



6

MICROPHONES

6.1 INTRODUCTION

In the previous lessons you were acquainted with principles of sound, sound technology, digital vs analog etc. You learnt about the importance of acoustics.

In this lesson, you will learn about the microphones, their classification etc. Also you shall learn about the major differences between dynamic and condenser microphones along with key considerations while selecting a particular type of microphone.

6.2 OBJECTIVES

After studying this lesson you will be able to:

- Defines microphone and explain the functioning and working of microphones.
- Identify and explain the different types of microphones.
- Categorize the microphones based on their polar patterns.

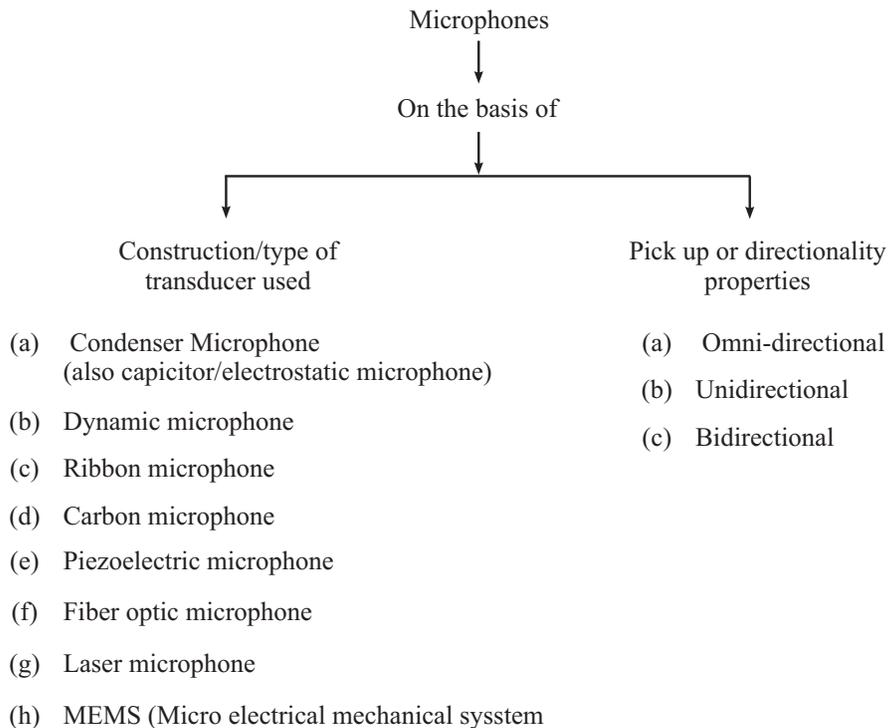
6.3 CONCEPT

The microphones (mic or mike in short) and the speakers are very common audio equipment. You see them not only in public meetings and conferences, you come across them even when you use your phone. The work of a microphone and a speaker are opposite of each other. A microphone converts sound vibrations into electrical entity (voltage/current) while a speaker converts the voltage/ current into sound vibrations by moving the diaphragm of the speaker and producing vibrations in the air. Basically a microphone has a diaphragm which moves when sound pressure pushes it. This movement can be converted into proportional voltage using several possible transducers. Here, a transducer is a device which receives electrical, mechanical or acoustic waves from one medium and converts them into related waves for a similar or different medium. Thus, it can be said that a microphone (mic) is a transducer that converts acoustical sound energy into electrical energy. Its basic function is therefore to convert sound energy into electrical audio signals which can be used for further processing.



6.4 CLASSIFICATION

We can classify the microphones based on construction/ directivity as shown below:



6.4.1 Microphones based on type of transducer /construction

1. **Condenser Microphone** called as **Capacitor Microphone** or **Electrostatic Microphone** also, is made up of two parallel very thin plates, positively and negatively charged respectively. The diagram 6.1 below shows a condenser microphone.

