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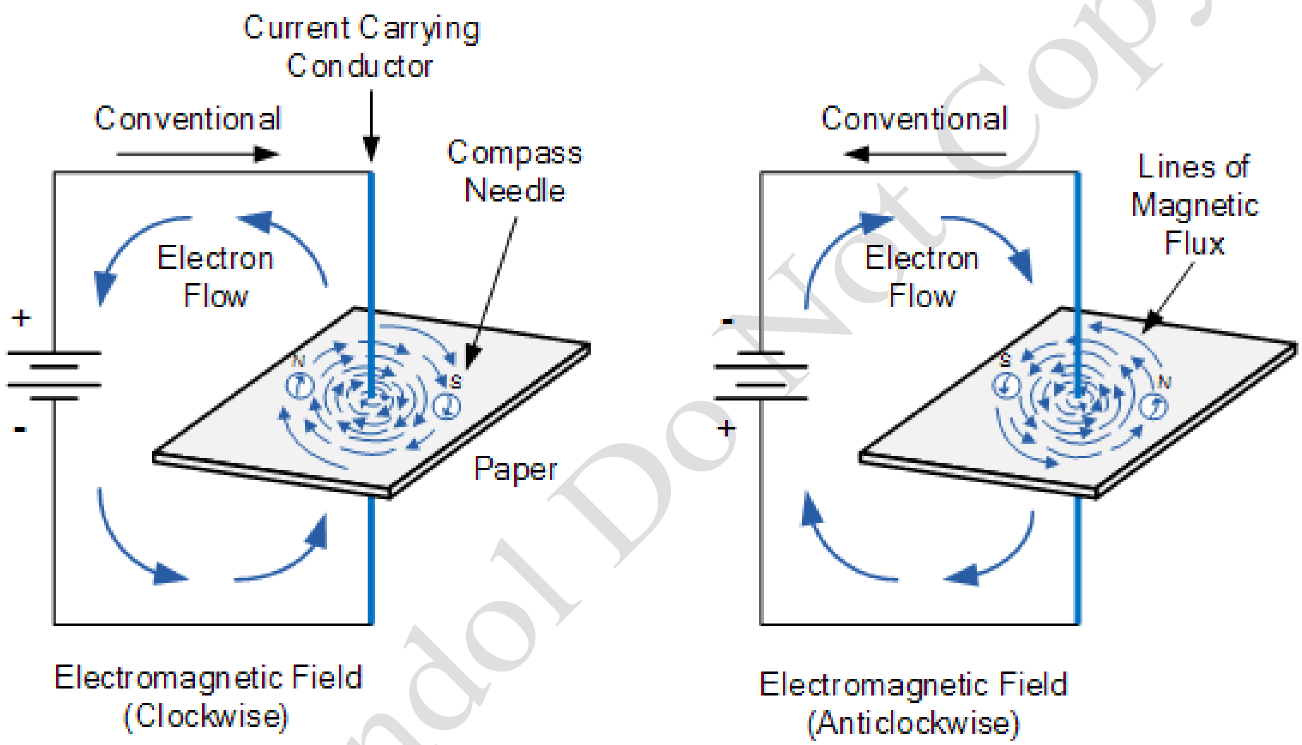
When an electric current flows through a magnetic field an electromagnetic force is generated.

When an electric current flows through a conductor, the magnetic force generated around it can interact with the magnetic field producing motion.

Magnetic Field Around Current Carrying Conductor



To determine the direction of the magnetic field lines, one can use the **RIGHT HAND GRIP RULE.**

THE RIGHT HAND GRIP RULE USES THE RIGHT HAND.

The thumb points in the direction of the conventional current while the fingers curve around the straight current carrying conductor.

The direction in which the fingers point to is the direction of the magnetic field.

