Microphones for Recording

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Understanding the different types of microphones and their characteristics will help the tape recordist get the high-quality results he always strives for.

WHILE THE MICROPHONE is a vital adjunct to the tape recorder, it is not an integral part of the latter. In fact, some of the high-quality home tape machines are sold without a microphone because it is felt that the individual critical enough to desire such a machine will also be critical enough to wish to make his own decision concerning the microphone for his purposes. On the other hand, it is virtually universal practice for medium- and low-price tape recorders to include a microphone as part of the package.

If moderately accurate reproduction of speech is all that the recordist desires, an inexpensive microphone of the kind that usually comes with a tape recorder will probably suffice. But if one plans to record live music or wishes a true facsimile of the spoken word, it is likely that a low-cost microphone will be unsatisfactory for one or more of the following reasons: inadequate frequency range, irregular frequency response, unsuitable pickup pattern, inability to suppress extraneous noises, susceptibility to overloading.

Accordingly, it is the purpose of this article to discuss the principal types of microphones in terms of their characteristics and advantages. To illuminate the path toward satisfactory recording of live sources, the discussion shall also deal with such things as microphone placement, low- *vs.* high-impedance microphones, mixers, and so on.

A microphone consists of an element which vibrates in accordance with the sound waves that strike it, together with a transducing device that converts the mechanical motion into an electrical signal. The nature of the transducer is the principal characteristic that distinguishes one type of microphone from another. For our purposes, which concern tape recording by the amateur in the home, school, church, and the like, we may distinguish among three fundamental types: (1) piezoelectric; (2) magnetic; (3) capacitive.

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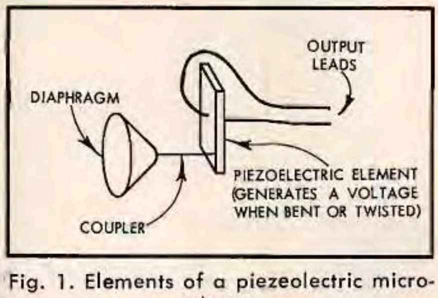

Fig. 1. Elements of a piezoelectric microphone.

Piezoelectric Microphones

The microphones included with popular-priced tape recorders are generally of the piezoelectric variety. *Figure* 1 shows the principle of operation in elementary form. A piezoelectric substance, such as a Rochelle salt crystal, has the property of producing a voltage when bent or twisted. The motion of the microphone diaphragm bends the crystal slightly, causing a voltage to be developed between the opposite faces of the crystal. This voltage varies in accordance with the sound.

For the most part, crystal microphones have limited response in the low bass region and exhibit a sharp drop above 7000 to 9000 cps. Also, they tend to exhibit a peak in response at about 4000 to 6000 cps, which adds clarity to voice reproduction but is ordinarily not desirable in the case of music. *Figure* 2

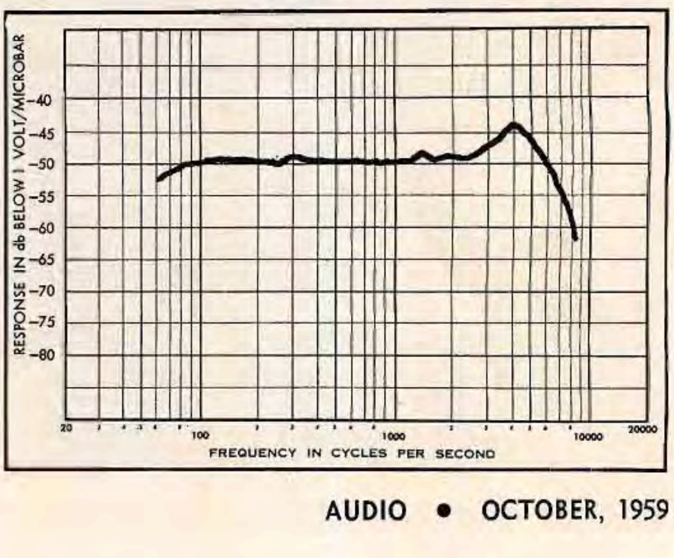

Fig. 2. Frequency response of a low-priced crystal microphone.

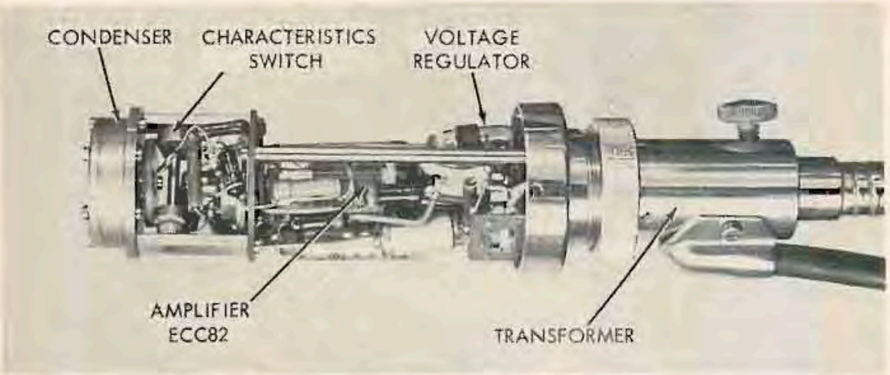

Fig. 10. Internal view of Teladi condenser microphone. (Courtesy Durant Sound Company)

