ANALYSIS OF AUDIO SIGNAL READING DEVICES

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Annotation: *This text provides a comprehensive overview of various types of microphones and their principles of operation. It covers dynamic microphones, which are popular for their reliability and performance in high sound pressure areas, condenser microphones, known for their superior sound quality and sensitivity, and electret microphones, which are similar to condenser microphones but do not require an external power source. The document also discusses the directional properties of microphones, including narrow, bidirectional, and omnidirectional types, as well as sound pickup angles. Additionally, it delves into the differences between balanced and unbalanced microphones, the types of cables used, and the modifications needed to use balanced microphones with unbalanced mixers.*

Keywords: *dynamic microphones, condenser microphones, electret microphones, sound recording, directional microphones, unidirectional microphones, balanced microphones, unbalanced microphones, sound pickup angle, microphone cable types, sound sensitivity, signal transmission.*

The first recordings of sounds were made using the direct cutting method. Air vibrations were transmitted to the gramophone needle through horn microphones, which reproduced the intersections of these vibrations on the rotating cylinder surfaces. Modern microphones convert air vibrations into electrical signals, and although this principle underlies the operation of all microphones, the differences lie in the processes that carry out these conversions. The variety of existing models is described through the three main types of microphones [1].

Dynamic microphones: These types of microphones are very popular among vocalists. Compared to other types, dynamic microphones have several advantages. They are relatively inexpensive, while also being reliable and capable of performing well in high sound pressure areas. Their stability in loud sounds makes these microphones suitable for capturing impact sounds. Its operating principle is similar to that of a dynamic speaker, but in reverse mode. Just like in a speaker, vibrations of an inductive coil are used for conversion.

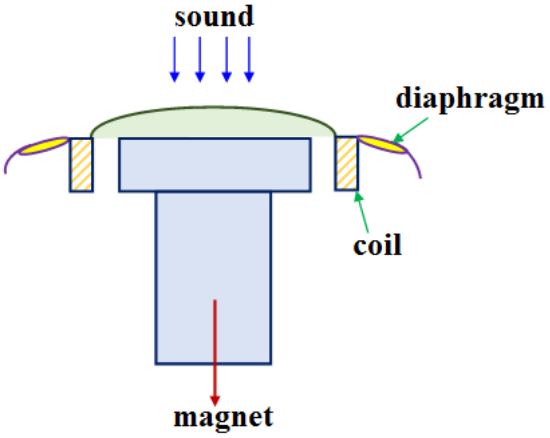

Fig.1. Structure of a dynamic microphone

As seen in fig.1, the magnetic core is surrounded by an inductive coil, which, under the pressure of sound waves emitted from the source, undergoes vibratory motion. The generation of an electrical current occurs each time the coil moves (this phenomenon is known in physics as Fleming's law). Thus, the acoustic energy that falls on the microphone is converted into electrical energy, with the form of the electrical current corresponding to the character of the sound vibrations. If this current is amplified and supplied to a speaker the amplified sound can be heard. The unique characteristics of the internal structure of dynamic microphones may limit the number of directional patterns available [2, 3]. Such a microphone can only be unidirectional or omnidirectional. Additionally, the inertia of the coil moving within the magnetic field limits the frequency range that these microphones can capture.

Today, various companies have produced a large number of dynamic microphones, with prices ranging from hundreds to thousands of dollars. Therefore, many models are designed for specific applications or uses.

Condenser microphones: Condenser microphones are considered more advanced compared to dynamic microphones. Their operating principle is based on the change in the distance between two conductive plates, which results in a change in their electrical capacitance. One of these plates is fixed to the microphone's body, while the second (thin) plate acts as the diaphragm. The vibrations of the diaphragm caused by air vibrations lead to changes in capacitance. For the operation of such a microphone, it is necessary to apply an electrical voltage to its plates. To achieve this, a 48-volt supply (phantom power) is typically provided directly from a preamplifier or mixer console.

Professionals primarily use these microphones because they provide significantly higher sound quality. However, due to the complexity of their production, they are considered a relatively expensive type of microphone. Despite this, since their inception, they have gained widespread popularity and have become the most common model in the music world. The construction principle of a condenser microphone is shown in fig.2.

