

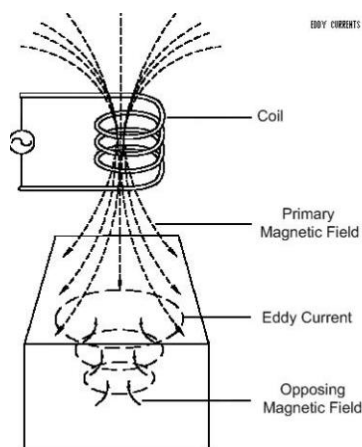
ELECTROMAGNETIC INDUCTION

EDDY CURRENTS

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Eddy currents are electrical currents induced in a conductor in response to a changing magnetic field. These currents circulate in closed loops within a plane that is perpendicular to the magnetic field. As dictated by Lenz's law, these currents swirl in such a way that they generate a magnetic field that opposes the change in the external magnetic field. To achieve this in a conductor, electrons within it swirl within a plane perpendicular to the magnetic field.

One key characteristic of eddy currents is their tendency to resist change, which results in a loss of energy. Eddy currents essentially convert more useful forms of energy, such as kinetic energy, into heat, which is generally not as useful.



Practical Application:

1. Brakes in Trains:

When trains apply brakes, they subject the metal wheels to a magnetic field, inducing eddy currents in the wheels. The interaction between the applied magnetic field and these eddy currents works to slow down the wheels. This effect is stronger at higher wheel speeds, making the braking force gradually reduce and ensuring a smooth stopping motion for the train.

2. Electromagnetic Damping:

Eddy currents are utilized in the design of deadbeat galvanometers, instruments used for measuring small electric currents. In such devices, a coil is usually suspended and may oscillate slightly before coming to rest. This oscillation can cause a delay in obtaining a stable reading. To mitigate this delay, the coil is wound around a non-magnetic metallic frame. When the coil is deflected, eddy currents form in the metallic frame, causing the needle to come to rest almost instantly. This damping effect is crucial for obtaining accurate measurements.

3. Electric Power Meters:

Electric power meters, the devices used to measure electricity consumption, often include a shiny metal disc that rotates. The magnetic field induces eddy currents in this disc, leading to its rotation. Observers can often see this shiny disc in residential electric power meters.

4. Induction Furnace:

Induction furnaces employ rapidly changing magnetic fields to induce large eddy currents. These eddy currents, in turn, generate heat. Consequently, the temperature rises significantly. A coil is wound around a conductive metal placed in an oscillating magnetic field generated by high-frequency currents. The heat produced is sufficient to melt metals, making it a valuable technique for extracting metals from ores and for preparing alloys at extremely high temperatures.

5. Speedometers:

Eddy currents are employed in speedometers to gauge the speed of vehicles. A speedometer typically includes a magnet that rotates in accordance with the vehicle's speed. Eddy currents are generated within a drum as it turns in response to the rotating magnet. A pointer attached to the drum indicates the vehicle's speed based on these eddy currents.

In summary, eddy currents are a fascinating phenomenon with a range of practical applications, from improving the performance of brakes in trains to enabling accurate measurements in galvanometers and electric power meters, as well as facilitating metal extraction and alloy preparation in induction furnaces. Additionally, they are instrumental in speedometers, aiding in determining vehicle speed.

Example.

Determine the direction of the induced electric current within the wire segment AB when it is subjected to an anticlockwise rotation through an angle denoted as ' θ .' This analysis pertains to the initial orientation of the wire as depicted in the provided diagram.

Solution.

Range of Angle

0 - 90

90 - 180

180 - 270

270 - 360

Rotated Direction of induced current

A To B

A To B

B To A

B To A