and plate form a capacitor[1] having a value of a few micromicrofarads. A d.c. voltage, between 100 and 200 volts, is applied through several megohms resistance to the diaphragm, causing the capacitor to charge. Sound waves striking the diaphragm cause it to move very slightly toward and away from the plate, thus changing the capacitance. The ability of a capacitance to store current (accept a charge) varies with the value of the capacitance. When the diaphragm moves toward the plate, the capacitance is increased, resulting in current flow toward the capacitance. The current flows through the large resistor R_1, producing an a.c. voltage across R_1. Conversely, when the diaphragm moves away from the plate, the capacitance is decreased, resulting in current flow away from the capacitance. Current again flows through R_1 but in the opposite direction, producing an a.c. voltage of opposite polarity across R_1. The a.c. voltages resulting from the movements of the diaphragm are fed to the grid of a tube enclosed in the microphone. The tube serves as an amplifier and to isolate the capacitor from the following circuitry. (The capacitor has extremely high impedance, and if it is to work properly it must work into a very high load resistance. The tube supplies such a load. On the other hand, the output of the tube has suitably low impedance so that the signal may be fed without losses to the next stage.)

A power supply is required to provide a high d.c. voltage to the microphone element as well as to supply the current required by the tube in the microphone housing. The power supply is connected by cable to the microphone. The principal disadvantage of the condenser microphone, is its need for a relatively bulky and cumbersome power unit that must go wherever the microphone goes. However, it is possible to operate the microphone at a considerable distance from the power supply, so that the former does have some independence of movement.

Figure 10 is an internal photo of a condenser microphone, and *Fig.* 11 shows internal and external views of another condenser microphone and its associated power supply; note that there are two condenser elements for stereo use.

Impedance

Dynamic and ribbon microphones are low-impedance devices. This signifies that they produce, *in relative terms,* high signal current and low signal voltage. But the tape recorders in common use employ voltage amplifiers rather than current amplifiers. Therefore it is of little value that the microphone turns out a relatively large current.

Accordingly, it is necessary to step up the voltage produced by the microphone, which is done by a miniature transformer within the microphone housing. This results not only in a higher output voltage but also in a higher output impedance. Unfortunately, as the output impedance goes up, the microphone becomes more susceptible to treble losses caused by capacitance across the output. The principal source of such capacitance is the cable leading from the microphone to the tape recorder.

The so-called high-impedance microphones of the dynamic and ribbon type usually have an impedance in the range of 10,000 to 50,000 ohms; 25,000 ohms is typical. Hence one cannot use much more than 10 to 15 feet of microphone cable without endangering treble response. The microphone manufacturer can provide exact information as to permissible cable length for his units. Obviously, the use of low-capacitance cable will permit one to maximize the length.

To permit long runs of microphone cable, many dynamic and ribbon microphones employ only a limited step-up of voltage and concomitantly have a low output impedance. The values most commonly encountered are 30, 50, 100, 150, 200, 250, and 600 ohms. These output

Fig. 11. (A) Internal and (B) external views of Telefunken SM-2 stereo condenser microphone and (C) power supply. (Courtesy Gotham Audio Sales Co. Inc.)

[1] Use of the word "condenser" has practically disappeared from serious electronic literature, partially as a result of instruction manuals for the armed services. Navy brass maintains that a condenser is a device in which steam is reduced to water, and does not permit use of the word in electronic manuals to describe the device which has the property of capacitance—a capacitor. Only place where condenser is used acceptably is to describe this particular type of microphone. This may explain AUDIO's consistent use of "capacitor," although a sentence like "This capacitor has a capacitance of 82 μμf" may sound strange. "Capacity" is often used incorrectly where "capacitance" is meant, but should only refer to ability of a container to hold a specified amount, or in a phrase like ". . . power handling capacity. . . ." The device which has the property of inductance is correctly called an inductor. ED.

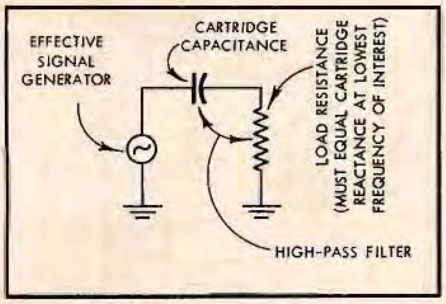

Fig. 3. Equivalent circuit formed by piezoelectric microphone and load resistance.

shows a typical frequency-response characteristic of a low-priced crystal microphone.

The piezoelectric microphone lends itself better than the other types to construction of an inexpensive unit, being fundamentally a simpler thing to build. Hence it tends to be associated with performance of moderate quality. But fairness requires us to recognize that crystal microphones can be and are made to have frequency response and other characteristics suitable for critical applications. Such microphones, which of course are substantially more expensive than the garden variety, have been employed by broadcasting and recording studios.

