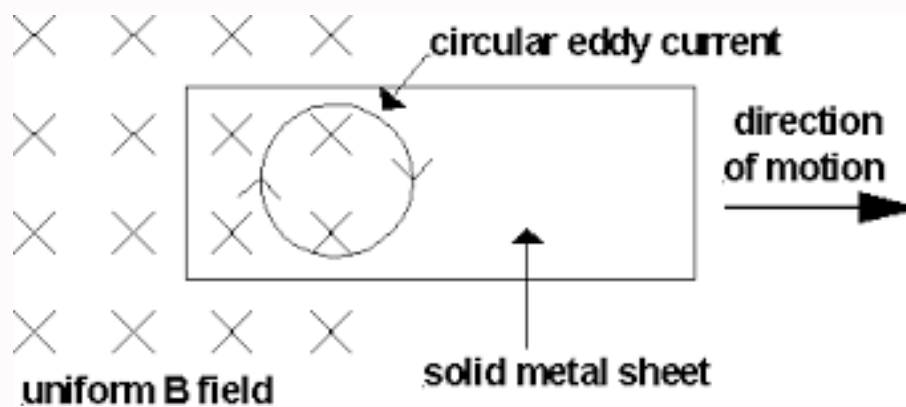




INVESTIGATORY PROJECT ON METAL DETECTOR

Currents can be induced, not only in conducting coils, but also in conducting sheets or blocks. Whenever the magnetic flux linked with a metal sheet or a block changes, an emf is induced in it. The induced currents flow in closed paths in planes perpendicular to the lines of force throughout the body of the metal.



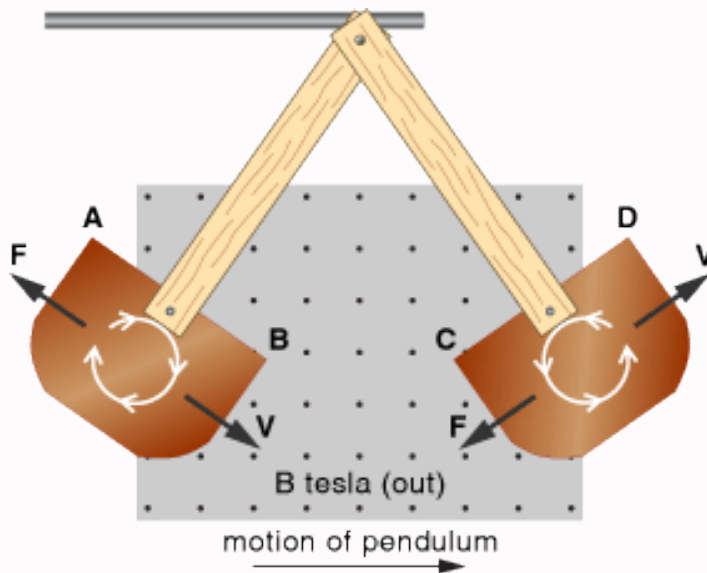
These currents look like eddies or whirlpools in water and so they are known as **eddy currents**. As these currents were first discovered by Focault in 1895, so eddy currents are also known as **Focault currents**.

There are two experiments to demonstrate eddy currents, they are as follows.



