
UNIT 10: MICROPHONES, SPEAKERS AND MIXERS

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10.0 INTRODUCTION

As you are aware, in the field of audio programme production, the sound conveys the content of the programme. When we say ‘sound’, it encompasses all the categories of sounds we listen to in a variety of situations. Hence, it is important that as a producer, you should have adequate knowledge about sounds and the chain of equipment involved so that, if needed, you should be in a position to operate at least the basic functions. You can carry out editing and mixing functions once the chain of equipment is made operational by a technical person. Even if a technical person is available for carrying out the tasks of recording, editing and mixing, you can get the desired results only when the chain is properly understood and you are comfortable with the equipment.

In this Unit, we shall introduce the basic components in the Sound Recording Chain, such as Microphones, Audio Mixer and Monitoring System. We shall discuss their various applications without going into highly technical details.

10.1 OBJECTIVES

After reading this unit, you should be able to:

- identify the principles of picking of sound waves;
- distinguish between different types of microphones;

- describe the basic features and applications of audio mixer; and
- explain the functions of an audio monitoring system.

10.2 MICROPHONE

The sounds we hear can't be processed as such by the electrical/electronic devices unless these sounds are converted into corresponding electrical signal (conventionally called "Audio"). A Microphone is the first link in the chain of Sound Recording. The word 'microphone' consists of two words 'micro', i.e., very tiny or small and 'phone' meaning sound. Since very small variations of sound levels are picked up by it, this is why it is called a Microphone. Microphones are made in different sizes and shapes depending on their applications in different conditions. There are varieties of microphones available for picking up sounds depending upon the use, such as, consumer, public address system and professional microphones for production work. We shall examine the principles and different types of microphones used for professional recordings. But before we attempt to know various microphones and how to use them, we should learn what is a microphone and how it functions.

We know that one type of energy can be transferred into other types of energy. For example, wind energy can be transferred mechanically to drive a water drawing machine. By rotating a coil of wire in a magnetic field, magnetic energy is transformed into electrical energy. That is how we get electricity. Any mechanism which transforms one type of energy to another type of energy is called a Transducer. Similarly, in the field of Sound Recording, the sound energy which is called Acoustic energy can be transformed to electrical voltage or electrical signal by the use of a Microphone. A Microphone is a device which enables the sounds arriving at it, to give out corresponding variations of electrical signal or voltage. Hence, Microphone is a transducer.

A microphone has a very light and highly sensitive diaphragm or a thin sheet suspended in a magnetic field. Any sound wave impinging on the diaphragm produces movements in the magnetic field and carries electrical signals through the coil on the diaphragm. This electrical signal or voltage (called audio signal) is very small and other chain of equipment brings up the low signal to the desired electrical voltage level. This enables us to hear audio through a Loud Speaker or recording on a Magnetic Tape or the latest memory chips (memory card or pen drive). The basic point to be understood here is that the sound waves are 'pressure waves' causing a change in atmospheric pressure surrounding the diaphragm, and due to this, the movement of diaphragm takes place. Based on this, different types of microphones have been designed which can be used for specific purposes.

10.2.1 Principles of Picking Up Sound Waves

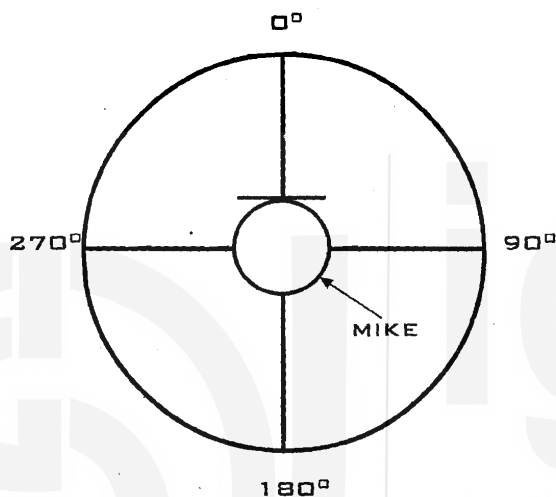
There are two principles of picking the Sound Waves by the microphone. These are:

- pressure operated; and
- pressure gradient.

In the pressure operated microphone, the relative change of pressure due to sound waves is the main factor for picking the sounds. In the pressure gradient type, the difference of pressure of sound waves on the two sides of diaphragm is the main factor for picking the sounds.

Pressure Operated Microphone

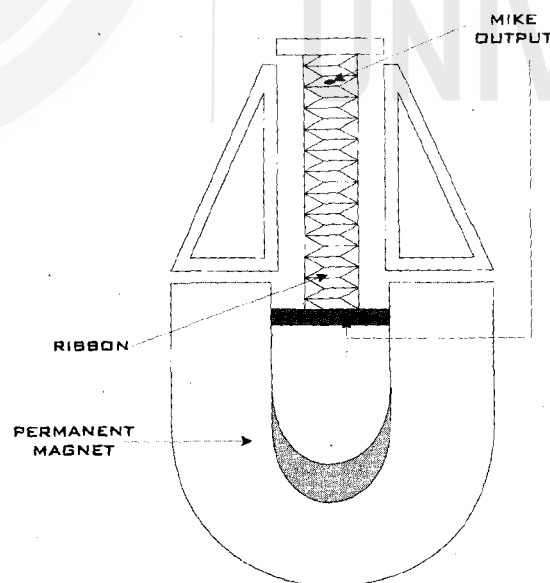
The diaphragm of microphone acts as per the variations of the pressure created by the sound waves. Hence, the diaphragm of pressure operated microphone is exposed to the sound waves on one side only. In this type of microphone, the sounds from all directions are picked up. The microphone that picks up sounds from all directions is termed as Omni-Directional microphone. When pick-up pattern of microphone is written as below, then it is called Polar Diagram of the microphone:



