Courtesy, Altec Lansing Corporation

LESSON 61 RA

THE OPERATION AND APPLICATION OF MICROPHONES

RADIO-TELEVISION TRAINING SCHOOL, INC. LOS ANGELES ESTABLISHED 1922

RADIO-TELEVISION TRAINING SCHOOL, INC.

5100 SOUTH VERMONT AVENUE • LOS ANGELES 37, CALIFORNIA, U. S. A.

THE OPERATION AND APPLICATION OF MICROPHONES

Introduction

Whenever we talk or perform with a musical instrument, we produce sound waves which at best can be heard only a few hundred feet away. In order to amplify sound waves or permit them to be carried greater distances, whether it be over a public address system or over telephone lines or by means of radio transmitters, it is necessary that these sound waves first be converted into an electrical signal. The device which is used to convert sound energy into electrical energy is known as a microphone.

Servicemen are often called upon to install and replace microphones. It makes no difference whether they be used on sound systems or home recorders. A thorough understanding of their operating principles and applications is essential.

THE CARBON MICROPHONE

The first microphone used by Graham Bell, the man who invented the telephone, was called a carbon-grain microphone because of its construction. The constructional details of a carbon microphone are shown in Fig. 1. Sound waves produce pressure and when near this microphone the pressure is applied to the diaphragm of the microphone causing it to move. The movement of this diaphragm causes the carbon granules held in a cup between two separate metal plates in a carbon microphone to be moved apart or compressed. This causes a change in the electrical resistance between these two metal plates, and this variation is at an audio frequency rate. It is this variation of resistance which causes the electrical signal to be generated from the sound waves applied to the diaphragm. This microphone can now be considered a variable resistance of special characteristics. It can be connected in a circuit as shown in Fig. 2 for the purpose of converting sound waves to corresponding electrical or audio signals. The circuit contains the resistance of the microphone button M, the primary winding of the step-up transformer T and the battery B. The latter is often known as the exciting voltage. The resistance of a single button carbon microphone depends upon the mesh of the carbon granules, the size of the buttons and the general design of the microphone. The resistance may be any value between 20 and 200 ohms. Generally, the resistance is about 100 ohms. The change in resistance is very low, and it is for this reason that the voltage is stepped up by using a step-up transformer.

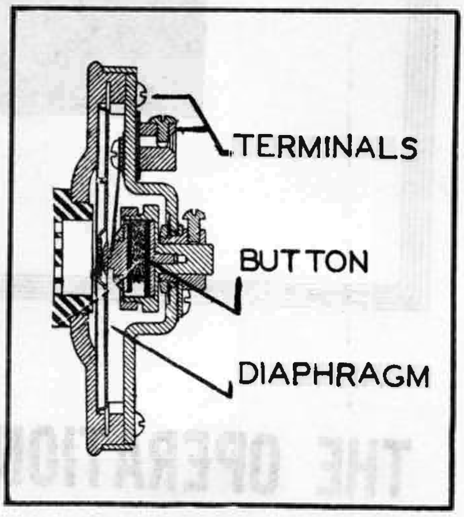


Fig. 1. Here is shown a cross-sectional view of a single button carbon microphone showing details of construction.

The direct current in the primary of the transformer is generally between 50 and 100 milliamperes. The primary impedance of this microphone transformer is usually about 200 and the secondary about 100,000 ohms. The secondary (a-f) voltage is generally of a value between 3 and 10 volts. This voltage is then applied to the desired amount before the a-f signal is again converted into a sound wave.

The similarity between the sound wave and the electrical wave or signal is a measurement of the fidelity of conversion. Many factors affect the degree of fidelity of conversion obtained from a microphone. The size of the carbon granules, the amount of carbon granules, the size and thickness of the diaphragm and the size and weight of the buttons are but a few of the important factors affecting the degree of fidelity.

The diaphragm in the carbon microphone is generally made of aluminum alloy measuring 0.003 inches in thickness. The electrodes are so shaped that the granular carbon between the metal plates or electrodes will permit the microphone to operate satisfactorily in any position. The carbon contacting surfaces of the electrodes are usually silver or gold plated. This reduces the electrical resistance of the microphone.

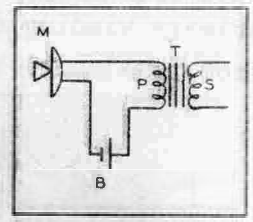


Fig. 2. The complete single button carbon microphone circuit.

The single button carbon microphone is one of the most rugged types of microphones insofar as physical damage and temperature changes, as it can withstand severe punishment which would damage most other types of microphones. Its limited degree of fidelity and the fact that it has a high internal noise level restricts its usefulness for the reproduction of music.

THE DOUBLE BUTTON CARBON MICROPHONE

The double button carbon microphone is very much like a carbon microphone except that it uses two buttons that are common to one diaphragm. A thin metal diaphragm is stretched between two heavy steel rings so that its resonant frequency is above its useful frequency range. Then a small cup containing loosely packed carbon granules is placed on each side of this diaphragm. These cups containing carbon granules are referred to as buttons and hence, the name "double button" carbon microphone. A cross sectional view of a high quality two button carbon microphone is shown in Fig. 3. In this figure, E is the diaphragm stretched tightly between two heavy steel rings by turning the stretching ring G. The items H and I are the two buttons forming the cups containing the carbon granules. A and B are the front and back insulated bridges that hold the buttons in place. The felt carbon-retaining rings are shown as C and D. The item F serves as the heavy steel damping plate. A typical double button carbon microphone is shown in Fig. 4. The photograph in Fig. 5 is of a double button carbon microphone within a protective cover.

