Speakers

introduction

- Loudspeaker is a transducer which converts electrical signals of audio frequency into sound waves of the same frequency.

Characteristics of Loudspeakers

- 1. Efficiency: It is defined as ratio of output sound power to the input audio (electrical power).
- Some manufacturers quote the efficiency in terms of sensitivity which is defined to be the input signal required to give sound pressure level of 0.1 Pa or 1 microbar at a distance of 1 meter from the loudspeaker.

Characteristics of Loudspeakers

- 2. Noise: The unwanted sound, not contained in the input signal but present in the output of loudspeaker is called noise. (The mechanical parts may vibrate at some resonant frequency, causing noise).
- What is more important is signal to noise ratio *(S/N)* which is defined as ratio of 'Signal output' to the 'Output of noise in the absence of signal'.

Characteristics of Loudspeakers

- 3. Frequency response: It indicates loudspeaker's response for the audible frequency range of sound. Ideally, response of a loudspeaker should be flat within plus or minus 1 dB for the frequency range of 16 Hz to 20 kHz.

Characteristics of Loudspeakers

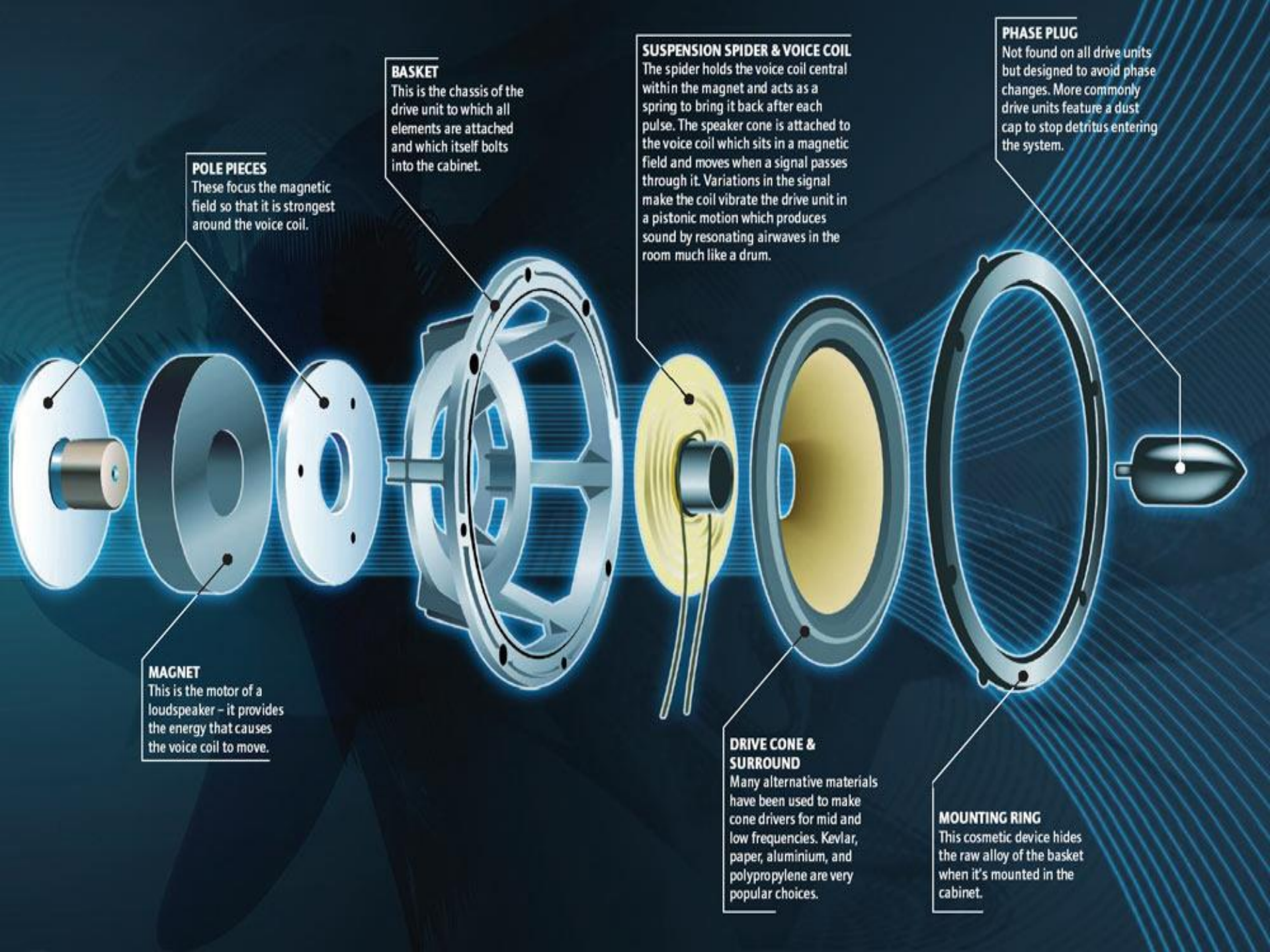
- 4. Distortion: Any change in the frequency, phase and amplitude complexion of the output sound as compared to the input audio signal is called distortion. Non-linear distortion will result due to non-uniformity in the magnetic field in which the coil moves.

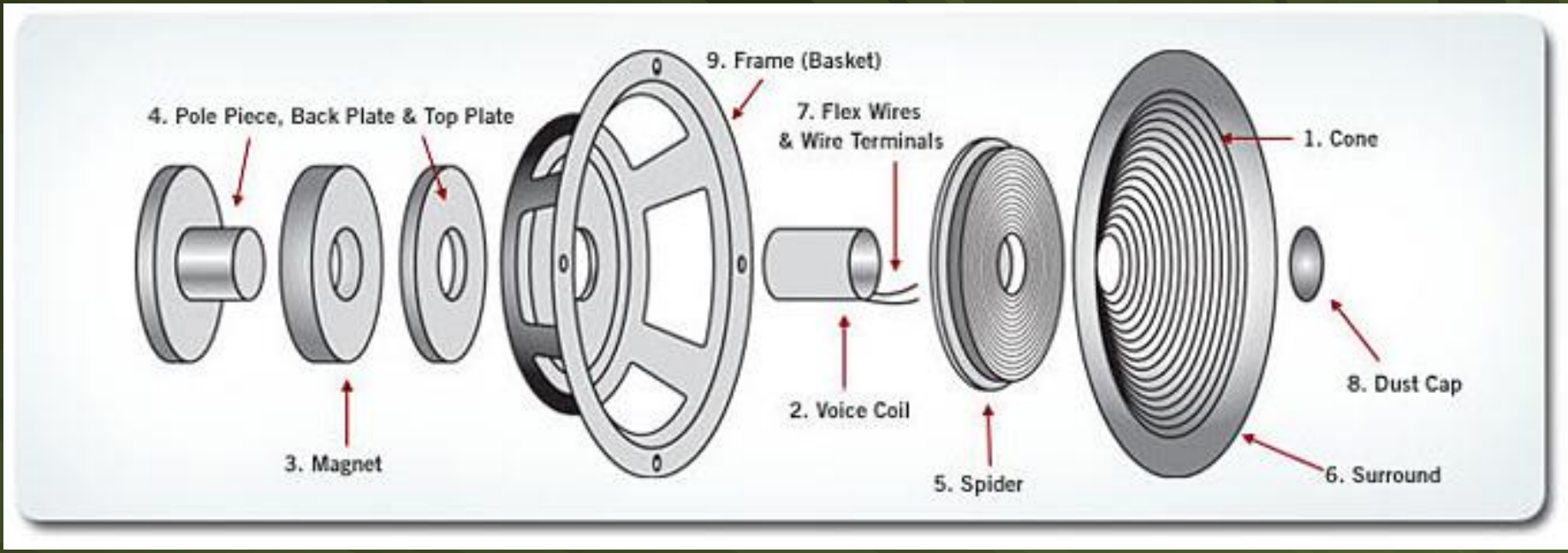
Characteristics of Loudspeakers

- 5. Directivity: Ratio of actual sound intensity at a point in the direction of maximum intensity to the sound intensity that would have been available there, had the loudspeaker been omnidirectional.