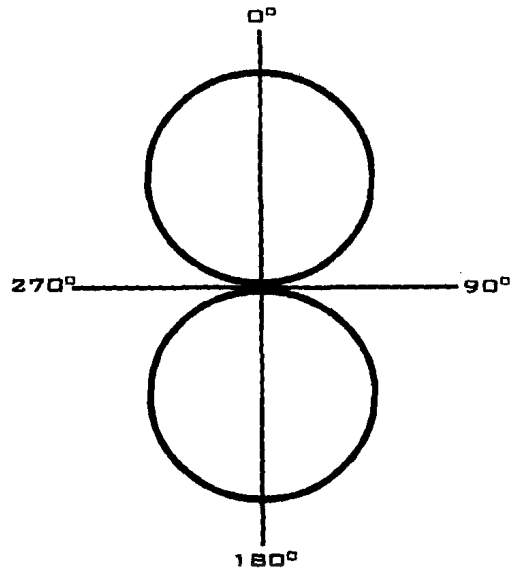
Polar diagram of Omni Directional microphone

Pressure Gradient Microphone

In this type of microphone, the sound waves acting on the diaphragm on front side are also acting on the back. This means that the diaphragm is open to both sides. The difference in the pressures applied on both the sides results in Voltage Variations. This is achieved by a thin ribbon suspended vertically in a magnetic field, open on both sides to sound waves. The variations of voltage in the ribbon due to sound waves, is fed to the necessary chain of equipment to increase the strength of the electrical signal.



Ribbon or Pressure Gradient Microphone



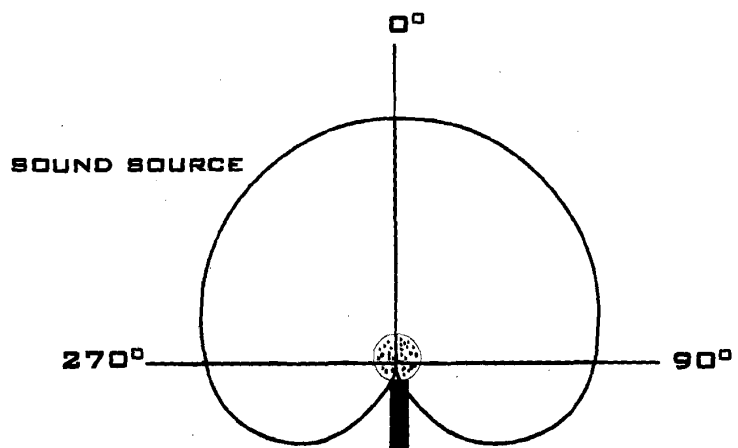
Polar diagram

When the sound waves coming from the sides (other than front and rear side) of the microphone are least picked up by the microphone, the microphone is called Bi-directional microphone. In such case the polar diagram is like figure of eight.

The Polar diagrams give an idea of how the microphone picks sound from a particular direction or from all directions. Since the basic principle of picking sounds is either Omni or Bi-directional, a combination of these in designing microphones gives a variety of Polar diagrams; this means that apart from Omni and Bi-directional, we can have different polar diagrams. By proper designing with the combination of both Omni and Bi-directional pick up patterns, we get a new polar diagram or picking pattern called as Cardioid.

Cardioid Mikes

In this type of microphone, the rear side of mike is less sensitive. That means whichever side the microphone is less sensitive gives us less pick up of sounds from that direction or area (figure 3).



Polar diagram of Cardioid Microphone

By altering the design of a microphone, we get different directional patterns, such as Hyper Cardioid, Super Cardioid and ultra direction patterns for a narrower pick up. This type of microphone can be pointed to a smaller area for pick up like a gun pointing at the target. That is why highly directional microphones are also called Shot Gun Microphones.

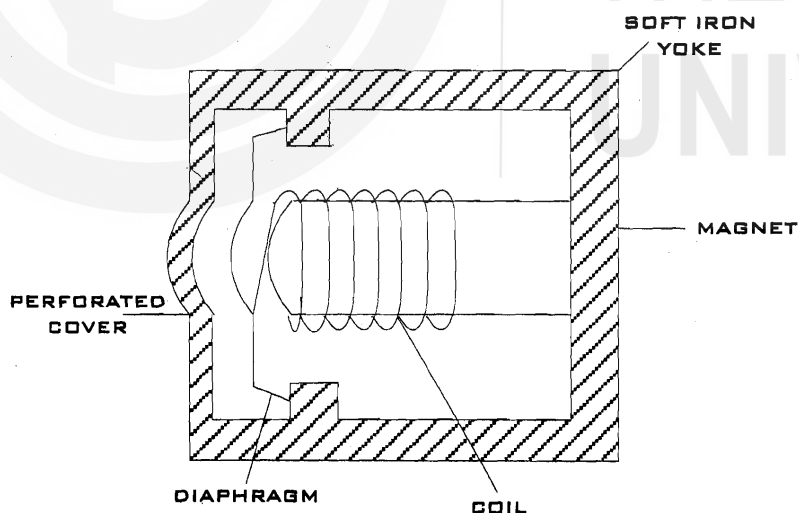
So far we have seen that the manner in which microphone picks up sounds. Let us see the methods adopted for converting the energy from sound waves, that is acoustic energy, to electrical voltage or audio signal. We have seen in the beginning that microphone is a device for converting the acoustic energy to electrical voltage or signal. Why is this conversion to electrical voltage required? This is because of the equipments used to transfer the sound waves for Recording, Playing back and for listening through loud speakers, all this involves the use of electrical signals. These electrical signals exactly correspond to the sound waves being picked up.

10.2.2 Types of Microphones

From the above discussion we understand that sound waves generate corresponding electrical signal through microphones. There are many methods to achieve this objective.. We will briefly learn about their working.

(i) Moving Coil or Dynamic Microphone

In the moving coil microphone, also called as dynamic microphone, a coil is attached to the diaphragm. The diaphragm with the coil is surrounded by the magnetic field. This coil moves, in the enclosed magnetic field, due to sound waves impinging on the diaphragm. In turn, a small voltage is generated by the coil and the same is taken out as microphone output, which is processed in audio equipment. In Moving Coil microphone, different directional patterns can be obtained for different applications.