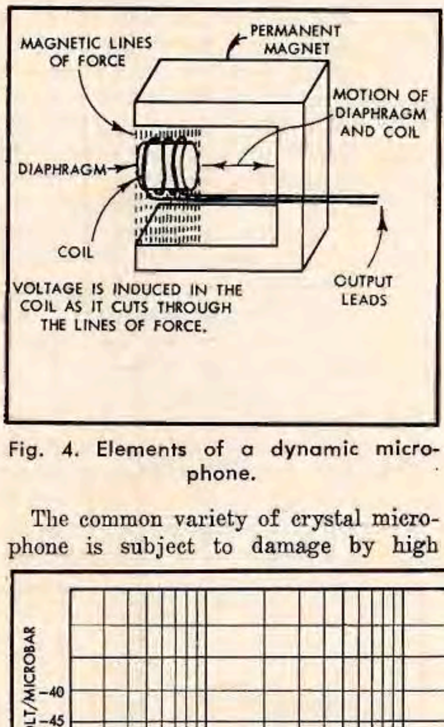

Fig. 4. Elements of a dynamic microphone.

The common variety of crystal microphone is subject to damage by high temperatures and by excessively dry or humid conditions. Thus a crystal microphone may come to grief if left in the trunk of a car on a hot day. On the other hand, there are some superior kinds of crystals which are able to withstand the extremes of temperature and humidity normally encountered.

Another way of meeting the temperature and humidity problem is to use a ceramic element having piezoelectric properties. Microphones with a ceramic element are considered relatively immune to climatic conditions.

The transducing element in a piezoelectric microphone is in the nature of a capacitance. *Figure* 3 shows the equivalent electrical circuit formed by this capacitance and the load resistance of the microphone amplifier (in the tape recorder). In effect, they constitute a high-pass filter. To preserve low-frequency response, it is necessary to have a sufficiently large load resistance. The minimum value for full bass response varies with the particular microphone. Typically, load resistances as high as 3 to 5 megohms are required to maintain bass response. Often, however, the load resistance in a tape recorder is a good deal less, perhaps as low as 250k ohms. In such a case, the input circuit of the tape recorder would have to be modified to provide a suitable resistance for the piezoelectric microphone to be used.

Dynamic Microphones

Most home recordists desiring results consistent with high fidelity standards and willing to spend between approximately $25 and $50 for a microphone will employ a magnetic type, frequently of the dynamic kind. *Figure* 4 shows in essence how a dynamic microphone works. Sound waves strike a diaphragm, to which is attached a coil situated in a magnetic field. Motion of the coil, as it cuts through the magnetic lines of force, causes a voltage to be induced in the coil. This voltage corresponds to the sound entering the microphone. *Figure* 5, which represents a good quality dy-

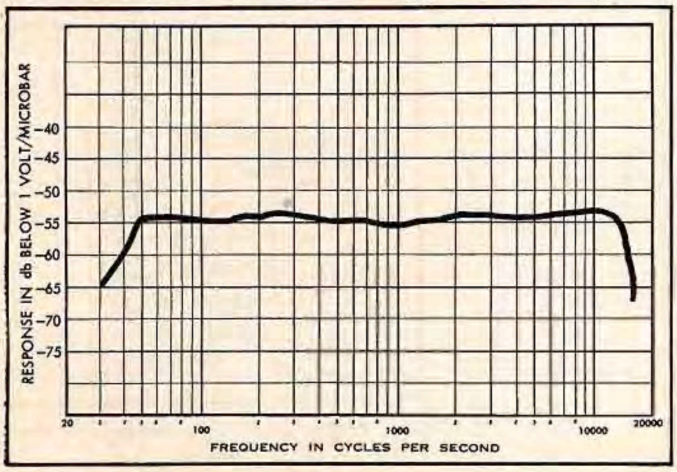

Fig. 5. Frequency response of a good-quality dynamic microphone.

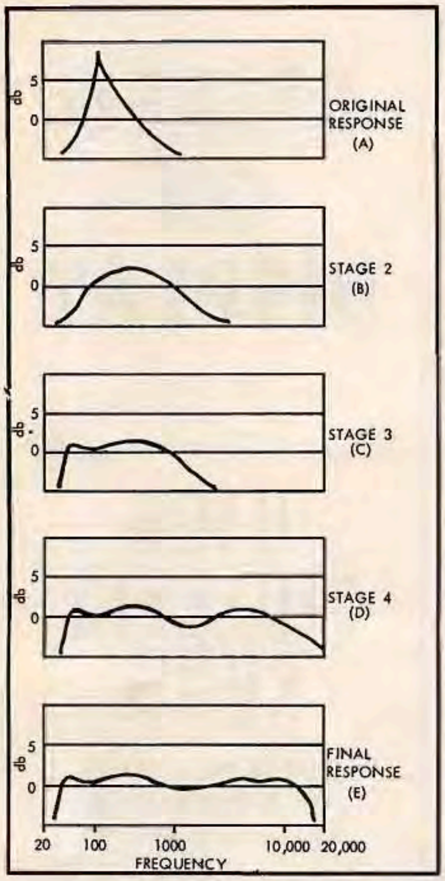

Fig. 6. Stages in smoothening and broadening the response of a commercial dynamic microphone.

namic microphone priced under $50, illustrates the smooth, wide-frequency-response characteristic of dynamic microphones.