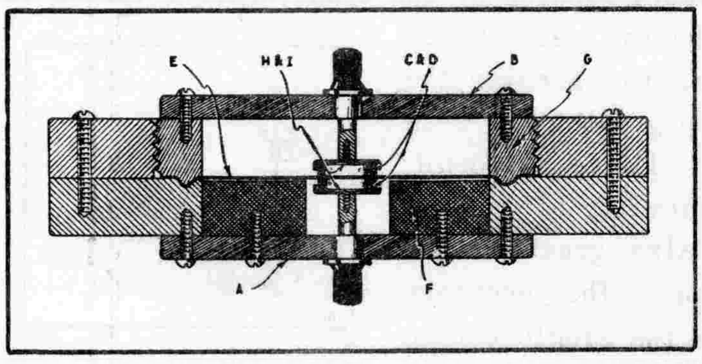


Fig. 3. A cross sectional view of a double button carbon microphone showing details of construction.

A typical circuit of a two button carbon microphone is shown in Fig. 6. Note the two buttons are connected to the terminals 1 and 3 of the opposite ends of the primary winding of the transformer T. The impedance between these two terminals of the primary winding is about 200 ohms. The impedance of the secondary winding is about 100,000 ohms. With a battery voltage of 6 volts, the current through the rheostat R is about 30 milliamperes per button. The electrons, according to electron theory, flow from the negative terminal of the battery B through the rheostat to and through each of the two buttons A and B and to the respective transformer terminals 1 and 3. This means that the lines of force about the primary winding of the transformer T will oppose and cancel each other as the resistance of button A is equal to the resistance of Button B. This occurs because the primary winding of the transformer T is one continuous winding, and when electrons flow from terminal 1 to terminal 2, the electromagnetic lines of force which would normally be built up in the iron core of this transformer are opposed or cancelled by an equal flow of electrons coming from the other end of the terminal 3 to terminal 2. This terminal 2 is common to both halves of the primary winding. This then means that there is no magnetizing force placed on the transformer core and any unbalancing caused by sound waves will produce magnetic lines of force.

Fig. 4. The front view of a two button carbon microphone is shown here. It has four mounting hooks for the supporting springs.

(Courtesy, Western Electric Co.)
Fig. 5. A two button carbon microphone within its protective cover is shown here with desk stand.

Sound waves striking one side of the diaphragm will cause the resistance of one button to increase while the other decreases. This causes the current from the battery to remain nearly constant because the increase in resistance of one button is equal to the decrease in resistance for the other button. However, the electromagnetic field about the primary winding of the transformer T varies in polarity in accordance with this change in button resistance. The greater the change in button resistance, the greater the number of lines of force and consequently, the greater the secondary voltage. This pushpull action tends to eliminate second harmonic distortion and thus improves the fidelity of reproduction. The frequency response range is also greater than that obtained from a single button microphone. The secondary voltage for a double microphone is lower than the single button microphone and is about .5 volts. An amplifier is again used in raising the signal voltage to the required amount. Even though the signal voltage is lower, the noise level is also lower for the double-button carbon microphone, however, with its improved frequency response and lower harmonic distortion, especially on the lower audio frequencies, it gives the best fidelity of reproduction obtainable from a carbon button microphone.

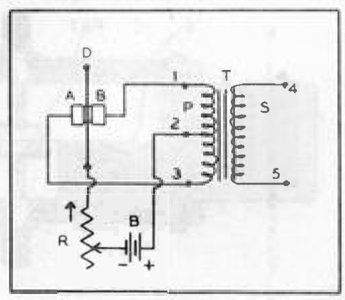


Fig. 6. Schematic diagram of a circuit employing a two button carbon microphone.

A sensitive high quality two carbon microphone may be seriously damaged by breaking the battery circuit while high currents flow through the buttons. Under such a condition, the microphone is said to be "caking". This term refers to the carbon granules bunching together in much the same way that particles combine to form a cake. Just as a cake will not revert back to flour particles, so a "caked" microphone cannot be agitated back into one with the normal amount of carbon granules, which number about 3000 for a single button. Serious caking can be prevented by using a rheostat which opens the circuit when turned in the direction of maximum resistance. Caking can also occur when a carbon microphone has not been shaken for long periods of time. This shaking action, which is very much like the shaking of a dispenser of salt, is done with the battery disconnected. This causes the carbon granules to be agitated so that new contacts of resistance occur between the granules.

Mobile police cars and some sound amplifying systems make use of single button carbon microphones because of their high sensitivity and ruggedness. The frequency response of these microphones is limited between 75 and 3,500 cycles, although the fidelity of a double button microphone is relatively good in comparison with other types of carbon microphones. All carbon microphones have a high noise level. This high noise level reveals itself in the form of a "microphone hiss" while the microphone is in use or idling without the presence of sound waves on their diaphragms.

THE CRYSTAL MICROPHONE

A microphone which depends on the piezoelectric effect is known as a crystal microphone. Rochelle type crystals are used. This piezoelectric effect enables a mechanical force, caused by sound waves and applied to the crystal, to be converted into an electrical signal. This movement enables the crystal to generate a voltage of about .01 volts. This a-f signal is again amplified as in the case of the carbon button microphone. Fig. 7 shows a cross-sectional view of a crystal microphone which is widely used with public address systems and home recorders.

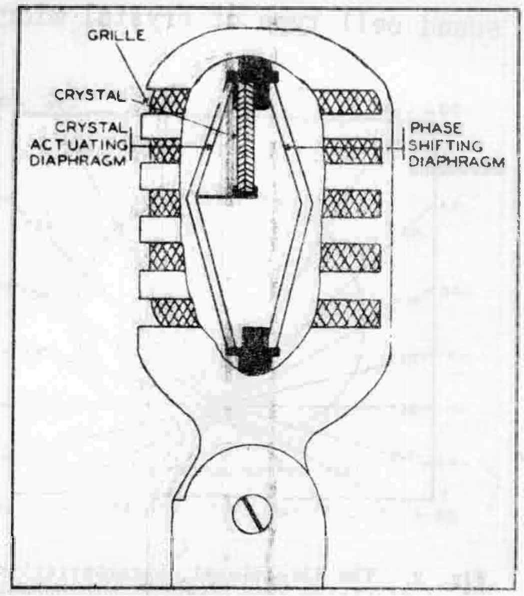


Fig. 7. Cross-sectional view of a typical crystal microphone.