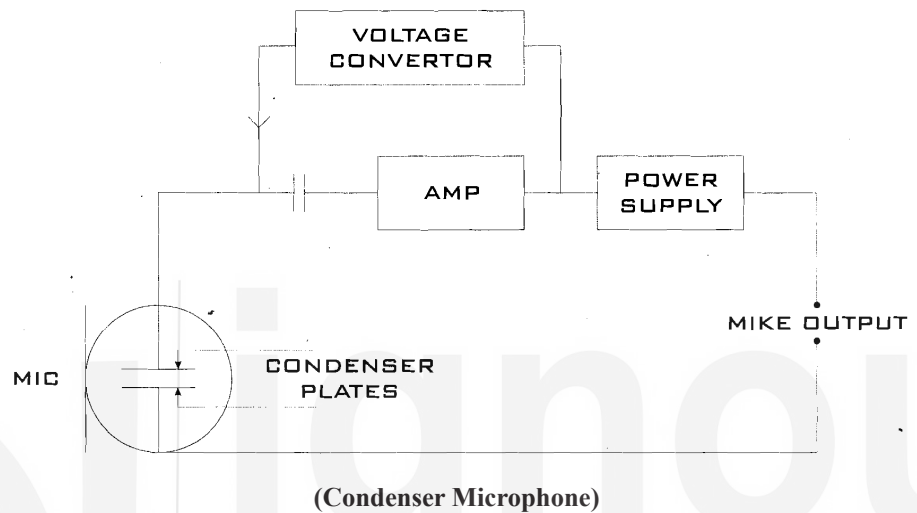
(Moving Coil or Dynamic Microphone)

(ii) Condenser Microphone

Condenser Microphone is also called as Capacitor Mike in which conversion of sound waves to electrical signal is achieved by variation of electrostatic charge by the diaphragm. The basic pick-up pattern of Condenser Microphone is Omni-Directional but with the addition of some components and electronic circuits, various combinations of pick-up

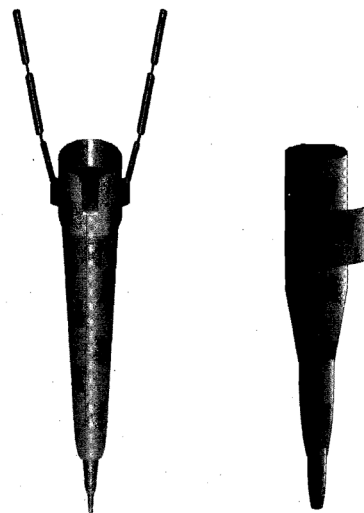
Recording

patterns are obtained. The condenser microphone has very good sensitivity on the audio frequency range, thereby very good quality of sound can be obtained. The diaphragm of condenser microphone is usually smaller and lighter than its dynamic counterpart. This is a very delicate microphone and highly sensitive to wind. However, with the use of a windshield, the effect of wind can be reduced in outdoors. The windshield is generally a piece of moulded foam that fits over the head of a microphone. Highly directional microphones like shot gun microphones are condenser mikes which we see in TV news coverage.



(iii) Lapel/Lavalier Microphone

Where microphone is not to be noticed nor block the view of a person speaking, the microphone with larger dimensions poses a problem. For this reason, Lapel or Lavalier microphones have been developed and are being extensively used. You would have seen various speakers having a tiny microphone clipped onto coat/shirt or wearing them as a pendant around the neck which is why it is called Lapel or Lavalier. It generally has a length of 1" to 1.4" with diameter of 0.4" to 0.7". This small mike can be kept hidden and even if seen, is not noticed that much. To keep them unobtrusive apart from their smaller size, they usually come in black colour.



(Lavalier / Lapel Mikes)

(iv) Wireless Microphones

The microphones described so far have a cable coming out so that it can be connected to an audio mixer or a tape recorder. You may have noticed that at times, an anchor-person in a TV show has to move in different directions to get replies from the audience. In such a situation, a cable from the microphone creates hindrance in the movement. Hence, a radio transmitter of small size is connected to the microphone. The audio signal from microphone is transmitted and received through a wireless system for the recording. For audio only recording, wireless microphones can be used when lengthy cables have to be avoided for picking the sound sources or the artistes that are moving in a live music or dialogue show on the stage.

10.2.3 Applications of Microphones

Although there are different types of microphones but the working principal is the same. A diaphragm, made of either metal or plastic, vibrates in response to the sound waves. The microphones are classified according to the way they pick up the sounds.

Microphones are used in many applications viz. phones, hearing aids, public address systems, film production, sound recording, two-way walkie talkies, radio and television broadcasting etc.

We may use a single microphone or more depending upon the situation for recording a particular sound source(s). We have already discussed three principal categories of sounds in programme production; these are; voice, music and sound effects. The application of microphone differs in the above given categories. Let us see why it differs and how we can record sounds properly.

A microphone has been designed for giving a good frequency response, with less or no distortion and not to introduce its own noise. In the main principles of recording, noise and distortion should not be present and even if present, should be at negligible levels. The quality of sounds should not change in the same given situation, abrupt changes in levels of sounds should not take place. Ambience should not change unless it is justified or going with the main line of information.

No microphone on earth is good for everything. It means different type of microphones would be used for different situations/purposes. The recording studios often use a range of microphones where each microphone is designed for a specific purpose. In case of voice recording, vocal (Cardoid) microphones with limited frequency response are used to prevent recording of unwanted sounds (noise) coming from other sources. The vocal microphones due to their directional nature are good at rejecting the voice being reflected from the four walls of the recording room/studio. For music, the long reverbration time is required thus multiple microphones are preferred. Microphones specially designed for picking the sounds of particular musical instruments are often used. The sound effects are often recorded using sensitive condenser microphones with hyper-cardoid pick-up pattern to capture good audio. Sensitive microphones are good for picking up the subtle sounds in sound effects.