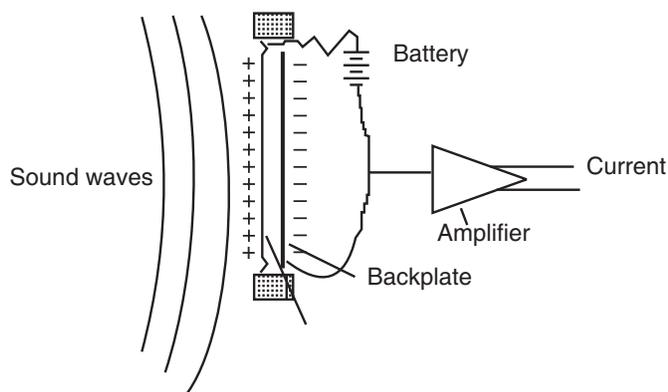


Fig: 6.1: Condenser microphone



Notes

It has a very thin diaphragm of thickness 1 to 10 micrometers. One micrometer (or micron) is one millionth of a meter or one thousandth of a millimeter. Close to this plate (metallic or metalised plastic) stands another metallic plate with holes. These 2 plates act as electrodes and are kept at opposite polarities by supplying D C to behave as a condenser, they should be insulated from each other. When sound wave pushes the diaphragm, it vibrates and the capacitance of the condenser (or capacitor) changes. This is because the capacitance is proportional to the potential difference and inversely proportional to the separation between the plates. Any change in the separation changes the capacitance. The capacitance is also dependent upon the medium but as the medium here remains the same, so we ignore this parameter. The values of the resistance and the capacitance are chosen such that the change in voltage is immediately reflected in the voltage across the resistance in series. Any change in sound leads to change of the capacitance and leads to voltage change. The voltage is fed to an amplifier to amplify the level of the signal. Condenser microphones were invented in Bell Labs in 1916.

2. **Dynamic Microphone:** works on the principle of electro-mechanical induction. This type of microphone is called moving coil microphone also. Here a very small coil is used which is attached to a diaphragm and suspended in a magnetic field of a magnet as shown in the diagram: 6.2 below. When sound waves impinge on the diaphragm it vibrates and attached coil moves. This movement of the coil inside the magnetic field produces a emf across the terminals of the coil. The current so produced in the coil is in proportion to the sound.

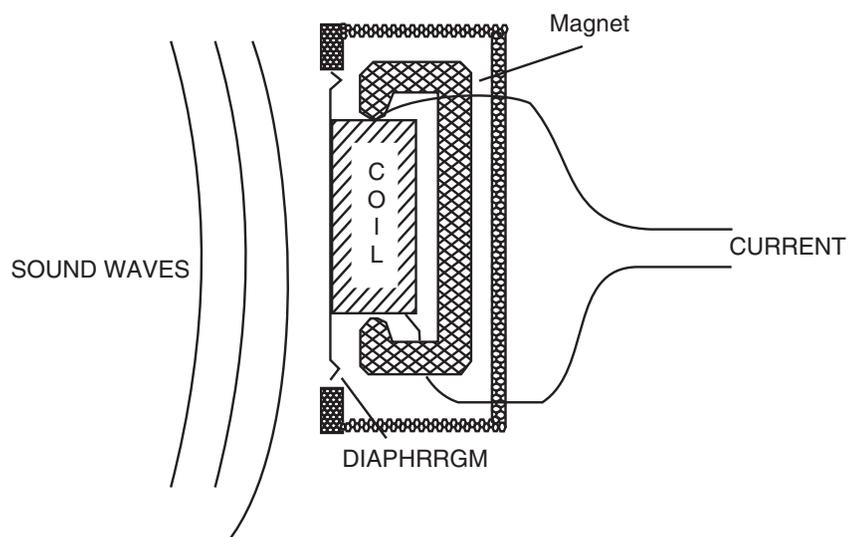


Fig. 6.2: Dynamic microphone



3. **Ribbon Microphone:** A ribbon microphone uses a corrugated ribbon made of a metal is suspended in a magnetic field as shown in the diagram: 6.3 below. Sound causes the ribbon to vibrate. This means change in magnetic flux through the ribbon. This induces an electric current which drives a speaker. When this current is flown through a coil attaches to diaphragm of the microphone, the diaphragm vibrates and produces sound. Special materials developed using nano technologies are being used to make ribbons that will be light but strong. Being light improves the response to sound. The ribbon microphone senses pressure-gradient and not just pressure. Therefore, it detects sound from both sides.

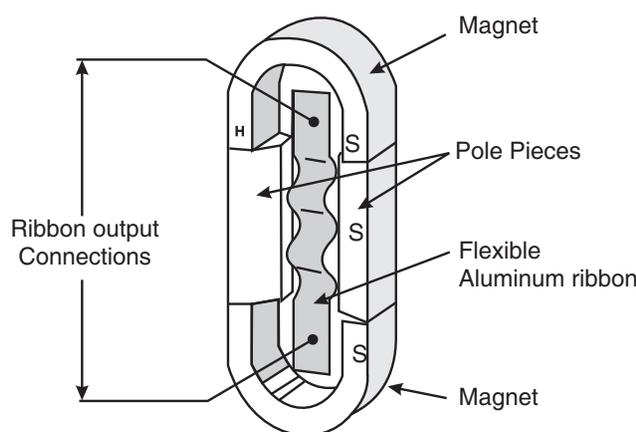


Fig. 6.3: Ribbon microphone

4. **Carbon microphone** is also known as a carbon button microphone (or sometimes just a button microphone), use a capsule or button containing carbon granules pressed between two metal plates.
5. **Piezoelectric microphone** uses the phenomenon of piezoelectricity—the ability of some materials to produce a voltage when subjected to pressure—to convert vibrations into an electrical signal.
6. **Fiber optic microphone** converts acoustic waves into electrical signals by sensing changes in light intensity, instead of sensing changes in capacitance or magnetic fields as with conventional microphones
7. **Laser microphones** are often portrayed in movies as spy gadgets, because they can be used to pick up sound at a distance from the microphone equipment.
8. **MEMS** (Micro Electrical-Mechanical System) microphone is also called a microphone chip or silicon microphone. The pressure-sensitive diaphragm is etched directly into a silicon chip by MEMS techniques, and is usually accompanied with integrated preamplifier.