The relatively high capacitance in a crystal allows a crystal microphone to operate satisfactorily with microphone cables up to about 20 feet in length. The crystal microphone is suitable for both indoor and outdoor applications. However, care must be used so that a crystal microphone will not be exposed to temperatures higher than 112 degrees Fahrenheit or placed in direct sunlight where the crystal or crystals will be permanently damaged by the excess heat. A good crystal microphone is invariably sealed against moisture to extend the life of the crystal. A photograph of a crystal microphone is shown in Fig. 8. The directional characteristics of this crystal microphone enables the user to rotate it to eliminate any undesirable noises. Note the attenuation from the rear of the microphone is considerably more than minus 22.6 decibels as shown in Fig. 9. This microphone permits random room noise and reverberation to be reduced as a result of careful internal diaphragm design. Since the signal voltage received from a crystal microphone is very low, it is necessary to have additional signal voltage amplification. That is, amplification in addition to that normally obtained from the usual signal voltage amplifier such as that used after the second detector of a regular superheterodyne radio receiver. The shielded flexible signal wire conductor from the crystal microphone is attached with the aid of a completely shielded cable connector to the grounded side of the input circuit. The center conductor is connected to the left end of the coupling capacitor C1 of the single stage voltage amplifier as shown in Fig. 10. This type of amplifier is called a pre-amplifier. The capacitor C and the resistor R1 are, along with the grid lead as well as the clip which attaches to the grid cap on the tube, completely shielded, that is, held within a shielded container.

Fig. 8. Here is shown a photograph of a crystal microphone of the diaphragm type.

Some crystal microphones contain a number of crystals which are so connected that the piezoelectric potentials are in series with each other. These microphones are known as sound cell type crystal microphones. The individual voltages produced are then added together to give a higher total signal voltage when connected in series. The sound waves are allowed to fall directly upon the crystals rather than upon a diaphragm. This sound cell type of crystal microphone has very excellent frequency response from 50 to 8000 cycles per second, but produces a very low signal voltage. Because of its low signal output, this crystal microphone requires a two stage pre-amplifier.

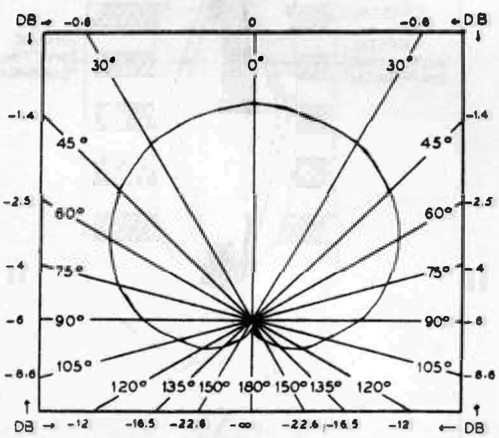


Fig. 9. The directional characteristics of a diaphragm type crystal microphone is shown here.

The internal noise level of crystal microphones is very low and is generally below the noises present in the pre-amplifier. These noises can be kept at minimum by using a non-inductive wire wound resistor in the plate circuit of the first amplifier tube. This non-inductive resistor is wound so that its inductance is balanced out, that is, sections of the resistance wire are wound in opposite directions.

THE ELECTRODYNAMIC MICROPHONE

A microphone which generates a signal voltage by virtue of an induced voltage in a conductor in the form of a coil moving in a magnetic field is called a dynamic or an electrodynamic microphone. Because of this self excited signal voltage which the dynamic as well as the crystal microphone generate in themselves, no external exciting voltage is required. The manner in which the moving coil in a dynamic microphone is placed with respect to the magnetic structure is shown in Fig. 11.

As a point of interest, a small (PM) permanent magnet loudspeaker makes a fair dynamic microphone, however, its frequency response is not good. This fact can best be appreciated by a comparison of the size and weights of the respective diaphragms in the PM loudspeaker and the electrodynamic microphone. The magnet and the moving coil are used in relatively the same place in both the PM loudspeaker and the electrodynamic microphone.

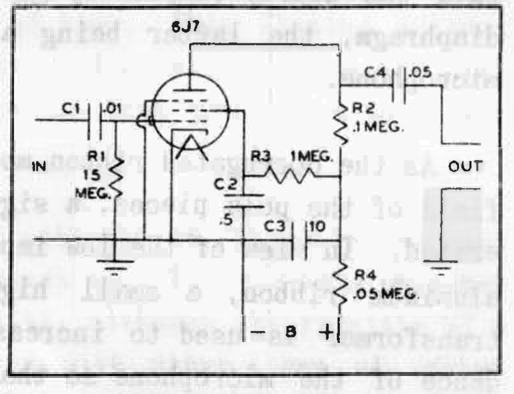


Fig. 10. Schematic diagram of a pre-amplifier circuit using a type 6J7 metal tube is shown here.

The moving coil assembly as used in the dynamic microphone consists of several turns of fine aluminum ribbon. The permanent magnet is made of high grade magnet steel. Most dynamic microphones are built to withstand rugged handling. Moisture and temperature changes have relatively little effect on the operational characteristics of the dynamic microphone. A well designed dynamic microphone can be made to have a good uniform frequency response from 40 to 10,000 cycles per second. A typical frequency response is shown in Fig. 12. This type of microphone is not very sensitive to hum pickup in view of the low output impedance which it possesses. A transformer is connected to the output of the microphone to provide output impedances of 50, 125 and 250 ohms. A photograph of the R.C.A. (Radio Corporation of America), Type 88-A dynamic microphone is shown in Fig. 13. Note the output cable connector and cable are attached to the right end of the microphone housing. Also note the thumb nut on the short support below the swivel joint. This short support slides over the vertical end of a conventional microphone stand.