Recording

The type of microphone used depends on the intended use. Parabolic microphones are used for distance recording e.g. recording a game match being played on the field. The best parabolic microphone can pick up sounds from as far as 300 yards.

Selection of Microphones

You know, none of the microphone is superior to other microphones. Each one is best suited for different purpose. The important factors in selecting a microphone include

- the sensitivity,
- quality of sound,
- overload characteristics, and

the size of the microphone. The selection of microphones has a bearing on the type and place of recording. The principles of selecting microphones can be applied to all voices or audio sources. The Sensitivity of the microphone, polar pattern, dynamic or condenser microphone and the frequency response, everything contributes in decision making that which microphone will work in a particular application. For studio recordings, generally condenser microphones are used both for spoken-word as well as for music. For outdoor recordings, Dynamic Microphones are preferred as they have sturdy construction and comparatively less affected by wind in outdoor recordings. For group discussions, Omni-Directional Mikes are used by placing them in the centre. For Music Recording as there are different types of instruments, such as Rhythm, Strings, Wind instruments, Voices etc. a number of mikes, depending upon the group of instruments, are required. Normally, cardioid mikes are used so that other group sounds are not picked directly to a great extent.

The guiding principles in the use of microphones are:

- placement
- balance
- separation
- perspective

Placement

Placement or the positioning of a microphone has important bearing on the different aspects of the sounds being recorded. The first point is the quality of sound whether recorded sound has the true character of the original sound. Improper placement gives rise to disturbing sound quality known as Distortion.

For the spoken-word, placing the mike for recording in front of the person gives more sound level. But there may be some problems arising out of straight blast of air coming from the mouth on to the diaphragm. So it is advisable to keep the mike slightly above the on-axis, i.e., mike being tilted towards the speaker. Normally in narration, the person who is speaking should maintain a posture so that head movements are under control.

Balance

Balance is a term often used in sound recording which has to be understood correctly. Balance is the desired loudness levels set for the sounds involved. When two voices are to be recorded or different music instruments are to be recorded, we have to maintain the relative loudness of voices or music instruments in such a manner that one sound is neither too loud nor too low as compared to the other.

Balance is not only between two voices or music instruments etc. Even with a single artiste, be it music or narration, balance has to be achieved. With a single music instrument, the balance is between getting good tonal structure of music and avoiding the noise generated by instrument like plucking or blowing effect. Although the mike picks up sounds in a wide area, yet at a particular angle and distance, the true nature is obtained in a better manner.

While balancing voices in a discussion, the clarity of each voice needs to be ensured. Depending upon the need, the relative sound levels have to be maintained by proper control at the time of recording. This can be achieved by proper placement of voices with louder voice away from mike and weaker voice placed nearer the mike. If placing voices on a single mike to achieve balance is not possible then two mikes can be used, and balancing is done on the Audio Mixer.

In Music Recording, the mikes are assigned to different groups, such as, singer, rhythm, lead instruments and supporting instruments. The balance is achieved by properly maintaining loudness levels of the singing voice supported by rhythm and other instruments. There is also balance between rhythm and other instruments and between individual instruments.

Separation

Separation is preventing one sound from interfering with the other. This implies the mike has to pick the desired sounds leaving out other sounds. For getting a better quality in Music recording, the physical separation of instruments and voices is made so that the interference from one to other is reduced. If separation is not done properly then the recording will be full of cross pick up resulting in distortion. It must always be remembered that the problem of cross pick up increases with the use of many microphones.

In most professional microphones, there are provisions of reducing the sensitivity of the microphone as well as filters. Any mistake in picking the sounds by microphone cannot be corrected later. That is why distortion and noise on a mike is the main point for any type of recording.

Perspective

Perspective is apparent distance of the sound source from the listener. In studios or indoors the sound produces reverberations. At all points from the listener, the ratio between the direct sound to the reflected sound (reverberation) keeps on changing depending upon the distance between the sound source to the listener. This quality of sound gives us the perspective, with reverberation getting less when source of sound is nearer and increasing when the source of sound is far, and direct sound relatively becomes less.

Recording

For recording effects such as mechanical noises of machines, the level will generally be very high and the mike should be at a distance to avoid distortion. There may be very low level mechanical effects for which the mike has to be taken reasonably closer, provided other noises are not interfering. In such cases, Cardioid and directional mikes are used for recording.

For recording natural effects of birds etc, one has to be away from the noises of traffic etc, and may be away from city/town to a calm place. Hence, Highly directional mikes are preferred, so that, we can get the recording in a better manner from a distance. Moreover, if we go nearer, the birds/animals may go away!

Check Your Progress: 1

Note: 1) Use the space below for your answers.

2) Compare your answers with those given at the end of this unit.

1) Name the two principles of picking sound waves by microphones and explain the difference.

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2) Mention the different types of microphones and their characteristics.

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3) Why is balancing important in a music programme?

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4) What do you understand by the term 'perspective' in the use of a microphone?

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10.3 AUDIO MIXER

We have seen in the previous section that there are Many types of sounds such as voice, music instruments, mechanical effects and natural effects. The level of sounds in all these sound sources have different intensities which vary from very low levels to very high levels. We know that sound is primarily a pressure wave and as the sound source pressure increases, so does the intensity of sound. Our ears are very sensitive in picking up sounds

from a very low level to very high levels and the ear can hear a large range in intensity of sound levels. The lowest level a human ear can hear is termed as 'Threshold of hearing' and the highest levels of sound which causes pain is termed as 'Threshold of pain'. In between these two points there is a vast amount of difference in the sound levels which is expressed as decibels (dBs). The **decibel** is the unit of measuring intensity of a sound relative to a reference sound level. The human ear can hear sounds in a range of 130 dBs. However, there are limitations for recording such a vast range of sounds and reproducing them on a recording medium such as magnetic tape. A Magnetic Recording system on a tape may have about 60 dB range (also known as dynamic range). Further, this range gets modified due to the place of listening and the listening conditions. The range of sound levels have to be reduced so as to accommodate the technical parameters in a recording chain for getting optimum range and quality in recording. The dynamic range of digital audio systems can far exceed that of analog audio systems. Though analog tape recording system can have a dynamic range of up to 77 dB but the modern digital audio recording system can have dynamic range exceeding 90 dB.