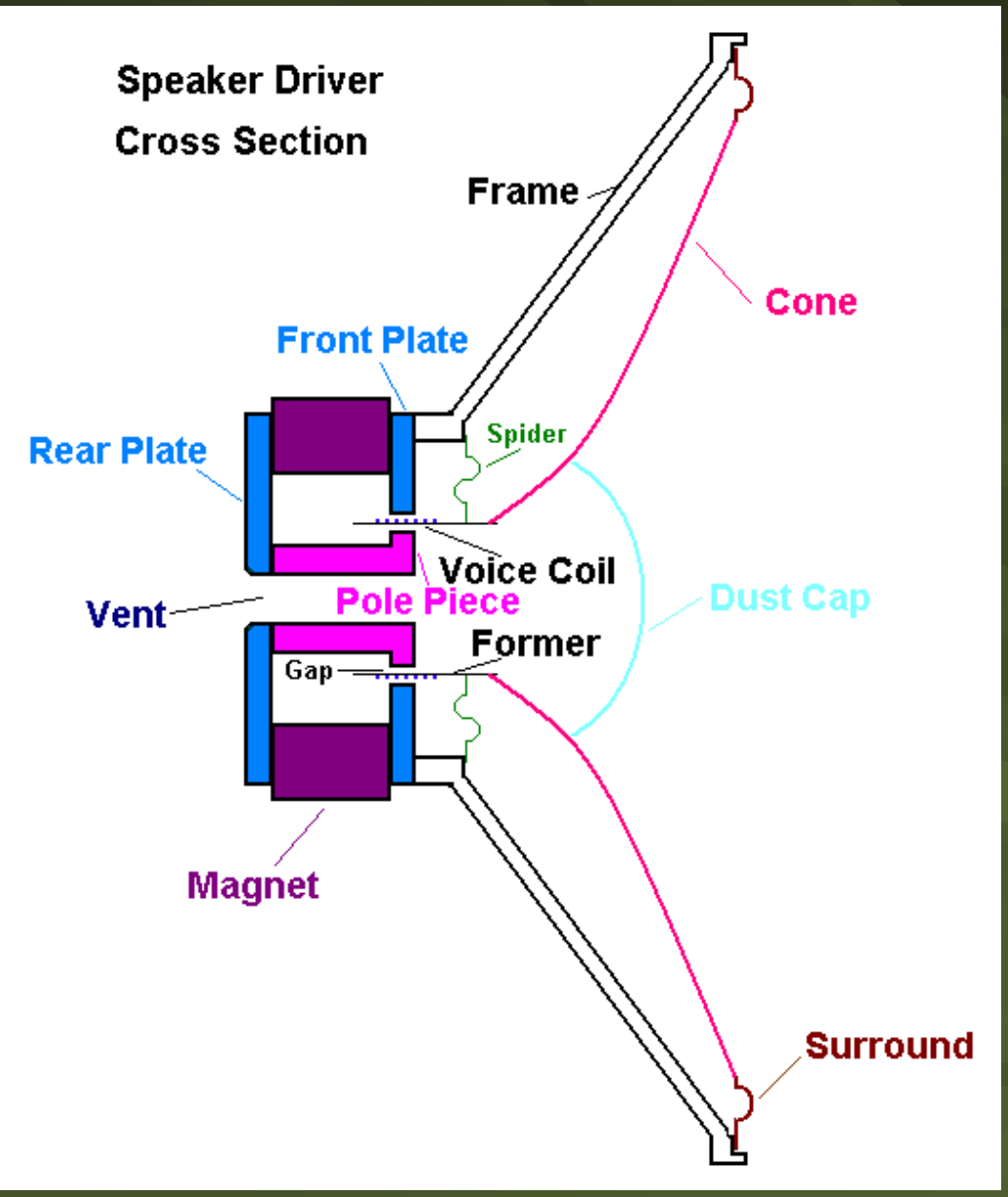
Characteristics of Loudspeakers

- 7. Impedance: The input impedance of the loudspeaker is represented in ohms and is an important parameter, as its matching with the impedance of source amplifier is necessary.


POLE PIECES
These focus the magnetic field so that it is strongest around the voice coil.
BASKET
This is the chassis of the drive unit to which all elements are attached and which itself bolts into the cabinet.
SUSPENSION SPIDER & VOICE COIL
The spider holds the voice coil central within the magnet and acts as a spring to bring it back after each pulse. The speaker cone is attached to the voice coil which sits in a magnetic field and moves when a signal passes through it. Variations in the signal make the coil vibrate the drive unit in a pistonic motion which produces sound by resonating airwaves in the room much like a drum.
PHASE PLUG
Not found on all drive units but designed to avoid phase changes. More commonly drive units feature a dust cap to stop detritus entering the system.
MAGNET
This is the motor of a loudspeaker – it provides the energy that causes the voice coil to move.
DRIVE CONE & SURROUND
Many alternative materials have been used to make cone drivers for mid and low frequencies. Kevlar, paper, aluminium, and polypropylene are very popular choices.
MOUNTING RING
This cosmetic device hides the raw alloy of the basket when it's mounted in the cabinet.



- **. Cone:** this is what pushes the air and begins the sound wave's journey. Most modern tweeters move air with a dome rather than a cone.
- **2. Voice coil:** the electromagnet that drives the cone.
- **3. Magnet:** the non-changing magnetic field that allows the voice coil's alternating magnetic force to be attracted or repelled.
- **4. Top plate, back plate and pole piece:** the magnetically conductive parts that efficiently concentrate the magnet's energy around the voice coil.
- **5. Spider:** a springy cloth disc that keeps the voice coil and bottom of the cone from moving off to the side while allowing it to move forward and backwards.
- **6. Surround:** a springy ring that keeps the top of the cone from moving off to the side while allowing it to move forward and backwards. Together with the spider, a suspension system is formed for the parts that move, the moving parts being the cone and voice coil.
- **7. Flex wires and wire terminals:** this is how the electricity from the amplifier connects to the voice coil.
- **8. Dust cap:** a cover glued to the cone that keeps debris from getting into the gap between the magnet and the pole piece where the voice coil resides.
- **9. Frame (or basket):** what holds all these parts together



