RCA PHOTOPHONE
VELOCITY MICROPHONE

with
ACCESSORIES

TYPE PB-144
(MI-3015-A, MI-3015-B)

PART I - DESCRIPTION

1. INTRODUCTION - The velocity microphone is the result of several years of intensive research and development toward the improvement of the characteristics of microphones as used for recording purposes, and is entirely different in principle and construction from other microphones now in use.

Instead of a "diaphragm" (in the commonly accepted meaning of the word), the velocity microphone contains a thin metallic ribbon suspended between the poles of a permanent magnet with its length perpendicular to, and its width in the plane of, the magnetic lines of force. The opposite ends of the ribbon are connected to a transformer which matches the impedance of the ribbon to a 50 or 250 ohm line. Sound waves reaching the ribbon vibrate it within the magnetic field set up by the magnet. The vibration of the ribbon is in exact accordance with the sound vibrations and, occurring as it does within the magnetic field, sets up corresponding alternating electric potentials across the primary of its associated transformer. These minute voltages are subsequently amplified to the power level required for recording. The microphone amplifier may be located remotely from the microphone unit when necessary or desirable.

2. DESCRIPTION - The MI-3027 microphone unit is furnished with a suspension fitting (Type UP-4212-A) to permit the unit to be suspended overhead. This location of the microphone is that generally used in sound motion picture recording. See Figure 1. The microphone may also be mounted on a program or announce stand as shown in Figures 2, 3, and 4.

The transmitter is enclosed within a perforated metal casing which serves to protect it from mechanical injury and adverse wind effects. The line coupling transformer is contained in a metal case as a part of the microphone unit.

3. SENSITIVITY - With an input sound pressure of 10 dynes per square centimeter perpendicular to the plane of the ribbon, the ribbon microphone unit will deliver 800 microvolts across a 250 ohm load, which is equivalent to an output level of -67 db. as compared with a zero level of 12.5 milliwatts, or -64 db. as compared with a zero level of 6 milliwatts.

On an open circuit basis of measurement, i.e., with an input of 1 dyne per square centimeter (1 bar) perpendicular to the ribbon, the output of the microphone across an open circuit is the equivalent of -81 db. with reference to a zero level of 12.5 milliwatts, or -78 db, with reference to a zero level of 6 milliwatts.

4. QUALITY OF RESPONSE - The operating range of the microphone extends from 30 cycles to 15,000 cycles.

When a velocity microphone is placed close to a source of sound, the low frequency response is accentuated. In view of this fact, provision is made in the MI-3027 microphone to enable the user to alter its frequency response in such a manner as to suit best the particular purpose desired; viz., the pick-up of voice (i.e., within 2 feet of the microphone), or the pick-up of music (which takes place at greater distances from the microphone). Emphasis is here placed on the fact that this feature of the MI-3027 microphone is not provided with the intention that such alterations in frequency response be made at will; i.e., between scenes; but is furnished for the sole purpose of supplying a microphone with the best possible characteristics for voice pick-up or for musical pick-up. It is recommended that the frequency response be adapted to either of these types of pick-up and the use of the microphone be restricted to that type of pick-up only.

To alter the frequency response proceed as follows:

A small circular hole will be found in the cover plate of the transformer casing. Through this hole will be visible the letter "V" (voice) or the letter "M" (music), depending on whether the microphone is at the time adapted for voice pick-up or for musical pick-up.

Voice pick-up requires the use of a jumper (upon which appears the letter "V"), which is to be placed across the two terminals marked "M" (music), located on the terminal block within the transformer housing. Access to this terminal block is obtained by removing the cover plate of the transformer housing.

When the jumper "V" is used, it connects a reactor in parallel with a part of the transformer winding (when the 250-ohm output connections are used), or with all the transformer winding (when the 50-ohm output connections are used). See the schematic diagram, Figure 5.

A response curve taken with and without the "V" jumper is shown in Figure 6. As will be observed from examination of this curve, there is a sharp decline at the low frequency end of the curve when the "V" jumper is used. It is to be noted that this curve was taken in a plane wave field, and that the curve is flat when the speaker is located at a distance of 1 foot from the microphone.

