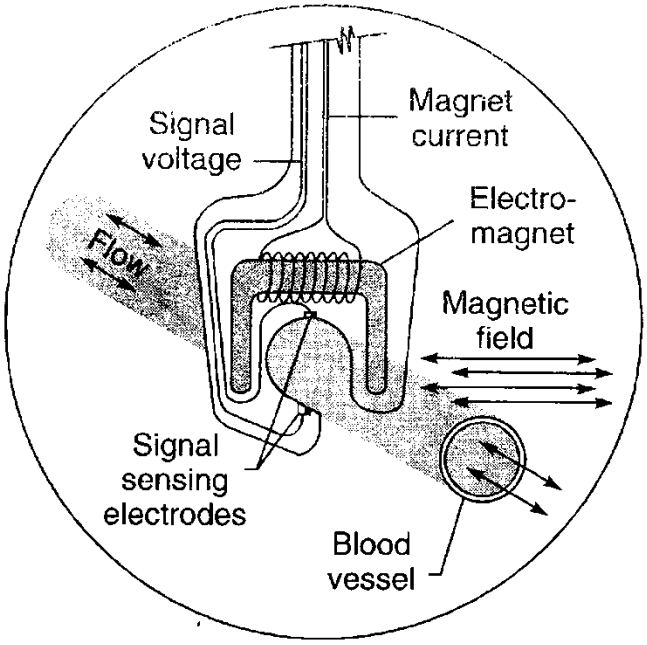

Figure7:Detail of system [10]

The Induced ***emf***;

$$e = \int_0^{L_1} \mathrm{u} \times \mathrm{B}.\, d\mathbf{L}$$

Figure8: Formula for microprocess [10]

Measure formula

B = magnetic flux density, T

L = length between electrodes, m

u = instantaneous velocity of blood, m/s

4.2.DESIGN OF FLOW TRANSDUCER

The electromagnetic flow-transducer is a tube of non-magnetic material to ensure that the magnetic flux does not bypass the flowing liquid and go into the walls of the tube.

The tube is made of a conducting material and generally has an insulating lining to prevent short circuiting of induced emf.

The induced emf is picked up by point electrodes made from stainless steel or platinum.

4.3.TYPES OF ELECTROMAGNETIC BLOOD FLOW METER

DC Flow meters:

- Use DC Magnetic field.
- Cause electrode polarization and amplifier drift.
- AC Flow meters;
- Electromagnets are driven by alternating currents.
- The transducer acts like a Transformer and induces error voltages that often exceed the signal levels by several orders of magnitude.

4.4.PROCESS OF ELECTROMAGNETIC BLOOD FLOW METER PROJECT

In this Project I used; artificial arms, artificial blood, electromagnet, transformer, electrode, voltmeter, copper wire, aquarium pump and sodium chloride.

Firstly,I made an electromagnet. This should be a strong electro-magnet. The materials used were not conductive so I need a strong magnet and I chose the AC magnet.

The number of spin is most important when create the electromagnets. When wrapping some calculations and experience are needed.

$V_1 = 4{,}44 \times B \times Sn \times N_1 \times f \times 10^{-8}$ formülünden N_1 primer sipir sayısını çekersek;

$$N_1 = \frac{V_1 \times 10^8}{4{,}44 \times B \times S_n \times f} = \frac{220 \times 10^8}{4{,}44 \times 10000 \times 8{,}57 \times 50} = 1156{,}34 \cong 1157 \textbf{ sipir}$$

Sekonder sipir sayısı iki şekilde bulunabilir.

I.yol:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} \Rightarrow \frac{220}{24} = \frac{1157}{N_2} \Rightarrow N_2 = \frac{24 \times 1157}{220} = 126{,}21 \cong 127 \text{ sipir.}$$

II.yol:

$$N_2 = \frac{V_2 \times 10^8}{4{,}44 \times B \times S_n \times f} = \frac{24 \times 10^8}{4{,}44 \times 10000 \times 8{,}57 \times 50} = 126{,}14 \cong 127 \textbf{ sipir.}$$

Figure9: Formula of spin number [11]

This formula help us on calculations. When we creating the electromagnet, have increased the number of spins. Electromagnet consumes a lot of energy. Approximately, after a few minutes magnet will heats up and burn. To extend this time I have increased the number of spin and using thin wire(0,35mm). thus increased duration of use. I grid 927 times. I used to silicone iron mixture in this electro magnet because this material cunductive and lighter than just iron.

Figure10: Industrial electromagnet

Intended use of transformers; voltage and current in an electrical circuit is used to decrease or increase. We used to same sproperties on this project. We had 3 different voltage output. First one is 80 volt, second one is 110 volt and third one is 220 volt. I grid almost 2613 times. We use the 110 volt(stronger than 80volt and ideal voltage) on the system because vein and arm is not reel material so they are insulator material.