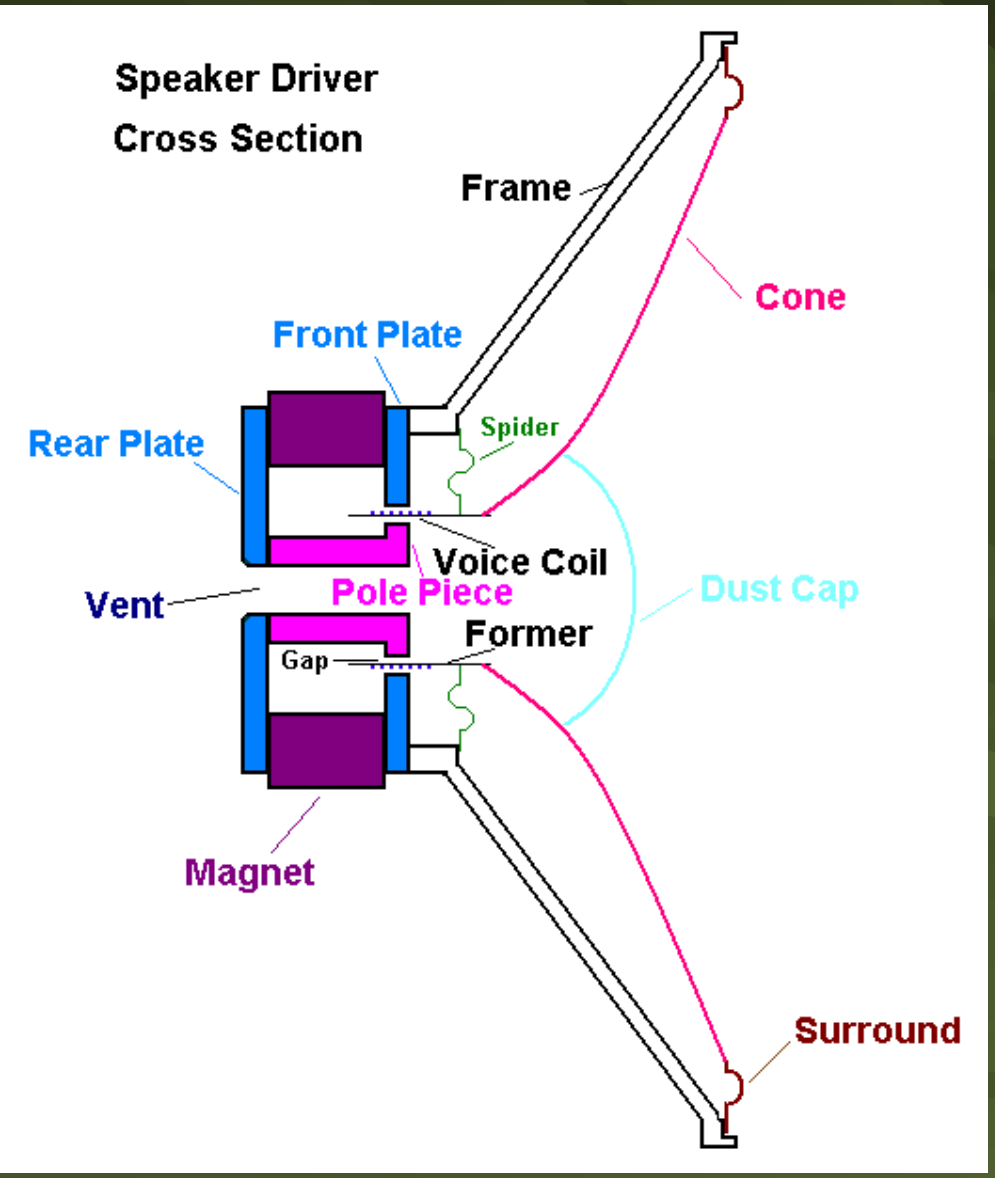
Speakers consist of one or more driver units in a box.

The driver is constructed of a metal frame to which is attached a cone, made of paper or plastic and occasionally metal.

At the rear end of the cone is attached a coil of wire (the "voice coil") wound around an extension of the cone, called a "former".

The two ends of the voice coil are connected to the crossover network, and the crossover network is connected to the speaker binding posts on the rear of the speaker enclosure.

The voice coil is suspended inside a permanent magnet so that it lies in a narrow gap between the magnet pole pieces and the front plate.



The voice coil is kept centered by a "spider" that is attached to the frame and to the voice coil.

A rear vent allows air to get into the back of the driver when the cone is moving, but a dust cap on the cone keeps air from getting in through the front.

A rubber surround at the outer edge of the cone allows for flexible movement..

In the case of a tweeter, the cone is very light, perhaps made of silk, and is glued directly to the voice coil.

It isn't attached to a frame or rubber surround because it needs to be very low mass in order to respond quickly to high frequencies

- When the musical electrical signal from the amplifier passes through the voice coil, the voice coil turns into an electromagnet.
- Depending on which way the current is traveling in the voice coil, north and south pole of the magnetic field will be at one end of the voice coil or the other.
- The permanent magnet has a north and south pole as well. Its magnetic field will push the coil (and the attached speaker cone) outward if the north and north poles of the two magnetic fields are lined up together (north to north, and south to south), or pull the voice coil inward if they are lined up oppositely (north to south, and south to north).
- So, as the electrical signal from the amplifier, which is a representation of the original musical waveform, passes through the voice coil, and changes direction with the musical waveform, the voice coil and attached speaker cone are driven outward and pulled inward in time with the music.

- The speaker cone pushes or pulls air in the room, which translates to increases or decreases in air pressure at your eardrums, and there you have it: music.
- A one driver speaker is called a "one way". If it has two drivers, one to handle high frequencies and the other to handle the mid and low frequencies, then it is called a "two way".
- Separate high frequency drivers (tweeters), midrange drivers, and low frequency drivers (woofers) are found in "three way" speakers.
- You might find a one way speaker in a pocket radio, but home theater and hi-fi speakers are generally two way or three way in design.