That is why, at the time of recording sounds, we have to control the level of sound sources so that a proper electrical output is fed to the recording system. In a music recording, a number of microphones are generally used. Control over the level of sound sources is required for proper balancing among sounds picked up by different microphones, and also to improve the quality of sounds being recorded.

Audio Mixer is used to accomplish these tasks. It facilitates with a number of microphone inputs, inputs from other recorders and accessories with quality controls like equalisers, outputs for recording and listening or monitoring the sounds being recorded. The Monitoring system allows us to judge the quality of sounds so that proper recording can take place. Mixer also provides visual indication on a meter to see that proper electrical levels are fed to the recorder.

10.3.1 Basic Features of Audio Mixer

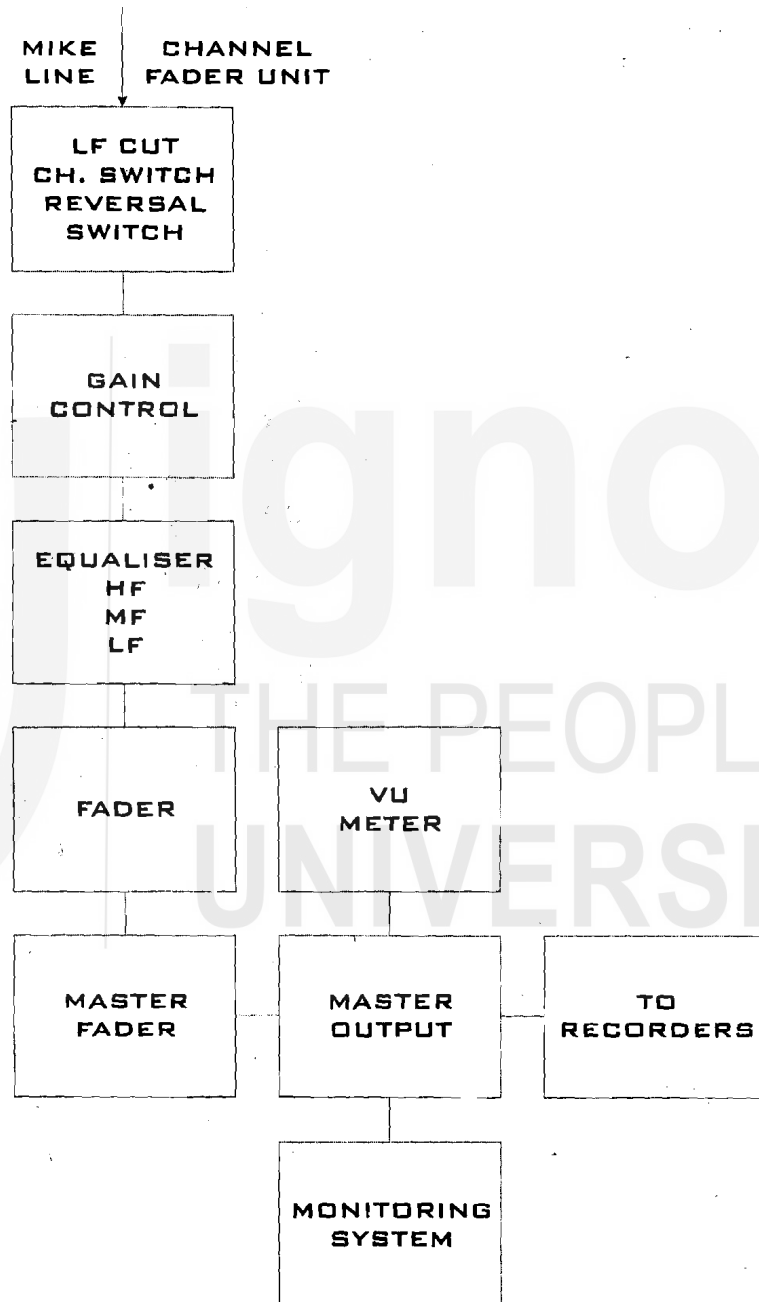
Professional audio mixers for studio recording are available with 10 channels to more than 40 channels, with many facilities for handling the sound signal, such as, faders, equalisers, artificial reverb control, amplifiers, mixers, talk-back and filters. Let us examine these facilities in some detail.

Each channel in an audio mixer means it can take one input like a microphone. For controlling the level of sound, a Fader is used. By sliding the fader up, the sound level increases and by sliding the fader down, the level keeps on falling and at the end the sound level is completely reduced to zero.

Each channel has a provision to take a low level signal from microphone or a high level signal from a playback machine. So each channel has a facility to accept low to high levels. In a typical Audio Mixer each channel will have other features, generally in this order: very low frequency cut off filter, phase reversal, channel on/off switch, channel gain control, treble and mid frequency filters and equalisers. The equalisers can be set at a chosen frequency from 150HZ to 7KHZ, which can be amplified or reduced, by 10 to 15 db. To avoid accidental use of equalisers when not required, a switch

Recording

is provided to cut off the equaliser. That means we can bring the equaliser into operation when it is required. The equaliser is primarily used to alter the frequency response of the channel being used. This way we can alter the tonal quality of the sound. LF means low frequency, MF means mid frequency and HF means high frequency. The LF is used when sound is a bit boomy or muddy and tweaking LF can add warmth and depth to the sound. HF cuts can reduce the noise from the incoming sound. Raising MF adds brilliance to the sound, particularly the vocals become more intelligible.



(A typical block schematic of Audio Mixer)

Then we find the often used Fader which facilitates a smooth increase/decrease in levels and achieving balance in sounds.

The channel outputs are fed to a Master Fader Unit, from where the mixed output of sound signals is taken and fed to a recorder for recording. From this Master Fader Unit some more outputs are taken for monitoring purposes.