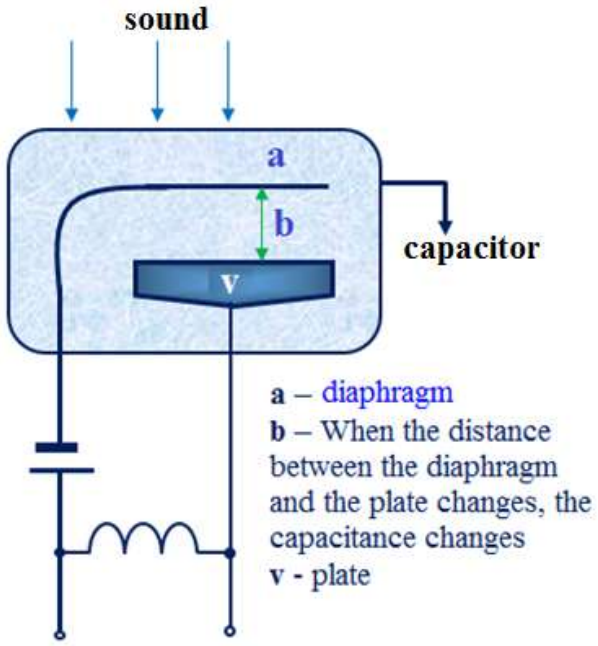

Fig.2. Structure of a condenser microphone

When an electric current is applied to the diaphragm and plate, they form a capacitor. When sound vibrations exert pressure on the diaphragm, they force it to move, which leads to a change in the distance between the diaphragm and the plate, thereby altering their capacitance. These changes correspond to the shape of the signal. The signal is then amplified. A distinctive feature of a condenser microphone is that it uses electric current. Another characteristic is the use of a lightweight diaphragm instead of the heavy coil used in dynamic microphones, which indicates higher sensitivity to sound. Therefore, the diaphragm of a condenser microphone can be made as thin as necessary (within required limits), which allows for significantly higher sensitivity and the ability to reproduce higher frequencies. For this reason, the frequency range of these microphones is notable. In addition, condenser microphones can have nearly any desired directional pattern. The sound emitted by a condenser microphone stands out even in sharp, high-volume impacts, thanks to its distinctive characteristics. Because of these features, condenser microphones are used in places where high demands are placed on sound reproduction quality and accuracy.

However, due to their low mechanical load capacity and instability, they are less suitable for live performances. But, for stationary use, they are considered unparalleled, especially in cases where maximum reliability in reproducing harmonic components of sound is required. In an electric condenser microphone, the diaphragm functions as a static electrical charge. It's enough to recall how a piece of plastic used to attract hair and dust in childhood. The electric condenser microphone works in a similar way. This type of microphone's capacitor does not use any electrical current, and as a result, these microphones are characterized by relatively low cost. The electric condenser microphone, like the regular condenser microphone, has the same features-high-frequency operating range and wide dynamic range. For personal magnetic

recording, both electric condenser microphones and dynamic microphones are considered the best option.

Electret microphones: The operating principle of electret microphones is similar to that of condenser microphones, with the difference being that electret microphones do not require an external power source to operate. The diaphragm of such microphones acquires an electrical charge during the manufacturing process, and a small voltage, typically around 1.5 volts, provided by a battery installed in the microphone, is sufficient to power them. Additionally, microphones are classified by their directional properties [4].

All of them have their own directional properties. In everyday speech, we don't use this concept, but in the use of microphone systems, it refers to the direction or directions from which sound reaches the microphone. From the perspective of directionality, there are three types of microphones:

- narrowly directional
- bidirectional
- omnidirectional

Narrowly directional microphones only receive sound signals from a single direction. They are characterized by high sensitivity to sound coming from the direct direction and very low sensitivity to sounds from other directions.

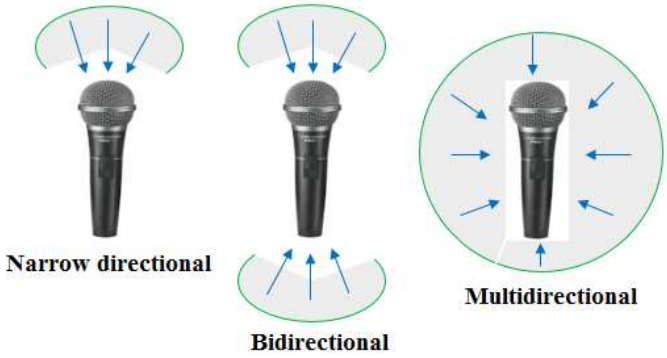

Fig.3. Directionality of microphones

Bidirectional microphones receive signals well from both the direct and reverse directions. Omnidirectional microphones receive sound signals from all directions. Figure 3 shows the directional patterns of these three types of microphones.