- Tweeters

- Midrange

- Woofers

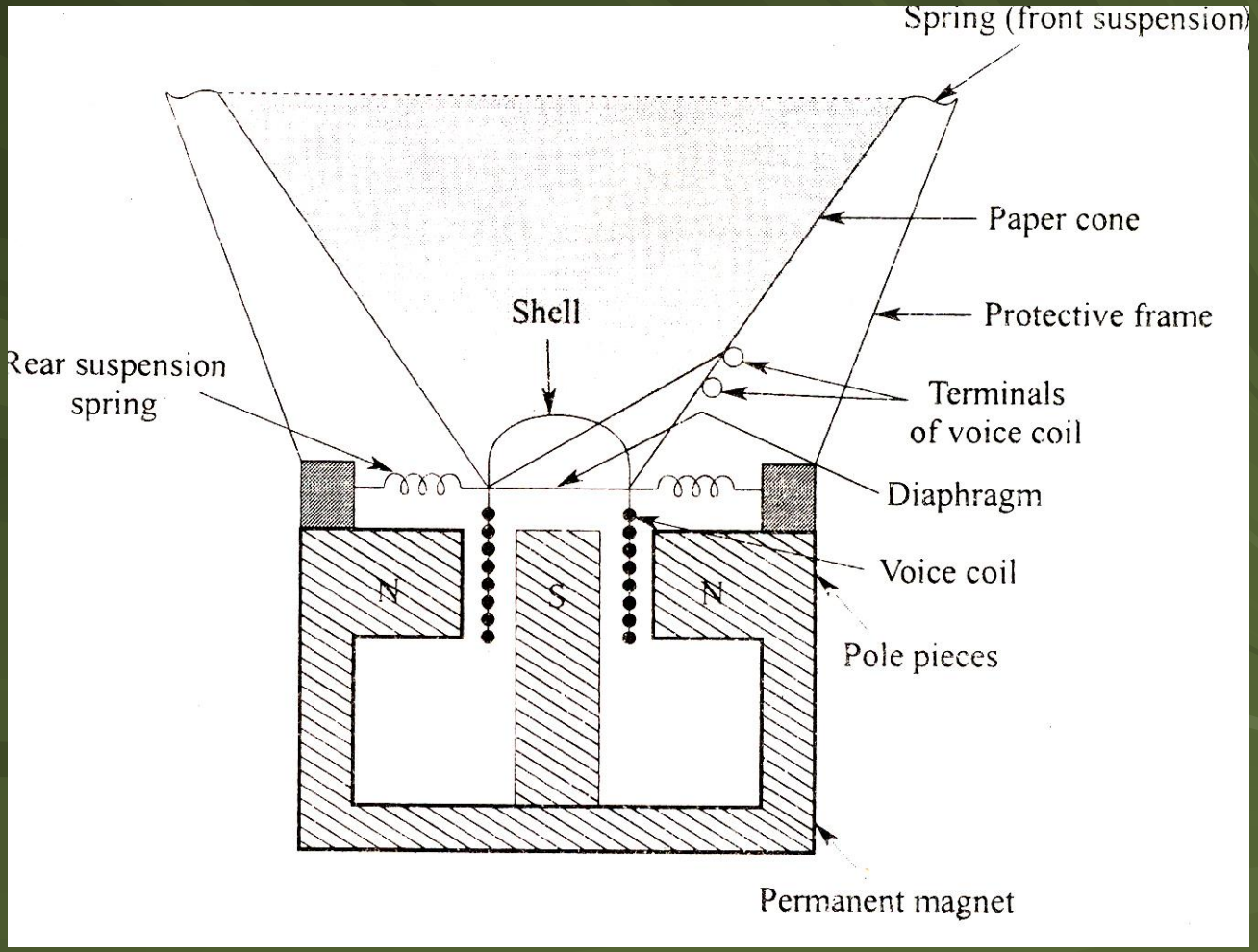
Moving Coil Cone Type Loudspeaker

- **Principle**

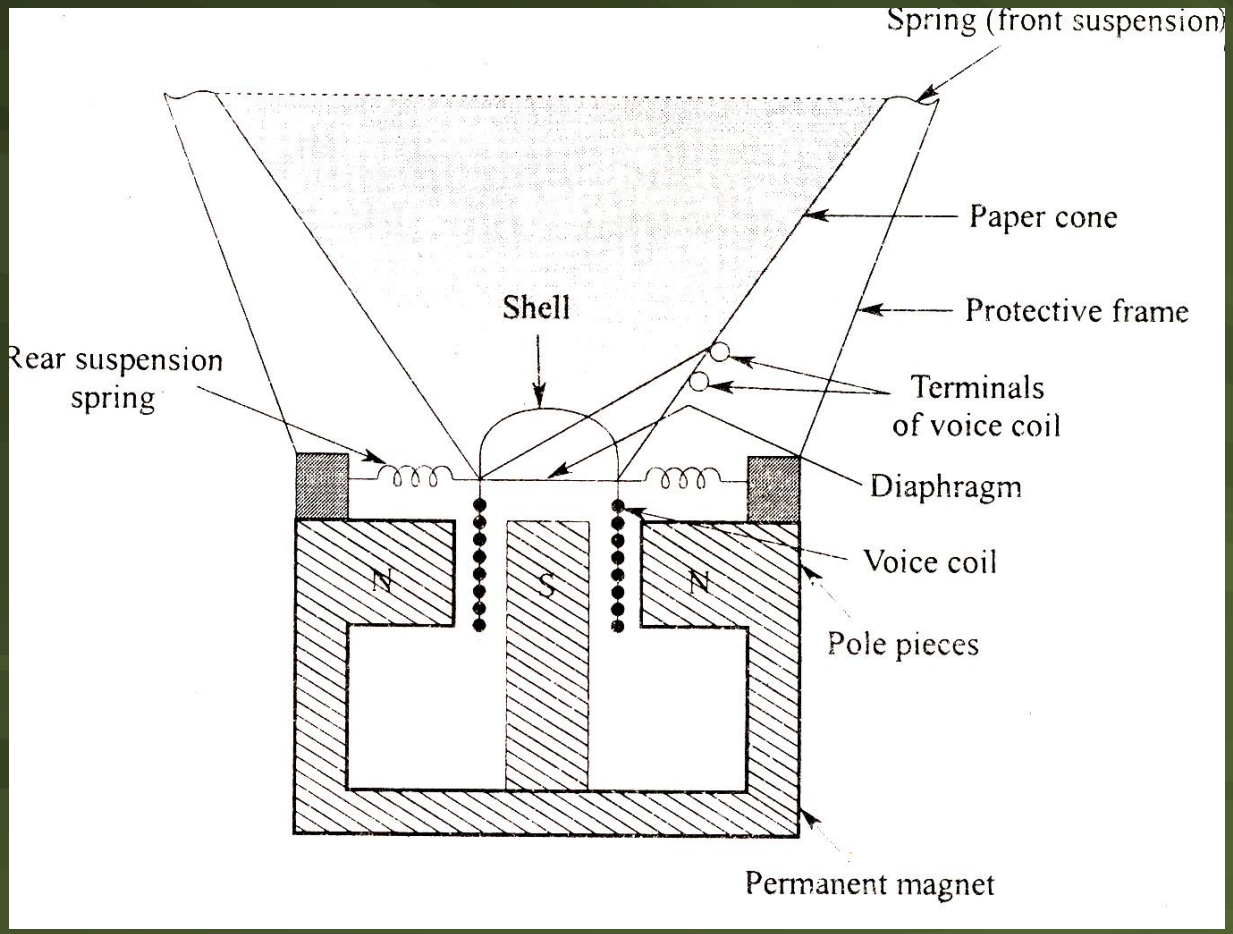
  The moving coil loudspeaker works on the principle of interaction between magnetic field and current in the same way as an a.c. motor works.

Moving Coil

A coil, called voice coil, is placed in a uniform magnetic field. When audio current passes through the voice coil, there is an interaction between the magnetic field and the current, resulting in a force working on the movable coil.



Moving Coil



This force is proportional to the audio current and hence causes vibratory motion (motor like action) in the coil, which makes a conical paper diaphragm to vibrate and produce pressure variations in air, resulting in sound waves.

Why cone type speaker is known as direct radiating type?

- The whole paper in cone type loudspeaker acts as a diaphragm and causes pressure variations direct in the listeners' area. Hence it is called 'direct radiating type loudspeaker'.

Characteristics

- Efficiency: The efficiency of a cone speaker is quite low, about 5 per cent only.
- Signal to noise ratio: It is 30 dB or better.
- Frequency response: It is restricted to mid frequencies only. Frequency response drops at low and high audio frequencies for typical loudspeaker. However, massive loudspeaker (called woofer) for low frequencies and small size speaker (called tweeter) for high frequencies can be designed.