Notes

6.4.2 Microphone Classification based on Polar Patterns

A microphone's directionality or polar pattern indicates how sensitive it is to sounds arriving at different angles about its central axis. Some microphone designs combine several principles in creating the desired polar pattern. Generally the pick up pattern / Polar pattern of microphones fall in following three categories:

- (i) Omni-directional
- (ii) Uni-directional
- (iii) Bi-directional

(i) Omni directional

An Omni directional (or non-directional) microphone's response is generally considered to be a perfect sphere in three dimensions as shown in the diagram: 6.4 below. In the real world, this is not the case. As with directional microphones, the polar pattern for an "omnidirectional" microphone is a function of frequency.

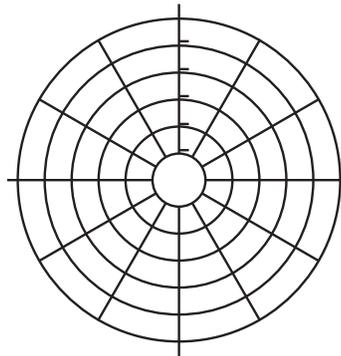


Fig. 6.4: Omni directional

(ii) Unidirectional

A unidirectional microphone is sensitive to sounds from only one direction. The diagram 6.5 below shows a photo and Diagrams 6.7 to 6.11 illustrates a number of these patterns



Fig. 6.5: University Sound US664A dynamic supercardioid microphone

Microphones

The most common unidirectional microphone is a cardioid microphone, so named because the sensitivity pattern is a cardioid. A cardioid microphone is effectively a superposition of an Omni directional and a Fig. 6.8 microphone; for sound waves coming from the back, the negative signal from the Fig. 6.8 cancels the positive signal from the omnidirectional element, whereas for sound waves coming from the front, the two add to each other.