Sound pickup angle: The sound pickup angle (figure 4) refers to the area around the sound signal source, within which a significant loss of the microphone's effectiveness is not observed.

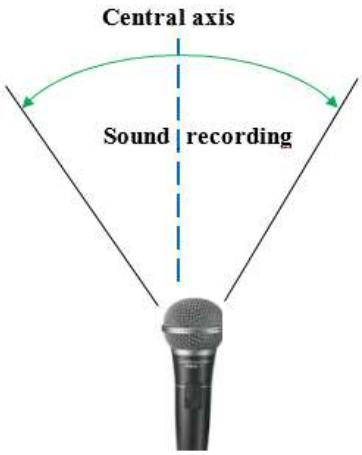

Fig.4. Sound recording diagram

In unidirectional microphones (such as cardioid, supercardioid, etc.), the angle between the point where the microphone's sensitivity significantly drops (up to a 3 dB difference) and the central axis (see figure 4) is considered the half-angle of sound pickup. For a cardioid microphone, the typical value is 131° (65.5° on each side of the central axis), while for other types of microphones, it is as follows:

- for omnidirectional microphones – 360°
- for cardioid microphones – 131°
- for supercardioid microphones – 115°

Balanced and unbalanced microphones: You may come across terms like "balanced" and "unbalanced" microphones. These terms refer to the way the signal is transmitted. The main purpose of using a balanced microphone is to eliminate electrical noise. For this reason, balanced microphones are typically used in professional recordings.

For a balanced microphone, the cable (figure 5) consists of three conductors, commonly referred to as "red," "white," and "shield".

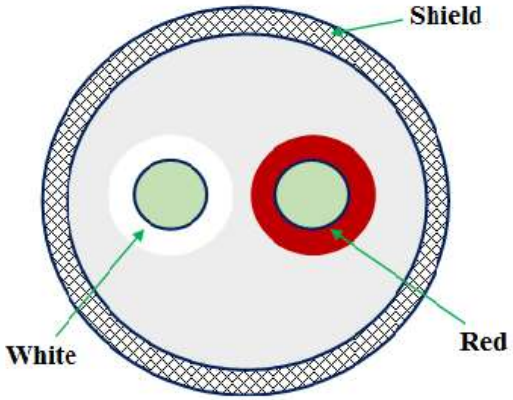

Fig.5. Cross-section of a cable for a balanced microphone

The shield protects the red and white conductors from unwanted external electrical currents. This is especially important when using a long cable with a low-impedance microphone. For a balanced microphone, connectors with three pin contacts are used. The difference in the placement of these three contacts is that in the

European version, pin №3 is red, while in the American and Japanese versions, pin №2 is red. Unbalanced microphones use only two conductors in their connections, one being white and the other serving as both the ground and the shield. These microphones meet various requirements, but they are suitable only for relatively short cable lengths. A standard 1/4″ phone jack is used for their connectors.

A balanced microphone can be used with a mixer that has unbalanced inputs (such as in the MT1X and MT2X models) if the connector contacts are appropriately modified. For this, the microphone's pins 1 and 3 must be connected to the shield (the casing) of a 1/4″ phone jack, and pin 2 must be connected to its central wire. When making such a modification, the cable length should not exceed 6 meters.

REFERENCES:

1. G. Yang and T. S. Huang, "Human Face Detection in Complex Background," Pattern Recognition, vol. 27, no. 1, pp. 53-63, 1994.

2. Oviatt, S. L. Multimodal interfaces. In The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications, J. Jacko and A. Sears, Eds. Lawrence Erlbaum Assoc. Mahwah, NJ, chap.14, 2003. — pp. 286–304.

3. Jochen Maydt and Rainer Lienhart."Face Detection with Support Vector Machines and a Very Large Set of Linear Features ,"IEEE ICME 2002, Lousanne, Switzerland, pp. xx-yy, Aug. 2002

4. D. Roth, M.-H. Yang, and N. Ahuja, "A.SNoW-based face detector," in Advances in Neural Information Processing Systems 12 (NIPS 12), MIT Press, Cambridge, MA, pp. 855-861, 2000