While it is not the purpose of this article to explore the refinements of design of microphones, a few words should be said to explain why high-quality microphones cost as much as they do, considering how simple is their basic principle of operation. We may use dynamic microphones to illustrate the point. Actually, these can become quite complex affairs, involving the application of mechanical-acoustic principles to smooth and extend the frequency response of the basic mechanism. Damping and resonating devices in the form of felt, tubes, air chambers and cavities, shape of the housing, and so on are combined to produce the desired frequency response. *Figure* 6 presents a series of curves showing how the initial response of an elementary dynamic microphone (A) was gradually smoothened and broadened by the successive addition of several mechanical-acoustic devices, culminating in a microphone of very high quality. *Figure* 7 is a drawing of another high-quality microphone, suggestive of its design complexity; note, for example, the three different entrances for low, middle, and high frequencies.

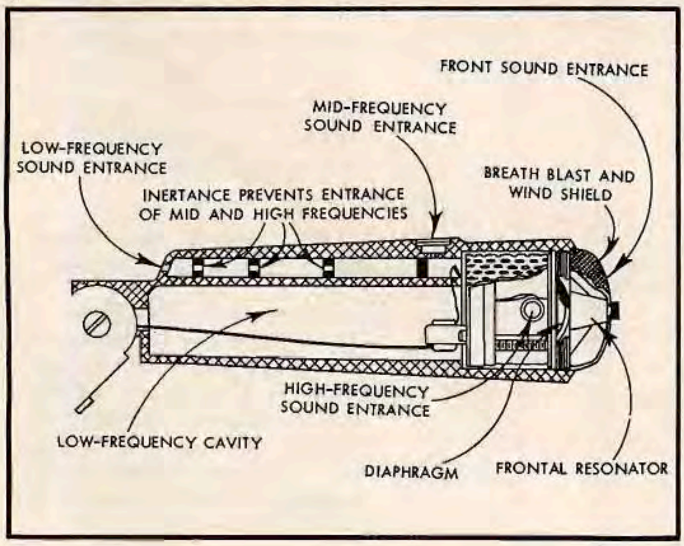

Fig. 7. Construction of a high-quality dynamic microphone.

Ribbon Microphones

The principle of operation of the ribbon (also known as velocity) microphone is shown in *Fig*. 8. It employs a very thin ribbon of metal suspended between the parallel pole pieces of a permanent magnet. As the ribbon moves in response to sound waves, it cuts the magnetic lines of force between the pole pieces, inducing a voltage in the ribbon. This is very similar to the operation of a dynamic microphone, except that in the present instance a ribbon instead of a coil cuts through the magnetic field. The ribbon, however, can be considered a coil with a single turn.

The ribbon microphone is capable of very smooth performance over a wide range, 30 to 15,000 cps or better. In the past, the ribbon microphone has been at a disadvantage in other respects, namely fragility, high sensitivity to shock, tendency toward boominess on close-up recording, and size (some units weighed as much as 8 pounds). But these flaws have been overcome altogether or in large measure, so that the modern ribbon microphone offers excellent performance in a small, reasonably sturdy unit that,

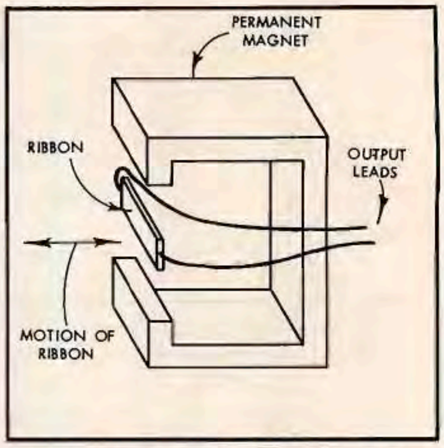

Fig. 8. Elements of the ribbon microphone.

considering its quality, is moderately priced. While the ribbon microphone may still be somewhat more fragile than the dynamic, some manufacturers of the former make it possible for the user to replace the ribbon in case of failure, thus avoiding a time-consuming return of the unit to the factory for repair, while practically no dynamic microphone can be repaired by the user.

Condenser Microphones

With respect to frequency range, smoothness, distortion, overloading characteristics, and—the ultimate test—how it sounds to the ear, the condenser microphone is considered by many to provide the highest quality. On the other hand, its cost is also the highest, being typically between $200 and $300, whereas very fine piezo-electric, dynamic, or ribbon microphones can be obtained for $50 and less. This is quite a difference. Yet some audio-fans pay close to or above $1000 for top quality tape recorders, and in their case the expenditure of an additional $150 or $200 for the best in microphones may not seem out of line.