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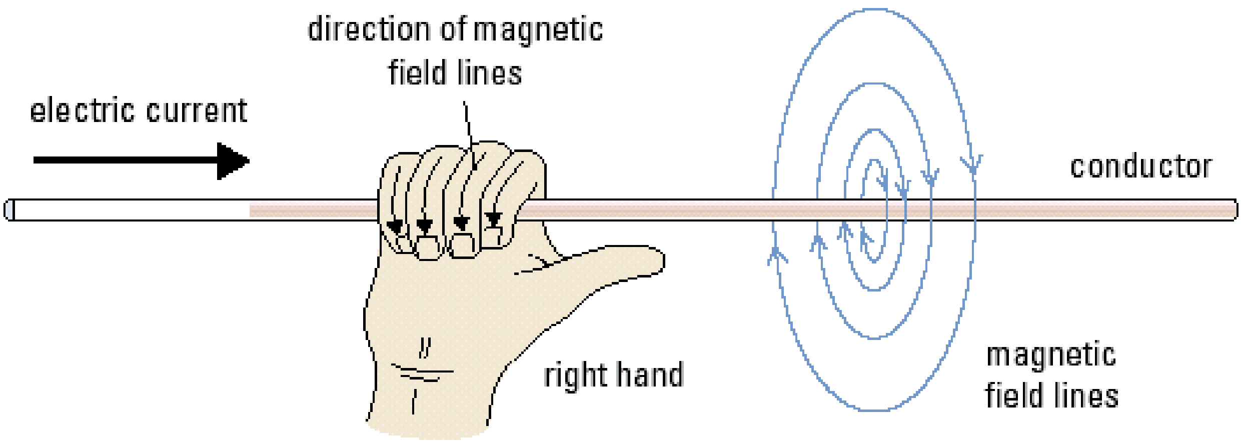

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Fleming's Left Hand Rule

This rule uses the left hand.

Fleming's left hand rule is used to determine the direction of motion given the direction of the magnetic field lines and the direction of the current.

Note: Fleming's left hand rule is used ONLY to find the direction of motion.

thuMb - Motion

Forefinger - Field Lines

seCond finger - Current

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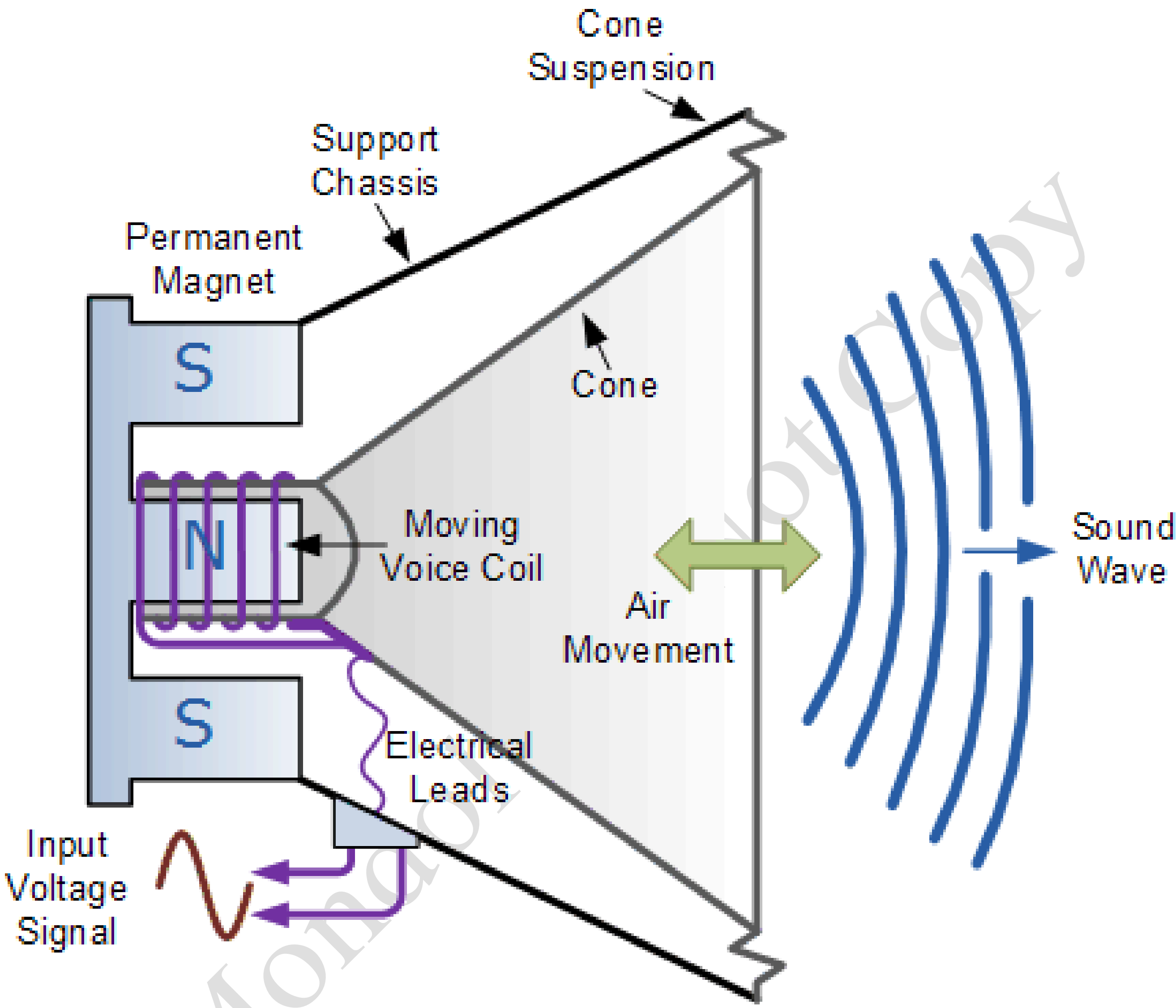
Moving Coil Loudspeaker