Monitoring means listening to the sounds being recorded and seeing that the required strength of sound signals are fed to the recorder for obtaining proper results. Therefore, to know the quality of sounds and corrections required, a high quality loud speaker is used. Definitely, you need a good pair of ears coupled with good brain understanding the quality of sound.

For listening to the sounds, output from the mixer is given to an Amplifier which drives the loud speaker. This enables us to know the quality of sounds and corrections required. As we have already discussed earlier, till the loud speaker, the sound signals are in electrical signals form with a specified voltage required for the recording. So there is a visual indication meter giving us the idea of strength of sound signals. This meter is called VU meter — VU meaning volume unit — and the maximum signal that can be recorded is 0 VU on VU meter. That means, if a signal goes beyond this, there will be distortion in the sounds being recorded. At the time of recording it is therefore necessary to judge the sounds from loud speaker and level on VU meter.

In addition to the above, there are some more facilities in a mixer. A mixer can supply a phantom power for a Condenser microphone. Talk-back facility gives us freedom to communicate with the artistes inside the recording studio, for giving instructions etc. To control unexpected and sudden rise in the sound levels, limiter and compressor units are used in the mixer which prevent damage to the equipment as well as help in avoiding distortion.

For enriching the liveliness of sounds and to give aesthetic appeal, artificial reverberation is used. This facility is available on each channel so that reverb can be added to any sound we desire. In all the professional recording studios, Artificial Reverb units are used along with the Audio Mixer. From this, we can simulate the quality of sounds as heard in a small room to those in a very large hall. For adding artificial reverberation, there is a reverb control to increase or decrease the signal.

Similarly, there are Filters to cut disturbances in very low frequency range and at high frequencies. There are equalisers for Low Frequency (LF), Mid Frequency (MF) and High Frequency (HF) to boost and cut as much as 15 db in each channel, improving the quality of sounds being recorded.

A good recording is possible only when the facilities available are optimally used in relation to the sounds being recorded.

10.3.2 Applications of Audio Mixer

In any recording, the lowest level and highest level which can be recorded properly is determined by the noise present in the lower levels and distortion occurring at high levels. The noise can be from acoustic sources like leakage of sounds from outside and from the structure of the building itself.

The Fader setting while recording has to be in such manner that the higher levels are around zero VU and lower levels are not falling below the scale at -20 VU. We must bear in mind that the meter is showing the strength of sound levels in direct proportion. At the same time we are listening to the sounds as per the ear characteristics. Hence, at times the levels shown on a meter and the levels perceived by ear can be different resulting increase or decrease of loudness of sounds heard, as the case may be. Though zero

Recording

VU corresponds to the maximum level for recording, it is not necessary that while recording, all sounds have to be maintained at this. It is the loudness levels which should not vary suddenly giving sudden drops or boost of the levels. Therefore, fader can be used effectively to maintain proper setting on the meter in relation to the sounds being heard. At MF and HF the level shown on meter will be less compared to LF, yet the loudness perceived may be more. While recording, say a single voice, if clarity is missing, then reduction of low frequency or boosting of middle frequencies can be used so that the loudness levels as heard are not varying with jerks and jumps. This is balancing in voice recording. Similarly, balancing in recording two voices is of maintaining the relative levels of loudness levels so that one voice is not clashing or masking the other voice. The two voices can be balanced on a single microphone or two microphones can be used, each one picking one voice directly and balancing is achieved on the mixer by adjusting the faders to get the desired levels.

In music recording, loudness levels are adjusted in such a way that the voice, rhythm and other instruments are heard distinctively and the levels are well maintained. In music recording, the inherent levels of each instrument change. Hence, perception of loudness also changes. Therefore, the placement of instruments on different microphones and balancing them while doing mixing is a very interesting and challenging job.

We have to keep in mind that the levels of music instruments have a huge frequency range as well as low to very high sound levels, depending upon the instruments involved. For example, rhythm (percussion) instruments like Drums, Tabla, Pakhawaz, Mridangam have very high levels. Strings and bow instruments have comparatively less sound pressure levels, but their impact on the ear's perception is more. Gongs and bells have intrinsic high levels on directional axis and if they are off the axis of pick up, their level gets reduced. So while placing different microphones for instruments, it would be better to keep microphones for groups containing rhythm separately and other microphones for the rest of the instruments. Although there is no short cut method of placement of music instruments, the objectives of balancing is that the music instruments are so placed that the sound level of any instrument is not overshadowed by any other. When microphones are placed for rhythm, string and wind instruments, the balancing is done on the mixer, with Faders increasing or decreasing a particular group, so that the sounds are well blended or mixed.

For recording a song, voice with music instruments are present and in this case, the balance is of voice and instruments. When voice is used for singing, then all the other instruments are only supporting and enriching the mood and content of the voice. As the tempo and notational changes increase so does the sound level. These have to be controlled so that the levels do not overshoot on the meter and sudden increase of loudness levels does not take place. The sound quality can be improved with the use of filters and equalisers but one has to be very careful in applying the same. The limiter /compressor unit on the mixer is provided to prevent over modulation which can cause distortion in the sounds being recorded. The artificial reverberation is used for both voices and for the instruments like violin, flute etc., to provide an artistic and aesthetic feeling while listening

to such sounds.

Check Your Progress: 2

Note: 1) Use the space below for your answers.

2) Compare your answers with those given at the end of this unit.

1) Enumerate the facilities available in an audio mixer.

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2) Explain the use of faders in audio mixing.

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10.4 MONITORING SYSTEM

For accomplishing a proper recording and to ensure that the equipment in operation are functioning properly, a good professional monitoring system is essential. It consists of an amplifier and loudspeakers. Amplifier is an electronic device by which sound signal level can be increased. Loudspeaker converts electrical signals from amplifier to sound waves for listening.

As mentioned earlier, the Audio Mixer gives output for feeding to the amplifier and this output from the mixer is called ‘Monitoring output’. We have partly discussed in the previous section about monitoring of sound levels on VU meter, while recording and playback. For understanding the nuances of sounds, to find sensitive points in the sounds, to appreciate perspective, sound balance and quality, a professional set up of high quality amplifier with a very well designed loudspeaker is required.