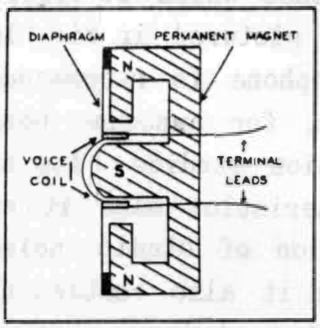


Fig. 11. Cross-sectional view showing the essential parts of an electrodynamic microphone.

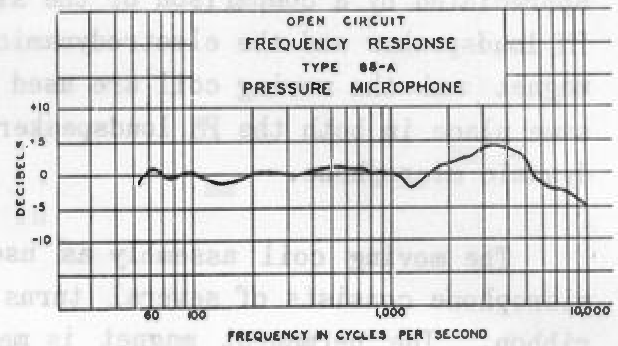
This type of microphone is often seen in the hands of radio station operators and announcers during street-interview programs. Its ruggedness makes it well suited for this type of use.

THE RIBBON MICROPHONE

When a flexible aluminum ribbon is placed in a permanent magnetic fieldsothat sound waves act directly upon the ribbon, a signal voltage is produced at the ends of the ribbon. We then have what is known as a ribbon microphone. The front cross-sectional view of a ribbon microphone is shown in Fig. 14. Note the permanent U shaped magnet has two pole pieces on the left and right side of the vertical corrugated aluminum ribbon, the ends of the ribbon being held by insulated material. The top view of the constructional details of the ribbon microphone are shown in Fig. 15. The edges of the ribbon, which serve as the diaphragm, almost touch the inner edges of the triangular shaped pole pieces of the permanent U magnet. The movement of the ribbon causes the production of a signal voltage because it is cutting magnetic lines of force.

It acts just like an a-c generator.

The ribbon microphone responds to the air particle velocity in the sound wave. That is, it does not stop the sound wave from traveling on through the microphone, there being no physical obstruction in back of the ribbon. It is usually referred to as a velocity microphone. This is unlike the electrodynamic microphone described in Fig. 11, where the sound wave was nearly completely reflected by the solid diaphragm, the latter being a pressure operated microphone.



(Courtesy, R. C. A.)

Fig. 12. Frequency response curve for the R. C. A. type 88-A microphone.

As the corrugated ribbon moves in the magnetic field of the pole pieces, a signal voltage is generated. In view of the low impedance value of the aluminum ribbon, a small high-fidelity stepup transformer is used to increase the output impedance of the microphone so that the signal can be fed into a transmission line without undue signal loss and distortion. The signal (level) voltage obtained from this type of microphone is lower than all other types of microphones, however, its fidelity of response is very good, the response being well within several decibels from 20 to 20,000 cycles per second.

A rather popular velocity microphone is the RCA Junior Type 74-B. Radio broadcasters in particular, make wide use of the Junior Velocity Microphone in view of its light weight, small size and the smooth bi-directional response which it offers. This microphone is pictured in Fig. 16. The 74-B type microphone is recommended for use in studios, for announce positions and for audition studios. Its bi-directional characteristics make it excellent for reduction of studio noises such as echoes, and it also enables the selection of a better balance between different sections of a band or an orchestra. This property of the microphone means that sound waves going to and coming from the rear of the ribbon are reproduced, while the sound waves coming from the sides have little or no effect.

(Courtesy, R. C. A.)

Fig. 13. The Radio Corporation of America manufactures this type 88-A dynamic microphone.

THE CONDENSER MICROPHONE

In a condenser type microphone, the thin metal diaphragm upon which the sound waves act essentially constitutes one plate of an air dielectric condenser. As the diaphragm moves back and forth, the charge on this condenser varies which in turn produces a voltage drop across a high resistance resistor connected in series with this condenser. This voltage drop is proportional to the frequency and amplitude of the diaphragm movement. The initial charge on the special condenser is obtained from a 200 volt d-c power supply as shown in Fig. 17. The rear solid metal plate of the condenser is held at ground potential and the thin metal diaphragm is connected to the top end of R1. Any sudden variation in the spacing between the thin diaphragm and the rear plate will cause a change in the voltage drop across R1. The voltage across C2 is held at a constant potential by the supply voltage since the value of R5 is so low as compared to R1. The a-c variation across R1 is the desired signal voltage. This voltage is conveyed by C1 to the grid of the pre-amplifier tube.

THE ALTEC 21B MINIATURE CONDENSER MICROPHONE

In the condenser microphone described above, we obtained the signal voltage variation across the resistor R1. In the Altec 21B miniature condenser microphone, the signal voltage variation is obtained across a charged capacitor. There are two capacitors connected in series and then to a source of d-c potential. A cross-sectional diagram showing the essential electrical and mechanical portions of this condenser microphone are shown in Fig. 18. The essential parts, electrically consist of a diaphragm and an electrode or backplate which is held close to the diaphragm. The backplate and the diaphragm being closely spaced constitute an electrical capacitance which varies with the microscopic mechanical deflection of the diaphragm. This variation is caused by the pressure variations in the sound wave.