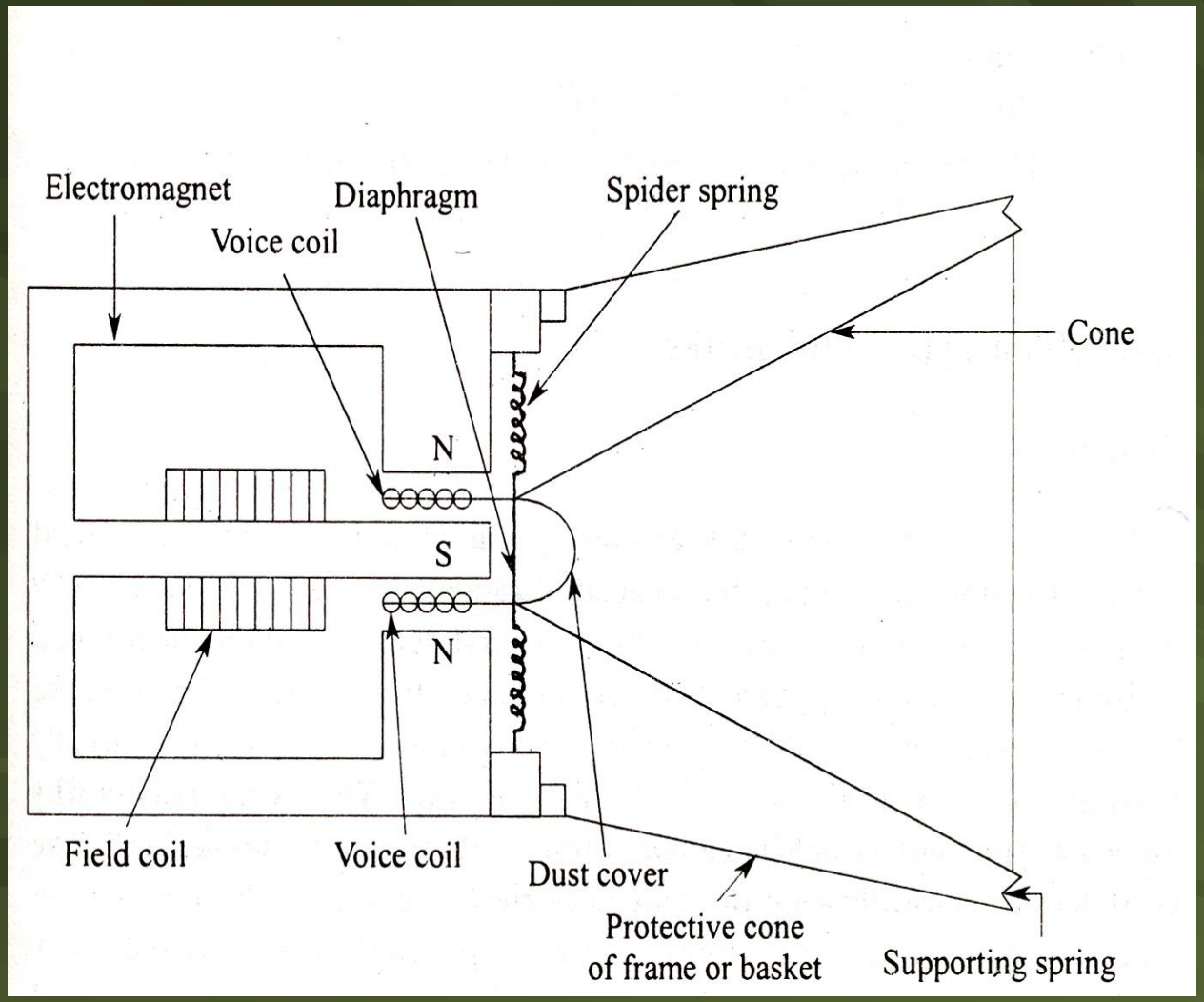
Characteristics

- Distortion: Non-linear distortion due to non-uniformity in the magnetic flux density causes severe distortion up to about 10%.
- Directivity: Basically the loudspeaker is omni-directional. But baffles and enclosures modify the directivity so that most of the power is in the front.
- Impedance: The effective impedance taking into account the mechanical and acoustical loads varies from 2 ohms to 32 ohms. The common impedances in commercial speakers are 4, 8 or 16 ohms .

Electrodynamic Loudspeaker

- To provide very strong magnetic field for high wattage speakers, electromagnet is used instead of permanent magnet. The working principle of an electrodynamic speaker is the same as that of permanent magnet type.
- Loudspeakers of more than 25 watt and up to a few hundred watt are of electrodynamics type.
- The strong and steady magnetic field is produced by a large field coil wrapped around a core. The shape of the magnet is pot type with south pole in the centre and North pole in the periphery.

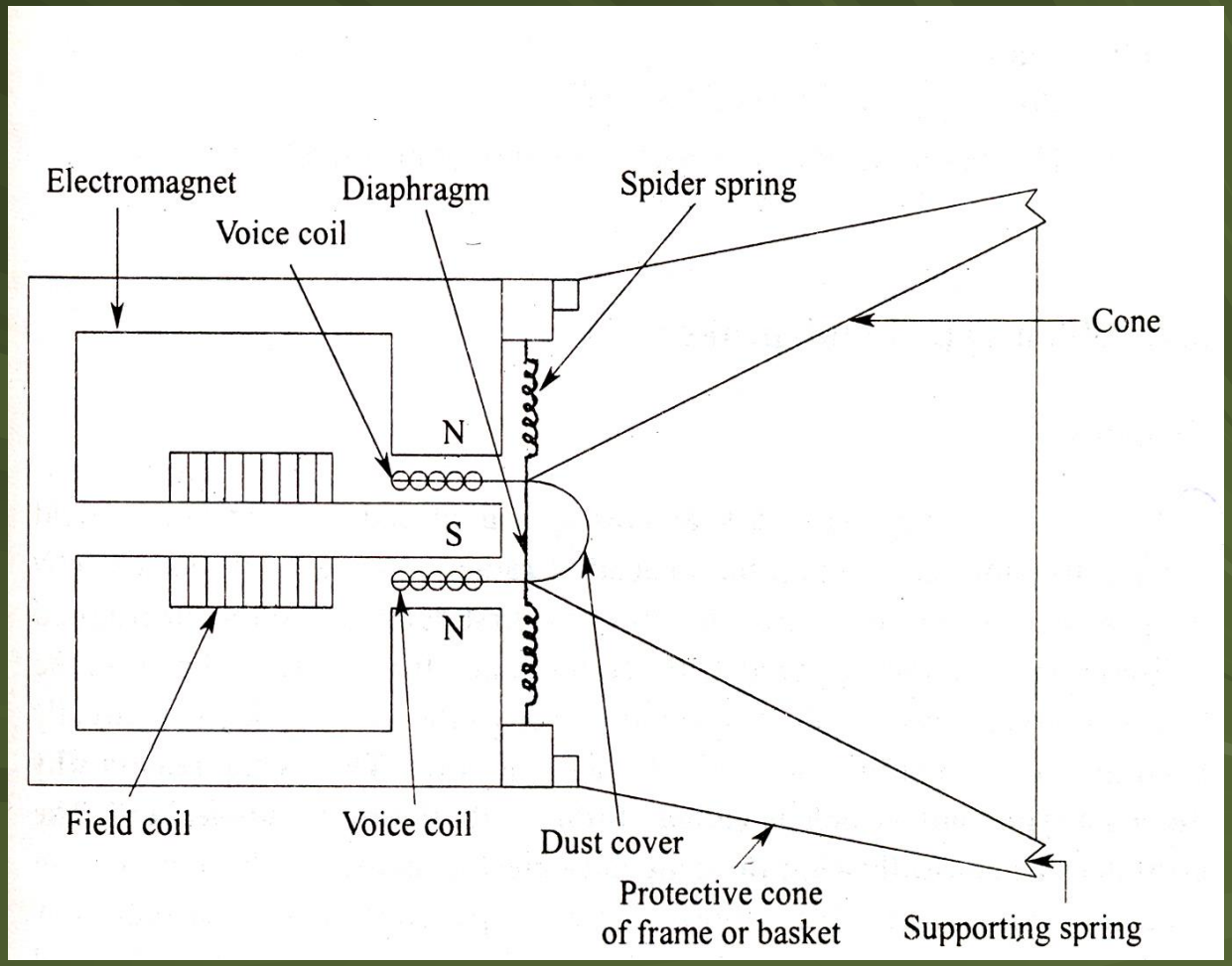
Electrodynamics



The voice coil is wound on fibre or aluminium (to keep it light weight). The audio signal from the amplifier's output transformer is applied to the voice coil. This signal causes a varying magnetic field. The resultant interaction between the two magnetic fields (one due to electromagnet and the other due to audio current in the voice coil) produces mechanical vibrations (motor action) in the coil assembly, which correspond to the audio signals.