Figure 9 indicates the basic construction of a condenser microphone. It consists of a very thin circular diaphragm of metal or a metallized substance, which is separated by a minute distance—of the order of one-thousandth of an inch—from a metal plate. The diaphragm

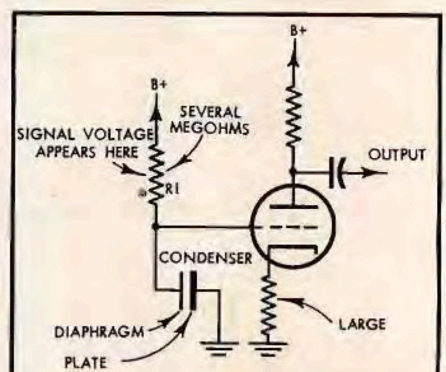

Fig. 9. Elements of a condenser microphone.

Fig. 12. An in-line microphone step-up transformer, UTC Model MC-1. (Courtesy United Transformer Co.)

impedances make feasible cable lengths of 100 feet or more.

A number of microphones give the user the option of high or low impedance, exercised by pushing a switch or by rewiring the cable connections to the microphone. Sometimes there may be a choice between two values of output impedance.

Low-impedance microphones deliver a much smaller signal than do high-impedance ones. Therefore it is necessary to step up this voltage before it is fed to the tape recorder. This is done by means of a microphone transformer located at the far end of the cable, either incorporated in the tape recorder or external to it. Tape machines of professional grade sometimes have a built-in transformer to accommodate low-impedance microphones. If not, then an in-line transformer such as that of *Fig.* 12 becomes necessary. The microphone cable is connected to the transformer, and the latter in turn plugs into the tape machine. While a high-quality in-line transformer is well-shielded, nevertheless care should be taken to keep it away from motors, transformers, and other sources of hum.

Use of a low-impedance microphone together with a step-up transformer leaves one with about the same signal level as can be obtained from a high-impedance microphone of similar construction.[2] The amount of step-up by the transformer is determined by its ratio of secondary turns to primary turns. The number of secondary turns is limited by winding capacitance, which causes treble attenuation. The number of primary turns can be reduced only so far (in order to obtain a high secondary/primary ratio) because it is necessary to have sufficient turns to match the impedance of the microphone; otherwise the signal level drops.

The piezoelectric microphone has a relatively high impedance. In this case the impedance is capacitive. As previously pointed out, it is generally necessary to have a load resistance of several megohms to prevent low-frequency losses. The capacitance introduced by a long cable does not affect treble response, but instead reduces the signal level at all frequencies.

The transducing element in a condenser microphone has an extremely high impedance, but as already explained the tube in the microphone serves to reduce the output impedance to suitable proportions so that cable or other capacitance will not significantly affect the treble frequencies. Moreover, the microphone contains a transformer—either in the housing or in the power supply—to further reduce the impedance and thereby permit a long cable run. Then, as with the dynamic and ribbon types, it *may* be necessary to employ a step-up transformer at the far end of the cable to provide sufficient signal voltage to drive the tape recorder. Whether the transformer is needed depends upon how much signal amplification has already taken place in the microphone.

Sensitivity

The greater the signal voltage produced by the microphone, the higher will be the ratio of audio signal to the hum and noise generated by the tape recorder amplifier. Hence microphone sensitivity —output voltage for a given sound pressure—is an important characteristic to be taken into account.

The customary method of rating the sensitivity of high-impedance microphones is on the basis of a sound pressure of 1 microbar or 1 dyne per square centimeter, which are the same thing. For convenience, we shall use the term microbar. The output voltage is expressed as a given number of db below 1 volt. Thus a typical rating is −55 db/microbar, signifying that for a sound pressure of 1 microbar the microphone delivers an output 55 db below 1 volt. The frequency at which this measurement is taken is customarily 1000 cps. Since the voltage is stated as a negative figure, the lower the digital value the higher is the sensitivity. Thus a microphone with a rating of −49 db (per microbar) is more sensitive than one with a rating of −52 db.

Generally, a sensitivity of −55 db or better is sufficient to permit a satisfactory signal-to-noise ratio when using a tape recorder having reasonably low noise and hum. With top-quality tape machines, a sensitivity as low as −60 db is practical. It is quite difficult to obtain a truly good signal-to-noise ratio with microphones that are appreciably less sensitive than −60 db.

Crystal microphones as a rule have considerably more output than do dynamic and ribbon ones. Sensitivities such as −50 db and better are common among crystals. On the other hand, when one gets into crystal microphones of superior quality, the sensitivity tends to go down in exchange for wider and smoother response. Then the sensitivity may be no better than that of the magnetic microphones. It may be added that ceramic microphones, while possessing greater durability than the crystal ones, in exchange tend to be less sensitive, assuming that the two types are otherwise constructed in similar fashion.