EXPERIMENT-1

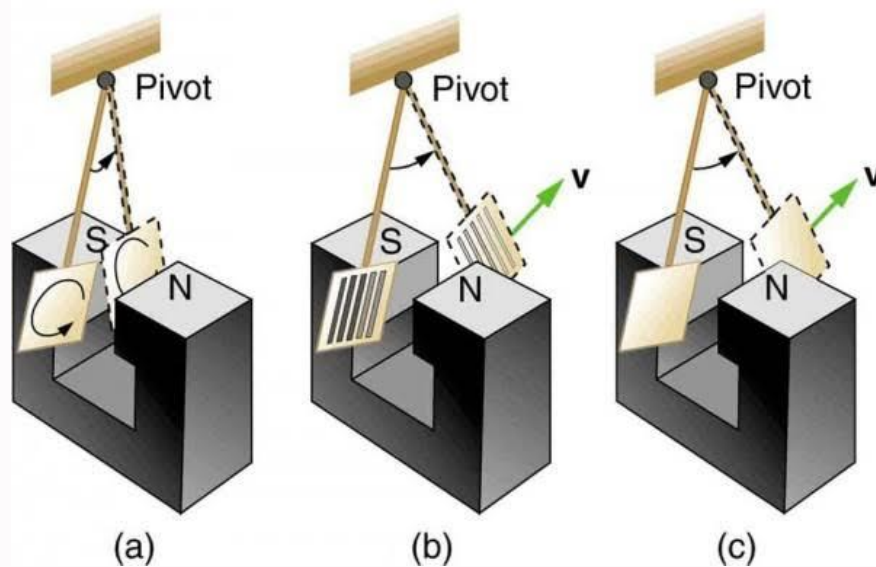
Take a pendulum having its bob in the form of a flat copper plate. It is free to oscillate between the poles of an electromagnet. In the absence of any magnetic field, the pendulum swings freely. As the electromagnet is switched on, the oscillations of the pendulum get highly damped and soon it comes to rest. This is because as the copper plate moves in between the pole pieces of the magnet, magnetic flux threading through it changes, so eddy currents are set up in it which according to Lenz's law, oppose the motion of the copper plate in the magnetic field. Eddy currents flow anti-clockwise as the plate swings into the field and clockwise as the plate swings out of the field.





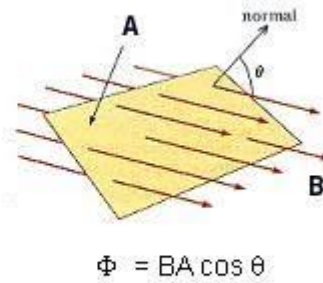
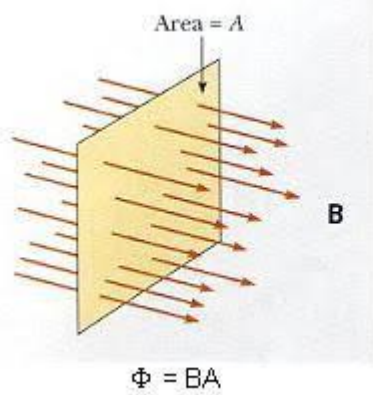
EXPERIMENT-2

Now take the pendulum of a flat copper plate with narrow slots cut across it. As the electromagnet is switched on, eddy currents are set up in the plate, but this plate swings for a longer duration than the plate without slots. This is because the loop has much larger paths for the electrons to travel. Larger paths offer more resistance to the electrons and so the eddy currents are sufficiently reduced. As a result, the opposition to the oscillations becomes very small.





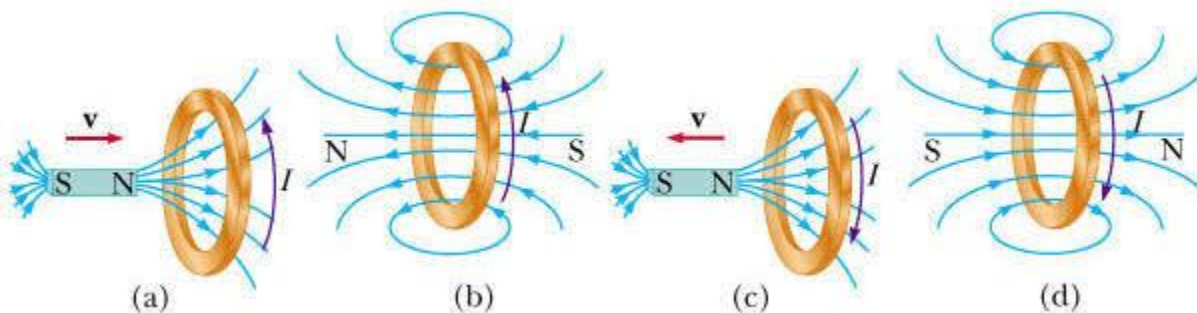
1) Magnetic flux- the magnetic flux through any surface placed in a magnetic field is the total number of magnetic lines of force crossing this surface normally.



2) Electromagnetic force(emf)-it is defined as the work done per unit charge

$$E = w/q = Blv$$

3) Lenz law- the polarity of induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produced it.