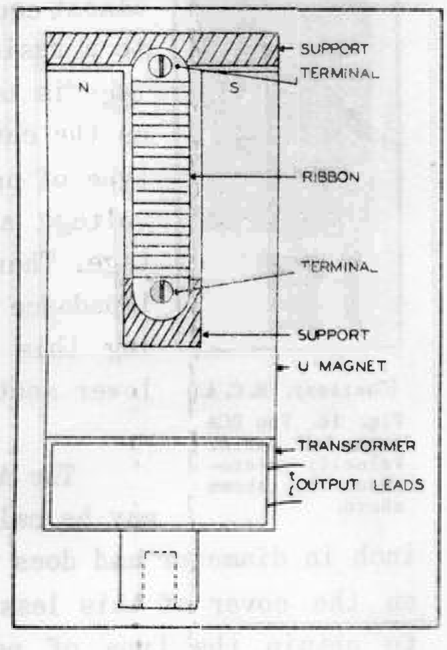


Fig. 14. The front cross-sectional view of a velocity microphone is shown above.

The backplate or center terminal is polarized with respect to the diaphragm through a very high resistance (several hundred megohms) across the capacitance formed by the lead to the center terminal and the inner shield so that a fixed charge accumulates on this center terminal. This charge is obtained from inner shield (circular) shown in Fig. 18. As the sound pressure causes the capacity between the diaphragm and center terminal of the microphone to vary, the voltage between the center terminal and the diaphragm changes resulting in the signal voltage being applied to the grid of a pentode vacuum tube amplifier. Electrical breakdown between the center terminal (backplate) and the diaphragm is prevented by placing a thin insulating material on and in back of the diaphragm.

In Fig. 19 is shown a photograph of the Altec condenser microphone head containing the diaphragm. The cap end can be seen. This cap is the protective cover to prevent physical damage of the diaphragm in the use of the microphone, and it also causes the microphone to pick up sound waves from all directions about it.

In Fig. 20 is shown the Altec 150A microphone base which covers a type 6AU6 tube whose function it is to translate the signal voltage generated by the microphone at extremely high impedances to a nearly equal voltage at a low impedance so that the signal can be conveyed over the length of cable to the following amplifier. Cable lengths of several hundred feet may be used.

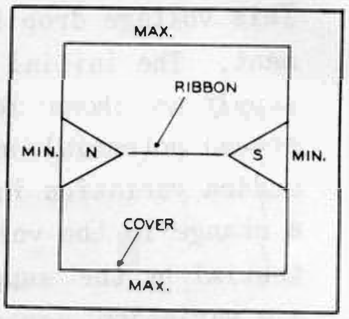


Fig. 15. The top cross-sectional view of the velocity microphone is shown here.

The specifications for the Altec 21B condenser microphone show excellent frequency response between 20 and 15,000 cycles. The output level received from the microphone is approximately minus 50 decibels for normal sound levels. This is consistent with the output levels received from crystal, electrodynamic and velocity type microphones. The pre-amplifier stage used in connection with the Altec 21B condenser microphone employs a rather unique circuit arrangement whereby the plate voltage of the tube is obtained directly from the B plus positive terminal of the high voltage d-c supply. The screen grid voltage for the tube is almost equal to the applied plate voltage, while the cathode is connected to a resistor having a resistance of about 100,000 ohms. The signal voltage is taken from the cathode circuit. This type of circuit is known as the cathode follower type. The overall circuit amplification in this type of pre-amplifier is equal to one. This means that the signal input voltage as applied to the grid of the tube is equal to the output voltage. There is no gain in the pre-amplifier stage, however, we do obtain impedance matching at both the input and the output circuits by employing this type of circuit. The pre-amplifier tube is within the large lower section of the Altec 150A microphone base in back of the name plate.

(Courtesy, R.C.A.)

Fig. 16. The RCA type 74B Junior Velocity microphone is shown above.

The Altec 21B condenser microphone has unique characteristics. It may be called the television microphone inasmuch as it is less than one inch in diameter and does not obscure the face of the individual performer as indicated on the cover of this lesson. It is possible to obtain the type of performance which has long been desired from this non-directional microphone with remarkably uniform frequency response. That is, the signal developed by this microphone is remarkably free from false bass accentuation which is encountered with many other types of microphones when placed near the sound source. All of these qualities permit the Altec 21B microphone to "hear" sound in the same way that the human ear hears it. It "hears" reverberant sounds naturally and provides acoustical prospective and spacial orientation. This means that the physical separation between various instruments or entertainers may be detected in the reproduction of the sound. This microphone does not

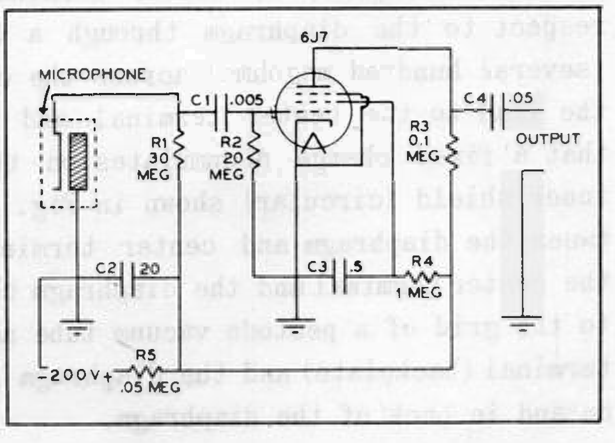


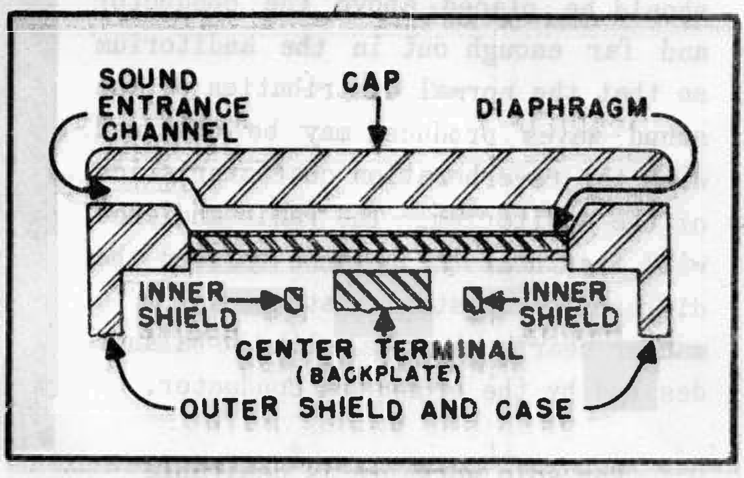
Fig. 17. Basic condenser microphone circuit using type 6J7 tube as pre-amplifier.

compress or distort the sound because its performance is not damaged by high sound levels.