Electrodynamic

The vibrations of the coil are transmitted to the attached cone which create sound waves in the air in listeners' area, and hence radiate sound energy directly.



Electrodynamic speaker

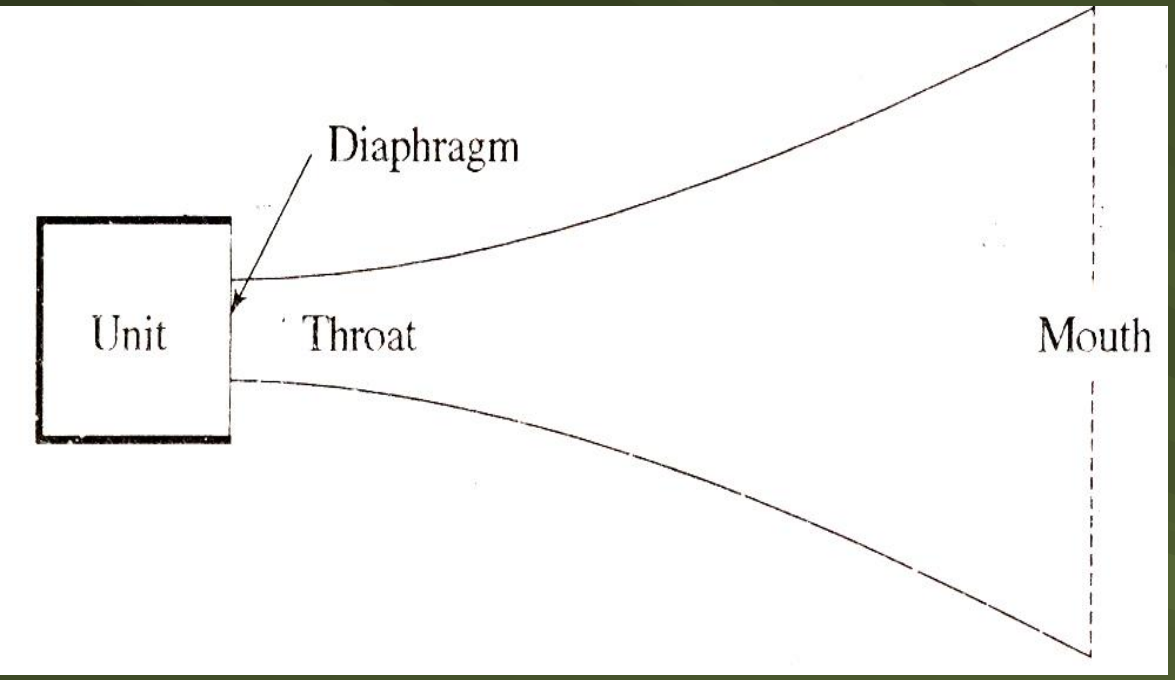
Advantages

- 1. Higher power can be obtained.
- 2. Frequency response is better.

Disadvantages

- 1. Power supply is needed for field coil.
- 2. Heavier in weight for the same amount of magnetic field.
- 3. Costlier.

Horn Type Loudspeaker



A horn type loudspeaker uses a moving coil placed in a magnetic field (similar to paper cone type), but instead of radiating acoustic power directly in open space of listeners' area, the power is first delivered to the air trapped in fixed non-vibrating tappered or flared horn, and from there to the air in the listeners' area.

Horn Type Loudspeaker

- To improve low frequency response, we need horn of large size. The length of the horn may be as big as 2 m and diameter of the mouth 1 meter. Such large dimensions for a horn are unwieldy, and hence horn structure is folded back in itself to conserve physical space (low frequency response is improved by wide mouth and high frequency response by small throat)

Speaker types
Advantages and Disadvantages

- Cone type
- Efficiency-5%
- Frequency response
  Poor, 500 - 5000 Hz.
- Signal to noise ratio
  30 dB
- Distortion about 5 - 10%
- Compact
- low Cost
- Small audience.

- Horn type
- Efficiency-40%
- Frequency response
  Good, 30 10000 Hz.
- Signal to noise ratio
  40 dB
- Distortion less than 5%
- Large
- High cost
- large audience

Loudspeaker Enclosure

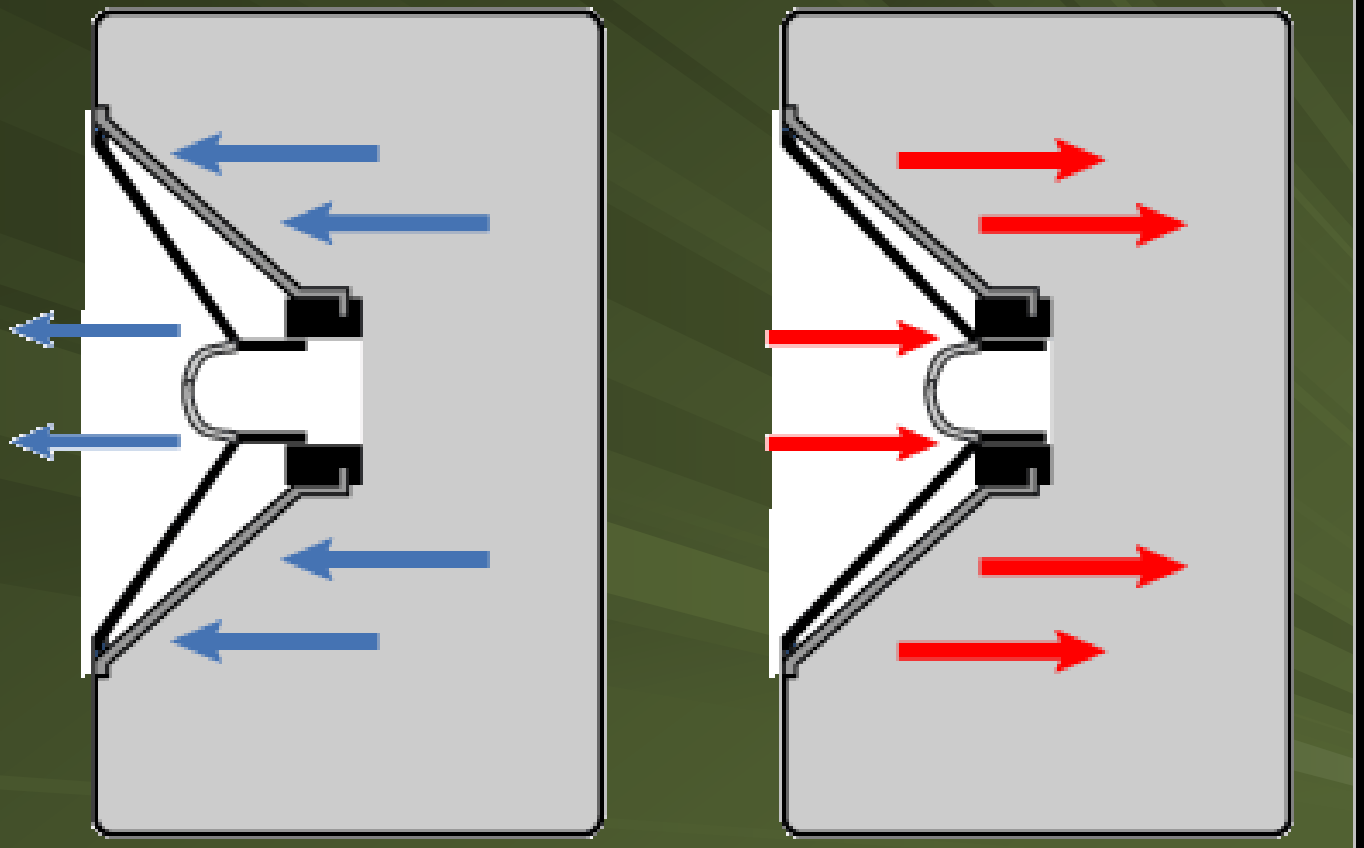
OPEN BAFFLE:

- This can be described as a speaker standing in free air, mounted in no cabinet. At best it is only about 5% efficient.
- The sound is not only produced from the front of the speaker but also from the rear of the speaker.

Sealed enclosure-Acoustic Suspension or Infinite Baffle:

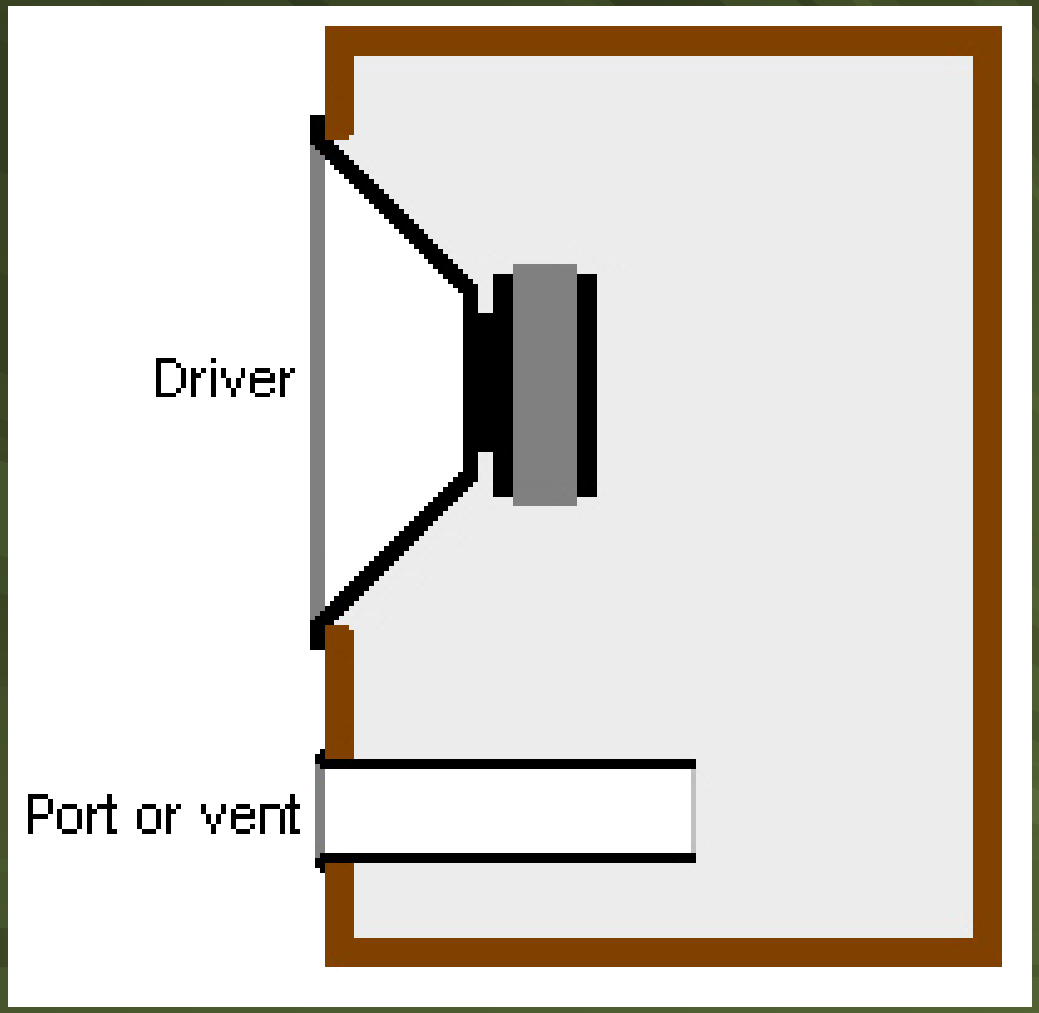
- Since there is a need to prevent the rear waves from combining with the front waves a separating wall is used.
- This system consists of a completely sealed cabinet where the air inside acts as a suspension system or “spring”. The trapped air will now control the motion of the driver’s cone.
- To minimized the internal resonance, polyfill is used to fill up the entire internal volume of the cabinet.

Sealed Enclosure



Vented Enclosure or Bass Reflex

- The vented enclosure has a hole cut in the front of the cabinet.
- This hole or TUNED PORT is placed in a position so that it reinforces a particular set of frequency's.
- It is designed so that the frequency's that are to be reinforced appear at the front of the cabinet at 0 degree phase angle with the same set of frequency's that are produced from the front of the speaker.


Driver
Port or vent

Crossover

- crossovers serve the purpose of splitting the audio signal into separate frequency bands which can be handled by individual loudspeaker drivers optimized for those bands.