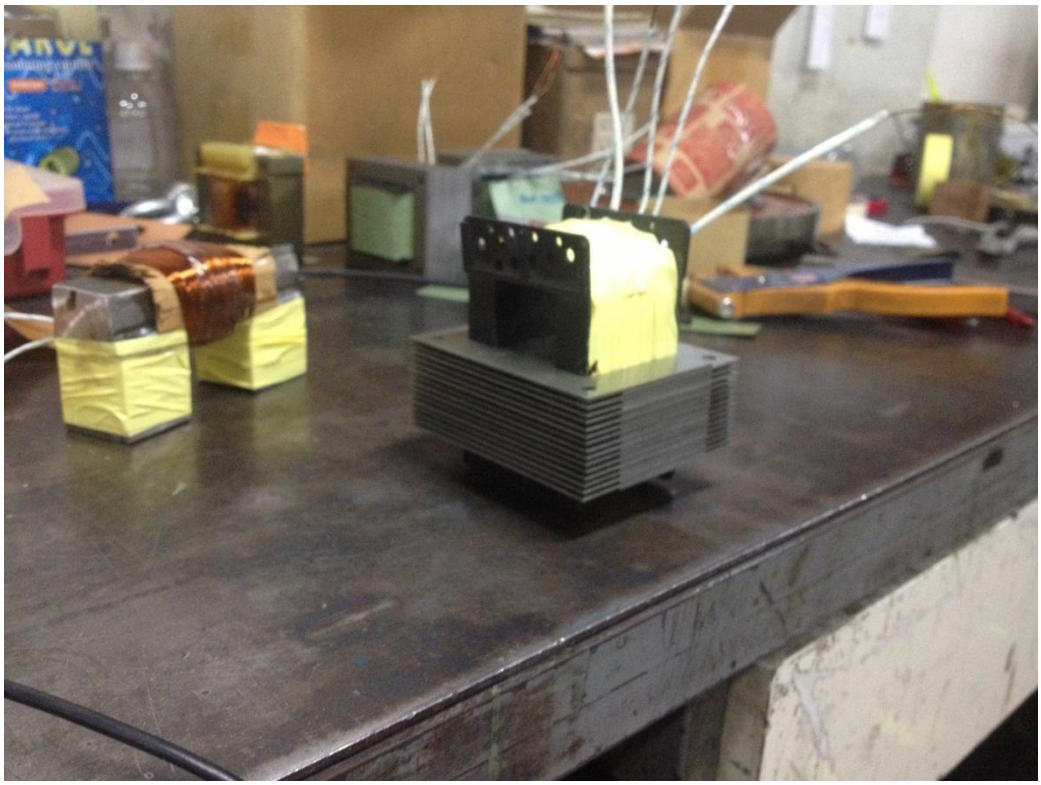

Figure11: Industrial transformer

When I griding transformer ı used to silicone-iron mixtures material. This material very conductive material than iron.

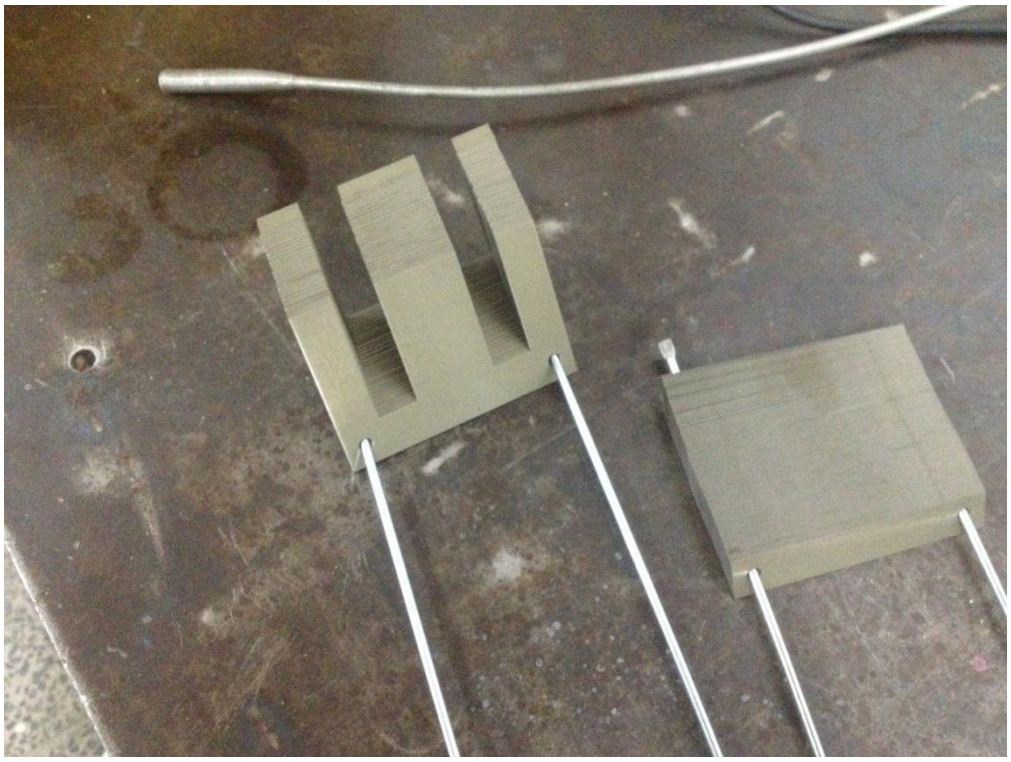

Figure12: Silicone and iron mixture material

I used to aquarium pump for water pump to vessel. I bought it. It has no special skills. It has just 10 watt power.