DIRECTIONAL CHARACTERISTICS OF A MICROPHONE

Although the Altec 21B microphone has excellent performance characteristics, there are conditions where other types of microphones may prove to be more advantageous. That is, it is possible to take advantage of the directional characteristics of a microphone. For example, a velocity microphone picks up sound waves best from the flat surfaces of the ribbon as indicated in Fig. 15. In this instance it is possible to place two people on its opposite sides in presenting a debate or a dialogue. Both of the individuals may be of equal distance from the same microphone. Noises from the rear of the stage and from the audience will be reduced.

In the event that a microphone is to be used for general group pickup, the most suitable pickup pattern for such a microphone would be one of a non-directional type such as the electrodynamic or the Altec 21B condenser microphone. Thus, the pickup response would be equally good from any direction. Whenever a person is speaking to an audience in an auditorium or out in a field event, it is important that the microphone be one of the uni-directional performance types.



(Courtesy, Altec Lansing Corp.)

Fig. 18. A cross-sectional view of the Altec 21B miniature condenser microphone is shown here.

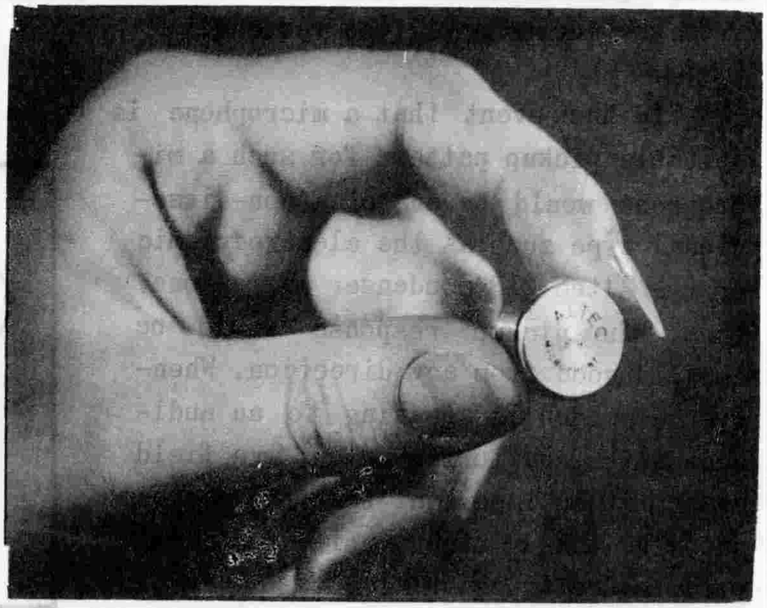
HOW TO PLACE THE MICROPHONE

The effective reproduction of speech and music can be materially improved by properly considering the acoustics, that is, the environment about the microphone. In the event that a microphone is placed in an area where the walls and ceilings are hard and flat, we may experience serious acoustic feedback. This is a condition where the amplified sound waves over a public address system feed back into the microphone and are reinforced as a shrill whistle. When wall treatment cannot be applied, the selection of one of the different types of bi-directional or uni-directional microphones may help in giving better sound reproduction.

The Altec Lansing engineers who designed the 21B condenser microphone have found that this microphone, in spite of its diminuitive size, should not be permitted to obscure the face of the individual where audiences are present. Keep the microphone 4 to 6 inches below the chin when addressing an audience. With this microphone it is no longer necessary to focus a television camera on an unsightly "birdcage" placed between the public speaker and his listener-viewers.

Since the Altec 21B microphone "hears" like a person, it is only necessary to use one microphone rather than several where there are vocals or dramatic groups. The simultaneous use of several microphones usually results in a blurring of sound quality due to the addition of sound being heard at different times between different microphones. Therefore, the entertainers should cluster around normally as you would when performing for their own enjoyment. The Altec engineers suggest that the entertainers stay 3 to 5 feet away from the microphone for normal dialogue when in a studio and, of course, move in as close as desired for very intimate "whispering in the ear" effect. Then back away 10 or 15 feet to simulate from across the room sounds.

For orchestral and choral work the sound of the entire group may be picked up with true perspective with a properly placed single microphone of this type. The listener who hears the symphony is given the feeling of being present in the hall where this symphony is being played. To achieve this effect, the microphone should be placed above the conductor and far enough out in the auditorium so that the normal distribution of the sound waves produced may be obtained with the reverberation characteristics of the auditorium. The radio audience will then hear the balance between the different orchestral instruments in a manner nearly identical with the balance desired by the orchestra conductor.



(Courtesy, Altec Lansing Corp.)

Fig. 19. The relative size of the miniature diaphragm of the Altec 21B condenser microphone may be seen from this photograph.

For solo work, it is desirable have a microphone close to the individual performing so that the normal noises within the immediate area may be reduced. The diminutive size of the Altec 21B microphone presents no obstacle between the soloist and the audience, and it enables the soloist to keep the conductor in full view. It is suggested that television performances be accomplished by attaching the microphone to a movable boom which holds the microphone in an inverted position above the entertainers.