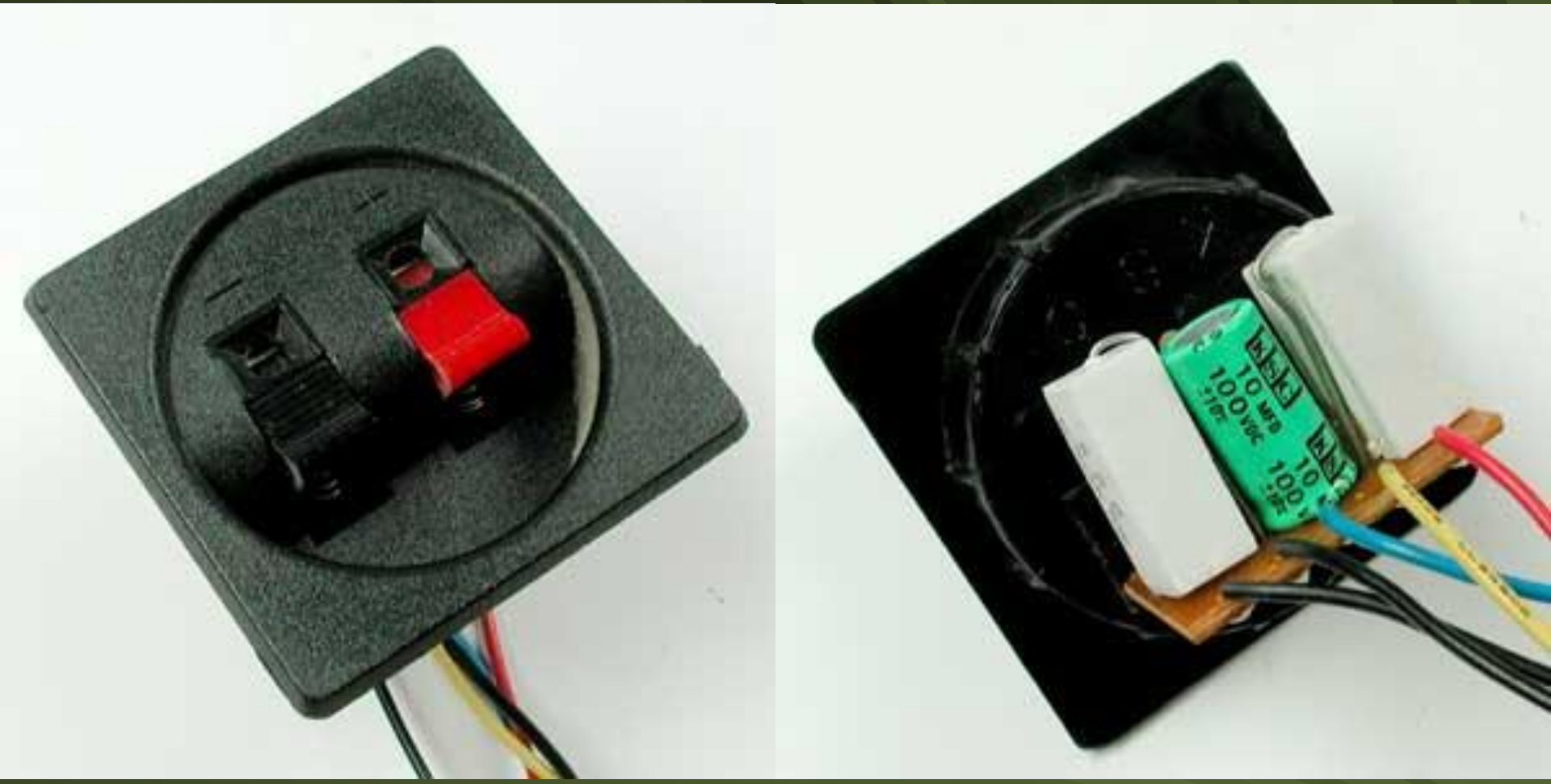
- Two type of crossover:

  Passive Crossover

  Active Crossover

Passive crossover:

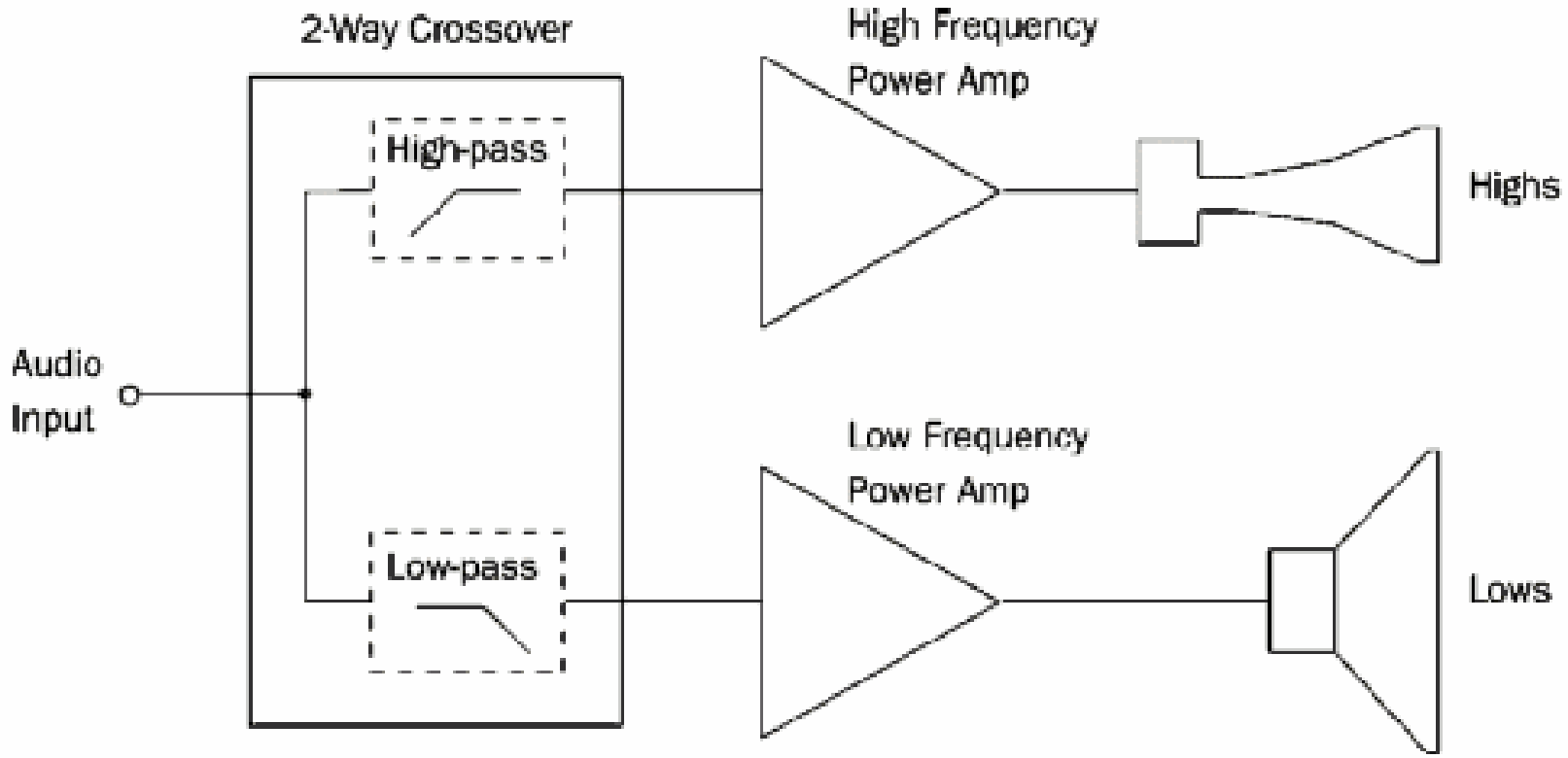
- The most common type of crossover is **passive**, meaning it doesn't need an external power source because it is activated by the audio signal passing through it.
- This sort of crossover uses inductors, capacitors and sometimes other circuitry components.
- A crossover capacitor will conduct the current very well when the frequency exceeds a certain level, but will conduct poorly when the frequency is below that level.
- A crossover inductor acts in the reverse manner -- it is only a good conductor when the frequency is below a certain level.



The typical crossover unit from a loudspeaker: The frequency is divided up by inductors and capacitors and then sent on to the woofer, tweeter and mid-range driver.

Active Crossover:

- Active crossovers are electronic devices that pick out the different frequency ranges in an audio signal before it goes on to the amplifier (you use an amplifier circuit for each driver).
- They have several advantages over passive crossovers, the main one being that you can easily adjust the frequency ranges.
- Passive crossover ranges are determined by the individual circuitry components -- to change them, you need to install new capacitors and inductors.
- Active crossovers aren't as widely used as passive crossovers, because the equipment is much more expensive and you need multiple amplifier outputs for your speakers



Active 2-Way Crossover

Line Array

Active speaker:

- Speaker which is powered by itself or there is an amplifier circuit inside the speaker.

Passive Speaker

- A Passive speaker need an external power amplifier. There is no built-in amplifier.

Speaker manufactures

- Genelec, JBL, Tannoy, Yamaha, Alesis, ATC, Dynaudio, Mackie, Roland, EAW, Event

Loudspeaker in Recording Studio