5. DIRECTIONAL CHARACTERISTICS - One of the most important characteristics of the velocity microphone is its directional property. Since the ribbon is suspended in free space, sound waves approaching the microphone from a direction in the same plane as the ribbon have no effect upon it. Sound waves FROM EITHER DIRECTION along an axis perpendicular to the plane of the ribbon have the maximum effect. For equal distances from the transmitter, the relative response to sound originating at various angles to the axis perpendicular to the ribbon is shown in Figure 7.

It is at once apparent that this characteristic is of considerable value in the solution of some of the difficulties usually encountered in reverberant locations by the reduction of the effect of undesired sound reflections, and in the increased possibilities of obtaining better balance, clarity, naturalness, and selectivity in sound pick-up. Extraneous direct or reflected sounds approaching the microphone from side directions will have little effect, and therefore background noises and reflected sounds in the recording are considerably reduced, which increases, by comparison, the quality of the direct sounds reproduced. The degree of sound-proofing necessary for sound originating within the "dead zone" is, of course, dependent upon the reflecting surfaces present which may return the undesired sound to the microphone from such directions that response may be obtained.

For the same allowable reverberation pick-up, the operating range of the velocity microphone is approximately 1.7 times greater than a non-directional microphone having the same sensitivity.

Sound concentrators and baffles used with condenser or inductor microphones are unnecessary with and inapplicable to the velocity microphone because of the fundamental difference in the principle of its operation. The transmitter must be used in free space where the flow of air particles is unimpeded. However, "pick-up" from the rear direction of the microphone may be eliminated by placing a baffle or shield of heavy sound absorbing material, such as heavy felt, at a distance of not less than three feet from the transmitter and so confine the "pick-up" to the area in front of the microphone.

PART II--OPERATION

6. MICROPHONE ASSEMBLY. - The microphone, as supplied by the manufacturer, is equipped for suspension mounting. For this purpose, a suspension fitting is attached to the yoke of the microphone fork by means of three machine screws, eyelets are likewise provided at the extremities of the fork.

NOTE:- When the microphone is suspended, see that its weight is carried by the suspension fitting with no strain on the microphone cable.

(a) STAND MOUNTING - If stand mounting is desired, the manufacturer is prepared to furnish program stand Type AZ-4090 (MI-4056) or announce stand Type AZ-4191 (MI-4058-A). When either of these stands is to be used an adapter (MI-3033) will be required. To mount the adapter on the microphone fork, remove the suspension fitting, pass the spindle of the adapter through the hole in the yoke and put on the flat washer, the spring washer and the clamping nut. If the program stand is to be used, screw the adapter assembly (the flange of which is drilled and

threaded for this purpose) to the top of the stand. If the announce stand is to be used, remove the cable clamp from the barrel and the flange from the bottom of the adapter, insert the barrel in the hole in the stand and fasten it in place by means of the three screws.

(b) CABLE CONNECTIONS - Remove the cover plate of the transformer housing.

Loosen the two screws in the cable clamp and pass the end of the cable through the clamp.

At one side of the terminal block are mounted four terminals. Of these four terminals, the two outside are output terminals. Between the two terminals nearer the center is engraved the number 250 (i.e., 250 ohms). Between each outside terminal and the nearer of each centrally located terminal is engraved the number 50 (i.e., 50 ohms).

If the microphone is to feed a 250-ohm line, the two small jumpers should be placed, one over the other, across the two centrally located (250-ohm) terminals.

If the microphone is to feed a 50-ohm line, one of the two small jumpers is to be placed across each pair of terminals marked 50.

No change is necessary in microphone cable terminal connections.

Solder the ground lead from the cable shield to the cable clamp.

The cable is to pass through the slot in the cover plate of the transformer housing.

Figure 12 shows the location of the various numbered contacts of both plugs and receptacles, and, in conjunction with the schematic wiring diagram, will serve to indicate the proper connections of the various leads when testing, repairing, or replacing any electrical part.