AIM-

To design a single coil metal detector and to learn more about eddy currents.





MATERIALS REQUIRED-

- PCB board
- 9v battery
- Battery connector
- Two 2 μ capacitors
- 555 timer IC
- Buzzer
- On/off switch
- 47 K Ω resistor
- 10 μ capacitor
- 0.2mm copper wire
- Connecting wires





METAL DETECTOR THEORY

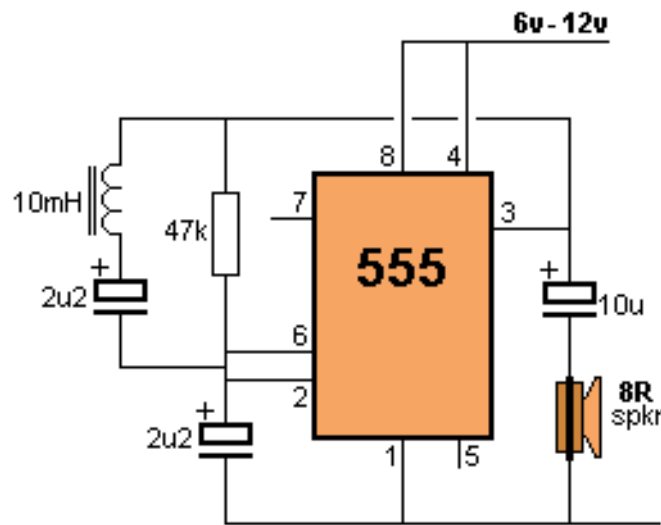
A **metal detector** is an electronic instrument that detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator. Usually the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes. Another common type are stationary "walk through" metal detectors used for security screening at access points in prisons, courthouses, and airports to detect concealed metal weapons on a person's body.

The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected.





CONSTRUCTION-



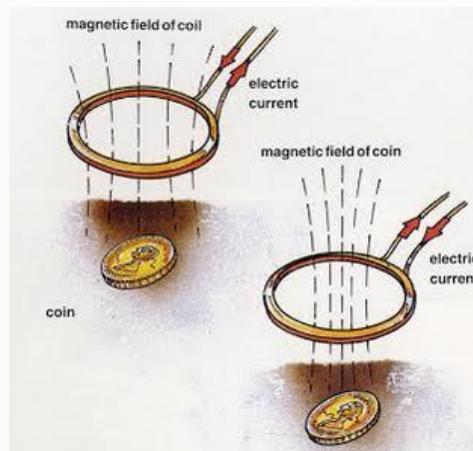
METAL DETECTOR

- Take the copper wire and convert it into a coil with two of its ends free.
- Connect the two ends with two different connecting wires.
- Solder the 555 timer IC on the PCB board
- As per the circuit diagram, do the required connections and solder them properly
- Attach the battery to the battery cap
- Check the connections once again, and the device is ready to use.

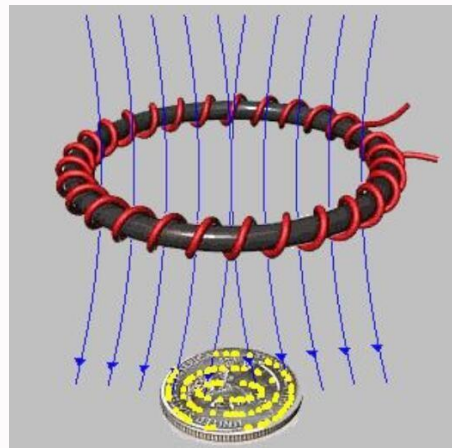


WORKING-

Metal detector works on the principle of electromagnetic induction. A pushing current is applied to the coil with the help of a battery, which induces a magnetic field, when the magnetic field of the coil moves across the metal, such currents (called eddy currents) are induced in the coil.



They induce their own magnetic field, which generates an opposite current in the coil, which in turn induces a signal indicating the presence of metal. The signal generated comes out in the form of sound (bleep!bleep!bleep!bleep!)





ADVANTAGES/DISADVANTAGES-

1)ADVANTAGES-





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