A different method of rating sensitivity is used for low-impedance microphones. Now the output reference level is 1 milliwatt (instead of 1 volt), while the standard sound pressure is 10 microbars (instead of 1 microbar). Thus if a low-impedance microphone delivers 55 db below 1 milliwatt of power for a sound pressure of 10 microbars, it is rated at −55 dbm/10 microbars. For low-impedance dynamic and ribbon microphones, −55 dbm is a typical rating and indicates sufficient sensitivity *when used in conjunction with a step-up transformer* to insure a satisfactory signal-to-noise ratio. After step-up by an in-line transformer, the voltage output will be close to that of a high-impedance microphone rated at −55 db/microbar.

A condenser microphone, because of amplification by a tube within the housing, may deliver considerably more signal than magnetic microphones. To illustrate, one make of condenser microphone has a rating of −48 dbm/microbar; another has a rating of −30 dbm, which is sufficient to drive a tape recorder with-

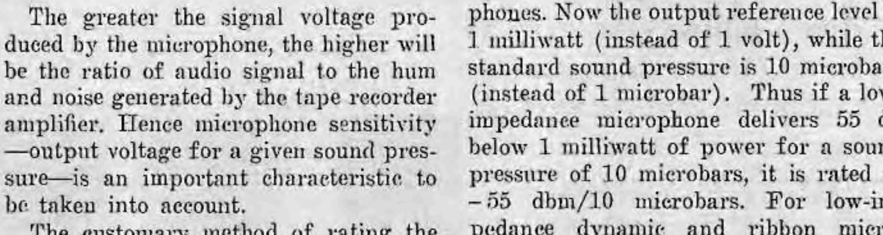

Fig. 13. Balanced microphone connection.

[2] The voice coil of a typical dynamic microphone usually has an impedance in the range from 30 to 50 ohms, and in the low-impedance form the output leads simply connect to the coil directly. High-impedance dynamic microphones usually have a transformer built into the housing. Ribbons used in microphones have impedances around ¼ ohm and it is almost imperative that a matching transformer be close to the ribbon. ED.

out a step-up transformer. However, these greater sensitivity figures do not mean that one is thereby going to obtain a proportionately higher signal-to-noise ratio than with magnetic microphones. Now the signal-to-noise ratio tends to be determined not by noise and hum in the tape recorder but by noise and hum in the microphone tube. Situations may arise where a noisy tube in the condenser microphone leads to a poor signal-to-noise ratio. Obviously this calls for replacement by a carefully selected tube.

Balanced Versus Unbalanced Connection

When a long cable is employed (with a low-impedance microphone), the chances of hum pickup are increased. Therefore it is frequent, though not universal, practice in low-impedance microphones to provide a balanced connection, illustrated in *Fig.* 13, as contrasted with the unbalanced connection ordinarily employed with high-impedance microphones, illustrated in *Fig.* 14.

In the unbalanced connection, one output lead of the microphone is connected to the cable shield, while the other lead goes to the inner (hot) lead of the cable. In the balanced connection, however, a microphone cable with two inner leads is used. These are connected to the output leads of the low-impedance microphone. The cable shield is connected to the microphone case and is grounded at the other end to the in-line transformer case. The primary of the in-line transformer has a center tap connected to ground, which serves to cancel the hum, static noise, and so on picked up by the inner leads in the cable.

Polar Characteristics

Microphones have three basic types of pick-up patterns, known as polar characteristics, which are illustrated in *Fig.* 15.

Probably the most widely used microphones although not necessarily the best in all situations, are those with an omnidirectional pattern, shown at (A), which pick up sound about equally well in all directions. Actually, as shown in *Fig.* 16, these microphones tend to be somewhat directional as frequency increases. Here the pick-up pattern is plotted for three different frequencies, and it may be seen that the pattern is more directional at 10,000 cps than at 1000 cps.

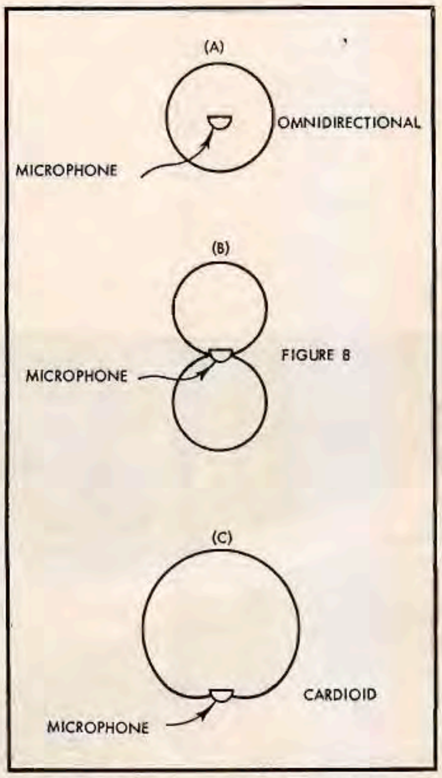

Fig. 15. Basic microphone pick-up patterns.