The moving coil loudspeaker uses the principle of Fleming's Left Hand Rule. The North Pole magnet is donut shaped and at its centre is a cylindrical south pole magnet. In the space between there is a paper roll with a copper coil. (This paper roll is connected to the paper cone that is hinged to the speaker box.

When a current flows through the coil (located within the magnetic field) an electromagnetic force is created. This results in the motion of the paper cone. When the paper cone moves, vibrations are set up creating sound.

If the intensity of the current is increased then the motion of the coil is increased which increases the loudness of the sound.

If the frequency of the change of current direction is increased, then the pitch of the sound is increased.

If a battery is attached to a moving coil loudspeaker, then a single short sound will be heard. This occurs because the battery produced direct current at a sustained level.

If the moving coil loudspeaker is attached to alternating current, then a high pitched continuous sound will be heard as the paper cone moves to and fro repeatedly.

The intensity of sound can be increased by:

1. Increasing the size of the current
2. Increasing the strength of the magnet
3. Increasing the number of turns within the coil

Induced EMF

When the magnetic field lines are cut by conductors a current is set up within the conductor. This current us called an induced current or induced EMF.

When the magnet (suspended by a string) is lowered through the coil, an induced emf is created. This induced emf is measured by the Galvanometer (measures the size and direction of the current)

When the magnet is pulled upwards out of the coil, a similar current is produced however the direction of the current is reversed.

When the magnet is being lowered through the coil, the magnetic field lines are continuously cut by the turns of the coil. This creates the induced emf.

Faraday's Law

Faraday's Law states that the magnitude of the emf induced in a conductor is dependent upon the rate of change of magnetic flux that is, the rate at which the field lines are cut.

Faraday's law can be demonstrated by varying the rate at which the magnet passes through the coil. In the first instance, the magnet is gently lowered and the size of the induced current is recorded using a galvanometer. The magnet is then dropped through the coil and it will be observed that the new galvanometer reading is significantly greater than the previously recorded reading.

Lenz's Law

This states that the direction of an induced current is such as to oppose the change causing it.

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In the diagram shown, an induced emf is set up when the magnet passes through the coil. According to Lenz's law, the direction if the induced emf must oppose the change causing it. The change causing the induced emf is actually the magnet. When the current flows through a coil (a solenoid), a magnetic field is created. This magnetic field resembles that of a bar magnet that is there exist a north pole and a south pole.

The direction of the induced emf should therefore be such that the pole of the solenoid closest to the magnet should be the same as that of the pole on the magnet that is closest to the solenoid.

In the diagram shown, the north pole of the magnet approaches the coil therefore the induced current has the direction such that a north pole is created close to the magnet. This north pole of the solenoid repels the magnet (that is opposes the change).

Dynamo Rule

This is similar to Fleming's Left Hand Rule except:

1. The right hand is used.
2. The dynamo rule is used to find the direction of conventional current given the direction of motion and magnetic field.

In the right hand:

thuMb	-	Motion
First finger	-	Field
seCond finger	-	Current