All of these outstanding characteristics of the Altec 21B microphone are possibly due to the fact that it is non-directional and its frequency response characteristics do not become modified due to the distance that the performer is away from the microphone.

The above suggestions for microphone placement should be kept in mind since faithful reproduction of music and speech depends largely on microphone characteristics and their placement. The best sound systems will perform poorly unless adequate attention is given to microphone pickup. Do not hesitate in making comparative performance tests during the operation of a sound system. Actually listen to the fidelity of reproduction in the audience.

OUTPUT IMPEDANCES OF MICROPHONES

It is very important to use microphones having relatively low output impedance and in particular, output impedances below 500 ohms and above 30 ohms when the signal voltage must be conveyed more than 20 feet. If this is not done, then high frequency attenuation may occur and also poor signal level will result in a high noise level in the amplifier. In general, a crystal and the condenser microphone are referred to as high impedance microphones. However, the Altec 21B microphone with the impedance translater within its base allows its use over longer cables. In general, high impedance microphones are not recommended for sound systems where long microphone cables are required.

The output impedance of a microphone should be equal to the input impedance of the amplifier to which it is connected to prevent signal loss and distortion.

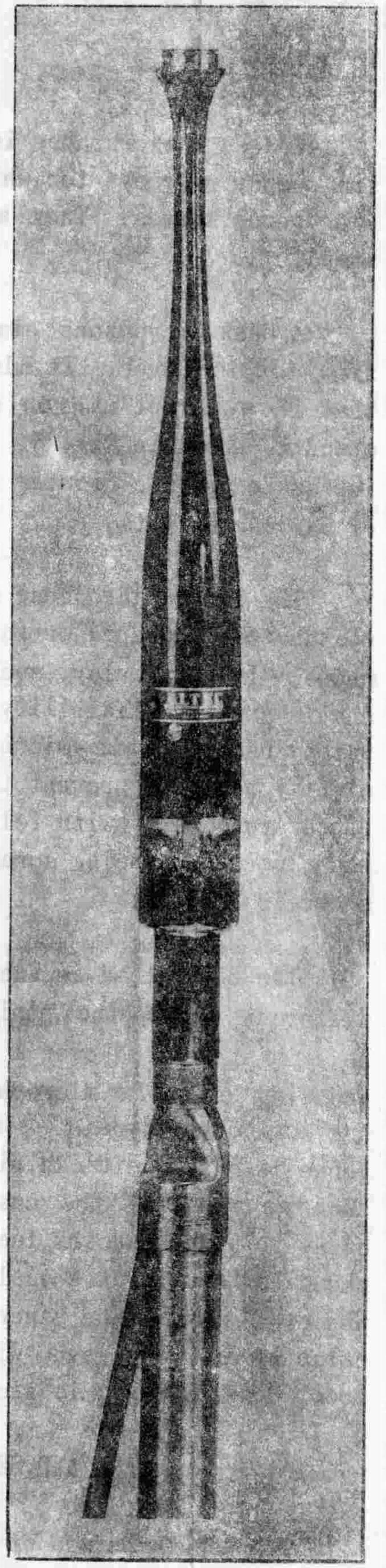


Fig. 20. The Altec 21B microphone is at the top of the 150A microphone base shown.

MICROPHONE CABLES

Most microphones deliver a signal which is very low in comparison to other signals carried over cables. The cable must, therefore, be covered by a shielding material to keep out interfering signals. Generally this is done with the use of hollow copper braid-like material placed over the two parallel microphone conductors. Over this braid may be placed a protective rubber-like covering.

Whenever microphone lines run near or parallel to high power audio frequency amplifier lines, it is desirable to use special cable connectors so that the coupling joints will not cause excessive electrical coupling between the two circuits. When microphone cables of this type must be joined, the conductors must be spliced together in the usual manner, and braid-like materials may be held to the braided shielding of the two cables being joined by wrapping fine tinned copper wire around the braid and especially over the overlapping points to provide a good electrical connection. Microphone cables exposed to water should be of the waterproof type or covered with waterproof paint. Whenever waterproof cable cannot be used, then the lines should be held up out of the water by means of permanent or temporary supports, depending, of course, upon the requirements of the sound system.

MICROPHONE STANDS

Unless a microphone is used with the proper stand, such microphone may not provide the proper response for which it was initially intended. There are three major types of microphone stands. They are the desk stand, the floor stand, and the adjustable boom stand.

A desk microphone stand generally has a heavy iron base to prevent the microphone from tipping over. It also has a felt bottom or other type of protective covering so that it will not mar or scratch the table or desk on which it rests. One model desk stand is shown in Fig. 5. Occasionally the neck of a desk stand can be extended several inches to provide greater flexibility in the use of such microphones on desks and tables of varying heights.

The floor microphone stands usually have telescoping tube sections which permit the stands to be lowered or raised, depending upon the height of the person using the microphone. In particular, such microphone stands should initially be selected with care to enable greater flexibility of use, particularly where youngsters and grown-ups may separately use the same microphone and stand. The base of such floor stands is made sufficiently heavy to prevent the microphone from tipping over, and such bases are covered with felt or other covering on the base to prevent the floors from being scratched or marred. A typical floor stand is shown in Fig. 21.

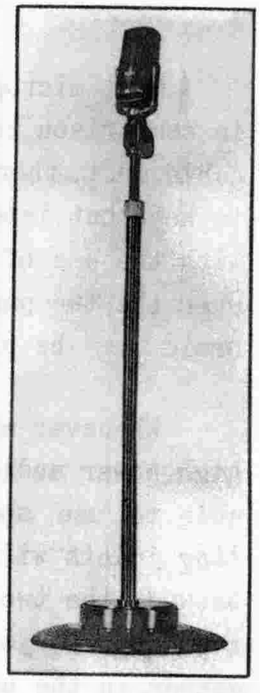


Fig. 21. A typical floor stand is shown here with microphone attached.