The second type of pattern is the cardioid, or heart-shaped characteristic, illustrated at (B) in *Fig.* 15. Here the microphone is essentially unidirectional, becoming more so as frequency rises. The difference in sensitivity of such a microphone to sounds in front of it and sounds behind it may be as much as 15 db and more. Some microphones have what is called a super-cardioid characteristic, signifying that the pick-up area is narrower still.

The third type of pattern, shown at (C) in *Fig.* 15, is the bidirectional, or "Figure-8," characteristic. Such microphones are about equally sensitive to sounds at the front and rear and have limited response to sounds arriving from the sides.

Dynamic, crystal, and condenser microphones are inherently omnidirectional, while ribbon microphones are bidirectional. However, by various mechanical and acoustic devices the inherent patterns can be changed. Thus dynamic, ribbon, and crystal microphones are available with cardioid patterns, achieved through multiple sound entrances, varying the size of these entrances, phasing devices, and other means. Condenser microphones, by means of double diaphragms—one on each side of the plate—and by applying voltages of varying level and polarity to each diaphragm, can be made to provide an omnidirectional, cardioid, or Figure-8 pattern as desired. Accordingly, one's decision to purchase a given type of microphone is not necessarily dependent upon the inherent polar characteristic of that type.

The omnidirectional microphone is advantageous when sounds are to be picked up all around it. If one is recording speech or music in the home, it is not necessary to place everyone in a restricted area in front of the microphone. Instead, it can be located in the middle of the group. When recording in a hall or auditorium, the omnidirectional microphone permits one to place it near the sound source, thereby providing a high signal output, and at the same time enables one to pick up an appreciable amount of reverberated sound arriving from the rear and sides, imparting the sensation of spaciousness.

The cardioid microphone, since its pick-up pattern is concentrated at the front, may be placed farther from the sound source than the omnidirectional microphone, yet produce equal signal output. One can place the cardioid roughly twice as far away.

Because it discriminates against sounds from the rear, the cardioid microphone can be oriented to exclude extraneous sounds. To the extent that it discriminates against reverberated sound, it prevents overemphasis of bass frequencies, which tend to reverberate more than high frequencies. The cardioid is highly useful where problems of acoustic feedback exist, as in public address systems, where it is necessary to prevent the microphone from picking up the sound emanating from the loudspeakers.

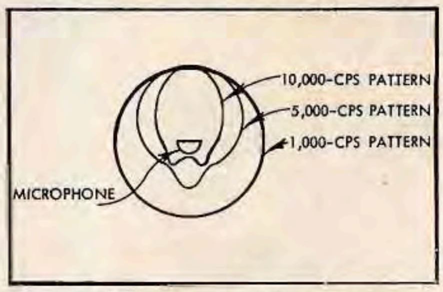

Fig. 16. Variation of pick-up pattern of an omnidirectional microphone with frequency.

The Figure-8 microphone, like the cardioid, enables one to "aim" at the sound source. The fact that the former is sensitive to sound at the rear as well as at the front means that it will pick up more reverberated sound than the car-

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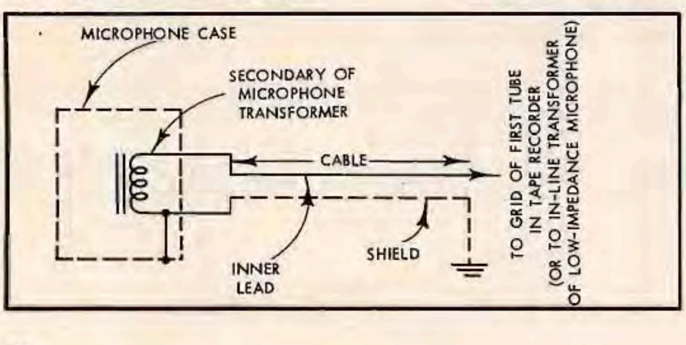

Fig. 14. Unbalanced microphone cable connection.

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dioid. The bidirectional microphone lends itself to arrangements of musicians or others in front of and behind it. Thus one can divide a performing group into two sections instead of trying to crowd them all before the microphone. It should also be mentioned that the Figure-8 microphone plays a special role in the stereo technique known as mid-side recording. The bidirectional microphone, coupled with one having a cardioid pattern, both in a single housing (see *Fig.* 11), is designed so that when the signals of the two microphones are properly matrixed (combined in phase and out of

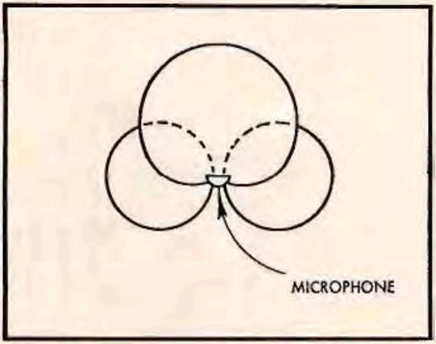

Fig. 17. Pick-up pattern of the mid-side microphone.

phase) they produce one signal corresponding to the left side of the sound source and a second signal corresponding to the right side. *Figure* 17 shows the pick-up pattern of the mid-side microphone.