Notes

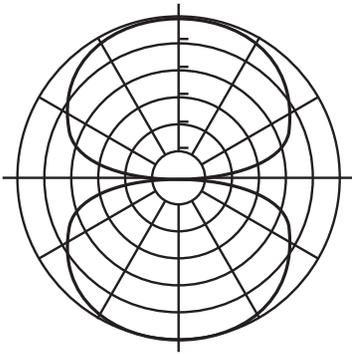


Fig. 6.6: Bi-directional

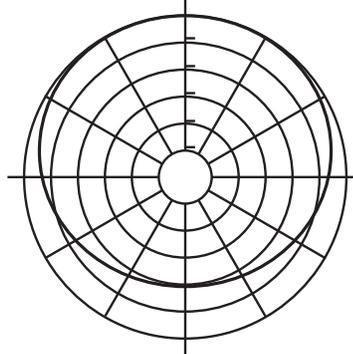


Fig. 6.7: Subcardioid

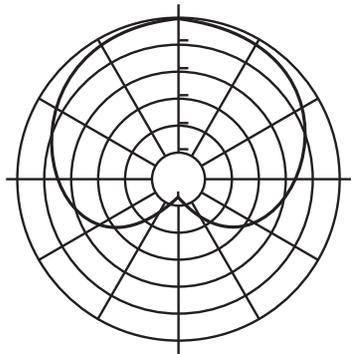


Fig. 6.8: Cardioid

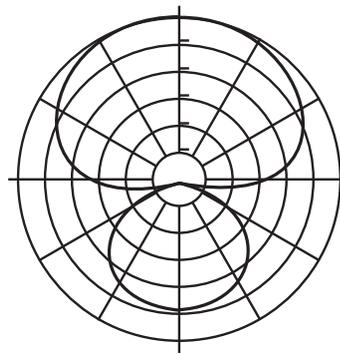


Fig. 6.9: Hypercardioid

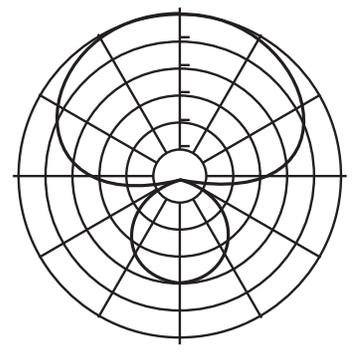


Fig. 6.10: Supercardioid

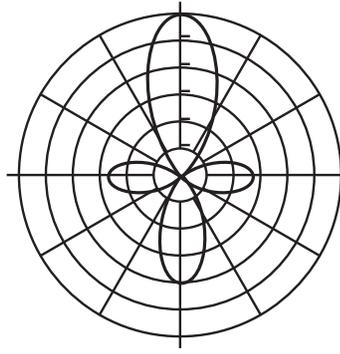


Fig. 6.11: Shotgun



Notes

A **hyper-cardioid** (Fig 6.9) microphone is similar, but with a slightly larger figure-8 contribution leading to a tighter area of front sensitivity and a smaller lobe of rear sensitivity. A **super-cardioid** microphone is similar to a hyper-cardioid, except there is more front pickup and less rear pickup. While any pattern between omni and Fig. 6.8 is possible by adjusting their mix, common definitions state that a hypercardioid is produced by combining them at a 3:1 ratio, while supercardioid is produced with a 5:3 ratio **Shotgun**



Fig. 6.12: An Audio-Technica shotgun microphone

Shotgun microphones (Fig 6.12 above) are the most highly directional. They have small lobes of sensitivity to the left, right, and rear but are significantly less sensitive to the side and rear than other directional microphones. This results from placing the element at the back end of a tube with slots cut along the side; wave cancellation eliminates much of the off-axis sound. Due to the narrowness of their sensitivity area, shotgun microphones are commonly used on television and film sets, in stadiums, and for field recording of wildlife etc.

(iii) **Bi-directional**

“Figure 6.8” or bi-directional microphones receive sound equally from both the front and back of the element. Most ribbon microphones are of this pattern. In principle they do not respond to sound pressure at all, only to the *change* in pressure between front and back; since sound arriving from the side reaches front and back equally there is no difference in pressure and therefore no sensitivity to sound from that direction.

INTEXT QUESTIONS 6.1

1. A microphone (mic) is a transducer that converts acousticalenergy into electrical energy
 (a) sound (b) noise (c) mechanical. (d) Kinetic
2. Condenser microphone was invented at Bell Labs in
 (a) 1917 (b) 1916 (c) 1918 (d) 1919



3. A microphone's directionality or polar pattern indicates how sensitive it is to
(a) light (b) wind (c) sound (d) energy
4. A unidirectional microphone is sensitive to sounds fromdirection/directions
(a) one (b) bi (c) multi (d) corner
5. microphones are the most highly directional
(a) Ribbon (b) Carbon (c) Cardiod (d) Shotgun

6.5 FACTORS TO BE CONSIDERED WHILE SELECTING MICROPHONES

Selecting on appropriate type of microphone is an important factor to control noise and produce quality sound. Factors which should be considered before selecting a microphone are:

- (i) **Impedance:** Generally, resistance is considered for circuits with dc source. In case ac supply is used and circuit contains inductor and capacitor in addition to resistors, impedance is considered. While selecting microphones impedance has involvement of frequency factor. The length of the cable used for microphone varies as per the impedance needed for a particular circuit or load. In most of the cases the wire impedance is kept low to increase the length of the cable for mic system.
- (ii) **Frequency response:** Frequency response is a microphone's capability to service high and low frequency sounds. Ideally, quality microphone can receive frequencies ranging from 20 to 25,000 Hz.
- (iii) **Pick up pattern:** This refers to choice of sound from one or all directions. Different microphones are used to cater such varied requirements.
- (iv) **Balanced and unbalanced microphone:** Balanced microphones are used for professional recording purposes and they carry three wires while unbalanced connection uses 2 wires i.e. central conductor carrying audio signal while shield/basket carrying ground wire.
- (v) **Sensitivity:** It is the ability of microphone to pick up faint sounds and thus termed as sensitivity. Highly sensitive microphones are used in studio while in field, low sensitivity based microphones are used as the chances of microphone being affected by strong wind are higher.



6.6 WHAT HAVE YOU LEARNT

In this lesson you have learnt about microphones and fundamental principle of working of microphone. Different types of mics based up on their working principle were discussed to familiarize with the basic differences of microphones. Later pickup patterns of microphones were discussed based up on their applications. Different mics and their applications were also discussed.

6.7 TERMINAL QUESTIONS

1. What is a microphone?
2. What do you understand by ribbon microphone?
3. Explain a bi-directional microphone.
4. Differentiate between Omni and Uni-directional microphones
5. What are the precautions to be taken while handling microphones.

6.8 ANSWER TO IN-TEXT QUESTIONS

1. A 2. B 3. C 4. A 5. D

6.9 REFERENCES

1. Audio Production/Module4/Unit 13 Certificate in Community Radio Technology CEMCA