The boom stand is exceedingly useful as it permits a great many different microphone positions. Thus, a boom microphone stand can be made to extend over a piano so that the piano player can speak and sing over the microphone while playing. It would be awkward to use any other type of stand in this application. The boom microphone is also useful in picking up sounds a few inches from the floor such as would be the case for a tap dancer. A desk stand placed close to a tap dancers feet would result in a movement of the microphone and destroy the quality of pickup. Commentators make frequent use of a boom stand since they will often make themselves comfortable by sitting in a wide, easy chair. The Amperite microphone boom, Model F.S.B., is pictured in Fig. 22.

CARE AND SERVICING OF MICROPHONES

The manufacturers of microphones design their microphones for continuous operation over a period of five to ten years. This is under normal humidity and temperature variations found where a man can live comfortably. It is, of course, understood that the microphone be operated in a manner whereby its internal mechanism is not damaged either mechanically or electrically.

The head of a microphone is one of those devices which is in constant operation from the time it is manufactured. It is at all times developing a signal voltage when subjected to a variation in sound pressure. This applies to crystal, dynamic and velocity types of microphones. Carbon condenser microphones require a potential in order to develop a signal voltage, however, even the diaphragms of these microphones move when subjected to changes in air pressure.

If microphones were not subjected to sudden and severe jars when they are transported from place to place, then they may meet the general life performance specifications given by a manufacturer. In other words, it is the rough treatment that a microphone receives while it is in operation or being carried from one point to another that usually causes it to become defective. When a microphone is dropped on a table or on the floor, then either its case or some of the items within it may become broken. Loose connections may occur and improper operation may result.

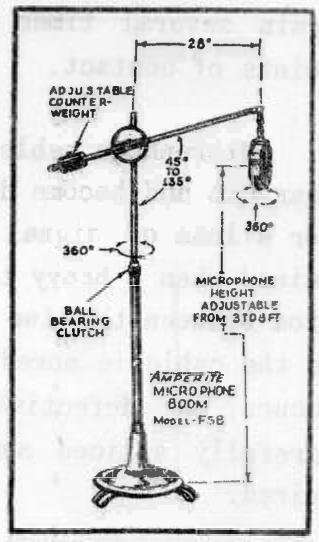


Fig. 22. The Amperite microphone boom stand is pictured above.

One of the most common causes for microphone failures occurs when someone accidentally pulls or trips over the microphone cable. The cable usually laying on the floor is always subjected to someone falling over it, and naturally, pulling the microphone either off the table, or when using a floor stand the stand is pulled over and the microphone strikes the floor with great force. Precautions should, therefore, be taken in preventing anyone from pulling on the microphone cord accidentally during its use or when not in use.

Whenever a microphone does not operate properly, then the cable to the amplifier and the cable connections should be checked for an electrical open circuit or unwanted closed circuits, and if the trouble is not found, another microphone should be substituted and the entire system checked again. The performance of the microphone may be checked by speaking at an average sound level and a few inches from the microphone. Many public address men will use the following technique. They will have someone say several times the words "testing, testing" and then count "one, two, three, four and up to ten" and if necessary repeat this procedure while listening to the overall sound level and quality of the voice being amplified. By saying these words and numbers, it is possible for all other technicians who may be listening to the re-enforced sound or to the other end of the amplifier system to know that a definite effort is being made to test the system.

Should there be a great difference in the sound level received from two microphones of the same make and model or type, then one of them is undoubtedly defective. Technicians listen for a change in sound level, a change in quality or fidelity of reproduction, and also any unwanted noises such as those which may occur when the microphone is moved slightly should it be one of the portable type. Sometimes high sound levels cause the diaphragms to move considerable distances and when this occurs a scraping noise may be heard. This may be due to foreign materials lying between the diaphragm and other parts within the microphone. Sometimes loose electrical connections within the microphone are detected in this manner.

Whenever a microphone fails to operate properly, then a careful check of the microphone cable should be made and the connectors between the microphone and its cable, as well as the cable and the amplifier or the other end of the microphone cable. Often times poor contacts occur and there is a loss in signal voltage. Since the signal level is very low, it is sometimes desirable to pull the receptacles apart and insert them again several times to remove any oxide which may have formed on the surfaces of the points of contact.

Microphone cables should be checked frequently for breaks since flexible cables do wear out and become damaged. Bend every foot of the cable in to a sharp curve and listen for a loss of signal level or noises. Excessive weight, such as that which may be obtained when a heavy truck or cart runs over the microphone cable, may damage the insulation between the two conductors and the shielding. Momentary contacts may be detected as the cable is moved causing an interruption in the sound being amplified. When this occurs, the defective section of the microphone cable should be removed and the cable carefully spliced and covered with copper braid, for complete shielding is usually required.

Whenever a microphone proves to be defective due to some internal defect, whether it be mistreated or damaged by an excessive heat, rain or dust, it is suggested that the entire microphone be returned to the manufacturer for repair. The individual serviceman does not have the facilities for the servicing of the delicate parts and can not make proper replacements or adjustments in his shop. During the time that the microphone is being repaired, the serviceman should provide a substitute microphone which will give satisfactory results to the customer. Manufacturers of microphones provide not only first class service on their microphones, but also invite servicemen to return microphones for the purpose of checking their performance. This is especially desirable when microphones are used where the degree of fidelity is of utmost importance. The constant changing in the temperature and the aging of any plastic or rubber supports within the microphone may cause a change in its frequency response and sensitivity.

Microphones made by a certain manufacturer and of the same model or type sometimes have different frequency response and sensitivity characteristics. It is, therefore, suggested that the serviceman, whenever possible, check the degree of fidelity received from a system by comparing the results received from one or more microphones. Many factors influence the results received, and in particular, the type of sound that is to be either relayed or re-enforced. Some microphones must be operated at low sound levels while others are operated in high sound levels.