Microphone Placement

Placement of the microphone depends upon the type of microphone used, as previously suggested, upon room characteristics, upon the nature of the sound source, and upon the amount of reverberated sound that is desired. The closer it is to the subject, the greater will be the ratio of direct to reverberated sound, and therefore the less the sense of spaciousness. On the other hand, clarity and definition will be heightened.

Close up recording will tend to reduce the exaggeration of bass, because it gives less prominence to reverberated sound, which consists primarily of the lower frequencies. On the other hand, one should avoid bringing the microphone too close to the source, because what is known as the proximity effect will then exaggerate the bass notes. The degree of bass emphasis depends upon the particular microphone. As a general rule, one should be at least one foot away from the microphone to avoid undue proximity effect. "Hugging" the microphone will produce those unnatural barrel tones we so often encounter. A little experimentation will indicate the closest that one may get to the microphone without sacrificing realism. A crooner may prefer singing within inches of the microphone, but this can well be a special case where his "microphone voice" is preferable to his natural voice.

Sometimes it is desirable to use more than one microphone. If one is dealing with a large group but does not want to get too far back because of undue pick-up of noise and reverberation, it may be necessary to use two or more microphones for adequate coverage. It may be necessary to use an additional microphone to give due prominence to a soloist. Or an additional microphone may be useful in picking up the desired amount of reverberated sound at a considerable distance from the source. In all these cases it is necessary to employ a mixer in order to combine the signals from the several microphones.

A mixer will have from two to as many as eight microphone inputs (or even more in professional studio equipment), each with its own gain control so that the various signals can be blended in desired proportion. Before attempting to make a recording, one should monitor the combined sound output through headphones or through an audio amplifier and speaker to ascertain that the gain controls are set for proper mixing. Or one can make a brief tape recording and promptly play it back to check the mixing.

Mixers are of two types, passive and active. The passive, sometimes called dry, type has no tubes and introduces some drop in signal level. Also, there may be danger of high-frequency loss unless the cable length from the mixer to the tape recorder is minimized. The active type of mixer employs tubes, achieves better isolation between inputs (so that adjusting gain on one input does not affect the gain of the others), usually causes no drop in signal level or provides some amplification, and minimizes danger of treble attenuation. On the other hand, the passive mixer does not introduce distortion since there are no tubes in the circuit, whereas the active mixer, unless well designed, may do so.

Mixers may range from very simple and inexpensive affairs, such as the passive two-input unit shown in *Fig.* 18, to

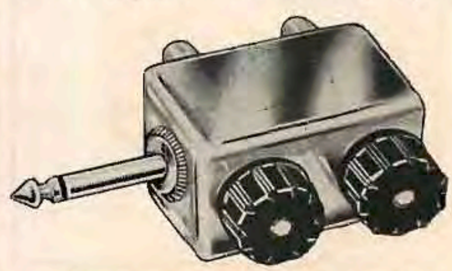

Fig. 18. Two-input passive microphone mixer, Lafayette PK-242.

tion of the intensity of an actual performance, for it is a rare singer indeed who will not surpass his "test" output by a few decibels when the take is slated and the tape machines are rolling. Consequently, a final adjustment is usually necessary at the last moment.

The position of a singer is also dictated by the nature and power of his vocal production as picked up by the microphones. There is no question that some voices are more phonogenic than others—that is, they are easier to place than most. It can be rather tiring for one such phonogenic artist to repeat his part in a scene over and over again while his partner is being sonically "fitted." Only after these basic positions have been discovered can the recording director concern himself with stage movement.

There are three main approaches to action in stereo opera. The first favors unlimited movement, not only in places in the score in which a specific change of position is indicated, but even in arias. According to this approach, the singer should behave at the session as he does on the stage during an actual theatre presentation; if he feels like moving his head from side to side, twisting his body in a lively dance, or even stepping forward or backward, nothing should restrain him from doing so for the sake of realism. The second approach involves a cast of characters spread out across the stage, but glued to their assigned positions; this might be described as stereo opera in white tie and tails. The third approach falls somewhere between the two extremes. Movement here is supplied when called for to underline the drama, and to indicate changes of position, exits, entrances, asides, and so on, but it is not employed at the expense of intelligibility and aural focus. Regardless of the degree or manner in which it is used, movement in stereo opera is here to stay and brings the theatre's visual and dramatic impact closer to the listener than ever before. Æ

AUDIO ETC

(from page 16)

This is what can be done with slow-speed quarter-track, and it's good. It ought to convince many who are doubtful.

Confusions

The Tandberg machine itself is interesting, if confusing. It *is* confusing, and to this day I have not yet figured out exactly what I'm getting onto my two tape channels in the way of recorded level. There are anomalies, ambiguities, inconsistencies, at least in my production model, that make recording quite a tricky business. It took me a long, long time before I managed to get things under control for respectable results under duress—that is, at public concerts, and so on. There would seem to be honest reasons for this, and interesting.

The Tandberg 5-2 is an adaptation of the well-established basic model, and some of the adapting had to be done pretty sketchily, on the outside; there wasn't any