Pins is my inner electrode. Arm and vein is not conductive so ı applied the pins into the vein. With the help of copper cable, I connected to the electrode of voltmeter.

Water is conductive element but we need more conductive material and I used to sodium chloride for the increase the conductivity.

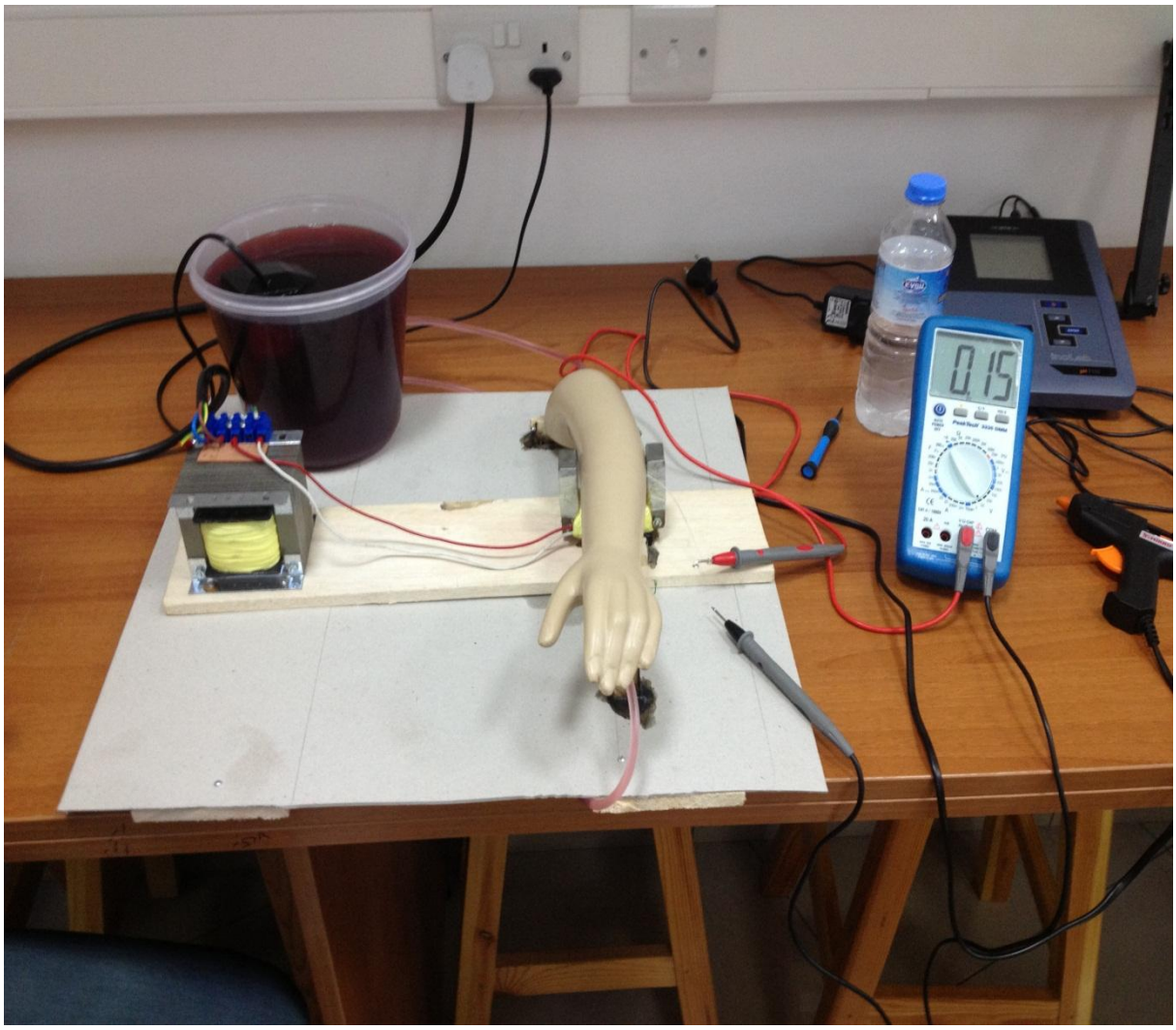

Figure13: Project of Electromagnetic Blood Flow Meter

And Icompleted the project. Electromagnetic blood flow meter is ready for measure.

5.CONCLUSION

We've got a bucket of water(with sodium chloride). We have a pump in the bucket. Our pump is pumping water and we use the cherry for the red coluor (like blood). Water turning around the system. Water comes to between two prallel magnet plates. It's tounching molecules of electrodes (pins). And pins transmitting the electicity to voltmeter and we saw the some data. When we compress the veins voltage parameters decreases. On the system workin we has a woltage parameter and when we compress the veins it changes so we can say the some problems on the vein in reel body.

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