The loudspeaker is the final point of listening for assessment, hence monitoring is absolutely necessary. The way the human hearing system works, we cannot get good quality recording by relying only on the VU meter unless we monitor the sound levels at the time of recording.

There is a specific difference between the sound quality as heard in the sound studio or indoors to that of sounds heard in outdoors. The sound quality in outdoors is different, due to dispersion of sound waves, resulting in a sort of dry quality due to loss of LF or HF depending upon the placement of microphone, distance between the source of sound and the mike. In the outdoors, the sound recording is done on Portable Digital Recorder. In such situations, monitoring of sounds is done by using high quality headphones. Assessment of sound quality is done on instant to instant basis as well as in a particular time frame. This gives the idea of a wrongly spoken word, less or more stress on a syllable and maintaining overall loudness levels in even manner. The headphones used get the required audio power from the recorder itself, whereas a separate amplifier and loudspeakers are required for studio recordings.

Monitoring of sounds is needed not only for improving quality aspects of sounds being recorded but also to listen to the various noises in the given place of outdoor location, the extent of noises and the strength or level of the noises. The external noises at low to very low levels will not pose any problem to the chosen sounds which are being recorded. On the contrary, this will lend realism since the ambience of that place is reflected in the recordings.

The monitoring of sound levels require a finely tuned ear to interpret sounds aesthetically. In radio listening, unlike TV or film where there is a minimum distance between the screen and viewer, the person is generally nearer to the radio, so any mistake in sounds being reproduced in radio is easily detectable.

10.4.1 Amplifier

We know that the sound waves make identical electrical signals which are passing through the different segments of recording chain. Often this electrical signal is in the order of few millivolt (millivolt is one thousandth of volt). For the system to be operational at various stages, these small voltages are insufficient to fulfill the tasks involved in various segments of the chain of equipment involved in sound recording. The minute voltages are increased to the required levels for operating the equipment. This increasing of smaller electrical voltage to higher required voltage is done by an amplifier electronically. This amplification has to be uniform for all the frequencies and also there should not be any distortion in this process of increasing electrical signal levels. That means whatever signal is fed, the same has to come out with more signal level. For monitoring sounds in the sound studio, a large speaker is used which requires quite a good amount of electrical signal power to give out high sound levels. An amplifier increases the electrical voltage or energy and in the case of monitoring amplifiers 100 watts to 200 watts outputs are used. That means, sound waves which are now in the form of electrical signals have an electrical output of 100 watts.



(Amplifier function)

For professional applications, the monitoring amplifier has a high quality design so that true sounds signals are present at the output. Since electrical energy in terms of watts are coming as an output from monitoring amplifier, it is called as 'Power Amplifier'. The output from this amplifier is fed to a suitable loudspeaker so that both amplifier and loudspeaker are matched.

10.4.2 Loudspeaker

The output coming from the monitoring amplifier, as discussed earlier, is an electrical output, which means it has voltage and power. The sound signal which is in electrical form has to be converted back to acoustic or sound form. We can't hear an electrical signal. The transducer or converter used to perform this conversion from electrical output to sound output is called

a Loudspeaker.

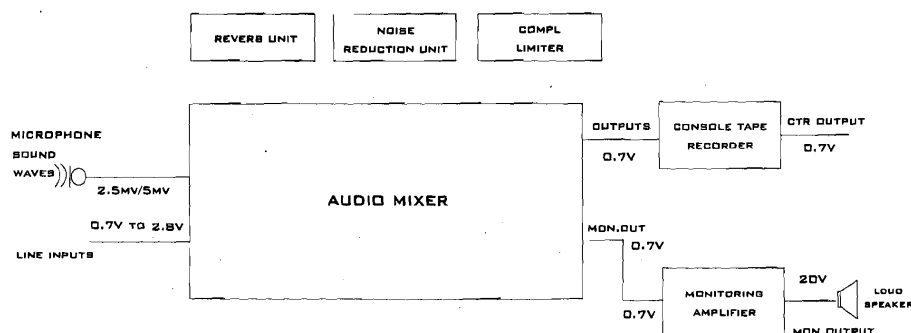
In a microphone, sound waves are converted into corresponding electrical signals and in loudspeaker the reverse happens. The difference is only that in microphone the electrical output is very small and in loudspeaker, a large voltage is applied to the coil attached to the cone of loudspeaker to give out high sound levels.

Loudspeaker is a very complicated device with high degree of specialisation required to make it sound smoothly in all the frequencies and sounds appearing natural while listening. It is difficult for a single loudspeaker to reproduce all the audio frequencies properly. Hence, generally in professional applications, the loudspeaker used is not one but may be two or three enclosed in the same cabinet. This is called two-way or three-way loudspeaker system. This simply means that the audio frequencies are split into two or three divisions so that only that particular range of frequencies is acting on the given loudspeaker. The loudspeaker handling LF is called **Woofers** and for HF it is called **Tweeter**. In a three-way system the third unit is called **Squeaker** for MF. But generally, two-way system is followed due to its cost effectiveness.

A loudspeaker has a wattage, like a bulb. If a torch bulb is applied with the main supply, the bulb gets fused. Similarly, loudspeaker is marked for the power in watts it can handle. So while using a loudspeaker it is essential to see that the amplifier is not having more rated power than the power a loudspeaker can handle. You may be wondering why so much wattage amplifiers are required, for driving the loudspeaker. The reason is that though electrically the wattage of sound signal is high, its conversion to acoustic power is very less. The efficiency of loudspeaker converting electrical energy to acoustic energy is very poor. In a loudspeaker, the efficiency may be 5% to 10% only. This is further reduced due to other technical factors. Moreover, especially for low frequency sounds to be heard at high levels requires an amplifiers with high wattage.

10.5 MICROPHONE TO LOUDSPEAKER: THE CHAIN

So far, we have studied the important aspects relating to Mike, Mixer and Monitoring system separately to give you clarity on each of them. In actual practice for recording, they form a chain - one leading to another to perform varying functions professionally in a sound studio. We can represent the chain consisting of microphone, audio mixer, monitoring amplifier and loudspeaker by a Block diagram as given below:



(Typical recording chain)

Recording

To give an idea of transformation of sound waves, the electrical signal level has been given for a typical chain. We can see the mike produces very small voltages which are fed to the mixer. The various electronic components like amplifier boosts the signal levels required before mixing operation takes place. The mixer is so designed that a proper signal level comes at the output to be fed to a audio recorder and to the monitor amplifier. The beginning and end of the chain, i.e. mike and loudspeaker are transducers and the rest has an electronic configuration.

Check Your Progress: 3

Note: 1) Use the space below for your answers.

2) Compare your answers with those given at the end of this unit.

1) What is the role of an amplifier ?

.....
.....
.....

2) Explain the chain from the artiste to the loudspeaker.

.....
.....
.....

10.6 LET US SUM UP

The sound waves produced vibrating air particles surrounding the source of sound are heard directly by the ears. But for recording on audio recorder, we require different devices so that the recorded sounds can be played as and when required. With technological advancement, excellent systems of recording have come up.

The microphone is the first link in the chain of converting sound or acoustic energy to electrical voltage so that electronic operation can take place. The way the sound waves behave in closed space and in open air and the way the human hearing system perceives the sounds are main factors in developing various equipment for recording and monitoring purposes.

The audio mixer tries to do what the human ear in the central nervous system does in mixing sounds in their levels by blending groups of sounds and improving the quality of sounds being recorded.

For accomplishing a proper recording and to know the equipment in operation are functioning properly, a good professional monitoring system is essential. It consists of an amplifier and loudspeaker. Amplifier is an electronic device by which audio signal level can be increased. Loudspeaker converts electrical signals from amplifier to sound waves for listening. This recording chain consisting of Mike, Mixer and Monitoring system performs varying functions professionally in a sound studio.

10.7 GLOSSARY

Acoustic Energy : The minute variations of Atmospheric Pressure created by sound waves from the source of sound and the same is interpreted as sound levels or sound energy by the ear.

Amplifier : An electronic device by which a audio signal level can be increased.

Balance : Maintaining a proper relationship among sound levels of various sound sources.

Decibel (dB) : A logarithmic ratio of two sound sources, two voltages or two powers. The original unit was Bel but it was large for applications and decibel is one tenth of Bel is used.

Distortion : If the wave form at the output is not similar to the input then distortion occurs. This can occur in a mike, recorder or mixer if proper care is not taken.

Equaliser : An Equaliser boosts or attenuates (with the use of electrical network) a particular range of frequencies for improving sound quality.

Filter : A Filter helps in attenuating sharply the level of a particular frequency.

Frequency : It is number Of sound waves per second given out by source of sound. It is expressed as Hertz or cycles per second, written as Hz.

Frequency Response : This is to judge whether passage of different frequencies is uniform in a device. The deviations are expressed as db above or below 1 KHz level.

Monitoring Amplifier : This is a power amplifier to drive a loudspeaker for listening at higher levels.

Reverberation : Reverberation is the resultant effect of multiple reflections occurring in an enclosure for a given frequency.

10.8 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

Check Your Progress: 1

- 1) The two principles of picking up sound waves are: pressure operated principle and pressure gradient principle. In the pressure operated principle, what matters is the relative changes of pressure due to sound waves on one side of the diaphragm while in the pressure gradient principle, it is the difference of pressure on both the sides of the diaphragm.
- 2) The different types of microphones include Ribbon, Condenser, Dynamic, Lapel and Wireless Microphones. From the directional point of view, there are three types of pick patterns or Polar patterns for the microphones. They are, Omni-directional, Bi-directional and Cardioid including highly directional mikes. Polar diagram for a microphone is generally fixed but in certain microphones the polar pattern can be changed.

Recording

- 3) In a music programme balancing is important because there are different music instruments involved in addition to the vocalist/s. Maintaining the relative loudness of the music instruments and the voice. Balancing helps in getting a good tonal structure.
- 4) Perspective refers to the apparent distance of a sound source to the Microphone or to the ear. In the case of music renderings, microphones are assigned to the vocalists and, different instruments. There is a balancing of instruments of different groups like rhythm, wind and string. This balancing helps in proper maintaining of loudness levels and providing depth or perspective in music.

Check Your Progress: 2

- 1) An audio mixer has the facility to take in a number of inputs and give the outputs for recording and listening. Latest Mixers, depending on their design, can facilitate as many channels as required. The facilities associated with a mixer include faders, filters, equalisers, reverberation control and outputs.
- 2) Faders serve the purpose of a gatesman' to regulate the entry and exit of audio into the Audio Mixer. With the help of the VU meter in the mixer which indicates the level of sound i.e. the input, the sound recordist regulates the level of sound avoiding sudden drop or boost. In this, s/he is guided by his/her own listening to the sounds in addition to the readings on the meter.

Check Your Progress: 3

- 1) Sound waves make identical electrical signals which pass through different stages of the recording chain. These electrical signals are of low voltage. To make the system operational, the low voltage has to be increased. The function of increasing small electrical voltage to higher voltage is done' by an amplifier electrically, so that an amplifier can feed power to electrical/electronic devices for recording or playback/monitoring
- 2) A Microphone is placed before an artiste who performs. The mike output is fed to an audio mixer where fader controls the level of audio to be recorded. Filters and equalisers present in the audio mixer improve the quality of the sound. Reverberation and other facilities of limiter /compressor give aesthetic appeal and feed the required output to the recorder and monitoring system with the use of VU meter on audio mixer. Audio mixer gives out a properly mixed output when there are more inputs given to the audio mixer. The Sounds of the artiste who is before the mike are judged by seeing the VU meter on the mixer and at the same time listening to the sounds through loudspeakers. When the quality is found OK the recording is done.