(c) PHASING - When more than one microphone is used in a single pick-up, it is possible that the output of the various microphone circuits may not be in phase when fed into a common circuit. The microphone circuits include the microphones themselves, microphone pre-amplifiers, microphone attenuators (mixers) and the necessary connecting lines. The output of the microphone attenuators (mixers) when fed into the overall attenuator (mixer) must be in phase, or varying degrees of distortion will result, depending upon the relative placement of the microphones. If two microphones are placed close together, the result will be practically zero output if their circuits are out of phase at the overall mixer.

For this reason each unit of all RCA recording equipment is carefully wired in accordance with a definite wiring color scheme in

order that they will always be in phase when the inter-unit connections have been made according to a uniform plan; i.e., where the "±" connection of ONE microphone is connected to a certain input terminal of its pre-amplifier, then the "±" connection of ALL microphones must be connected to a corresponding terminal of their respective pre-amplifier and so on through the system up to the overall mixing control.

In set-ups in which velocity microphones are used, it is possible to phase them by turning those out of phase through 180 degrees. This is not possible with any pressure operated microphone.

It is particularly important that the phasing problem be borne in mind when inspecting, testing, repairing or replacing any unit or component thereof, and care be taken to see that the internal connections of the various units are made strictly in accordance with their wiring diagrams.

7. TECHNIQUE OF VELOCITY MICROPHONE PLACEMENT - The proper placement of the microphone is essential in order to realize fully its inherent advantages. For this reason, the following instructions should be carefully studied, and close attention be given to the results of any special placement with a view towards future improvement of the technique. These instructions can of course only serve as a guide, and a study should be made to determine the best microphone placement for each condition.

(a) GENERAL CONSIDERATIONS FOR STAGE SET-UP - The directional characteristic and greater sensitivity of this microphone are especially important in sound recording for motion pictures. Because of the necessity of constructing sound stages for sight as well as sound, the acoustic properties of the set are frequently sacrificed in favor of the scenic properties, whereupon more difficulty is experienced in controlling the effect of undesired echoes and reverberations. Also, because the microphone cannot be in the field of view of the cameras, the microphone must be located farther from the actors than is the case in a broadcasting studio. With the increased distance between the sound source and the microphone, the reverberation, echo and background noise effects are more troublesome. Furthermore, there are always people and machinery in motion on the set other than those in the picture and sounds caused by them must not be picked up.

Also because of the usually more distant location of the microphone, it is unlikely that the connection of the microphone for voice pick-up, as described in section 4, will be used; although it may become desirable because of special recording conditions.

Previous to the production of the velocity microphone, it has been necessary with other microphones to use microphone baffles, sound concentrators, acoustic treatment of sets and studios, camera "blimps," etc. The use of these devices as aids to the perfect reproduction of sound and

picture with the proper illusion of naturalness has not been entirely eliminated through the use of the velocity microphone, but has been greatly minimized.

As mentioned in section 5, a felt baffle may be placed so as to cut off the "pick-up" of sound from directions opposite to the source of desired sound. The microphone, in many cases, may be placed so that an imaginary plane coincident with the plane of the ribbon will pass through sources of undesired sound, either direct or reflected, and so minimize the effects of extraneous or reverberant sound.

The necessity of highly sound-proofed booths and "blimps" is evidently reduced if cameras are operated in positions in the "plane of zero sound"; and the degree of sound-proofing necessary for sound originating within the "dead zone" is, of course, dependent upon the reflecting surfaces present which may return the undesired sound to the microphone from such directions that response may be obtained. A camera, for example, may be operated outside of a booth and without a "blimp" if it is placed in the plane of zero sound, providing that none of the camera noise is returned to the microphone from any other direction by reflecting surfaces, which condition may be most generally realized in out of door recording. See Figure 11.

(b) GENERAL INSTRUCTIONS - The source of sound, speaker, artist or musical instrument, should not be placed closer to the microphone than 2 feet and a distance of 3 to 4 feet is to be preferred. At shorter distances there is a tendency toward accentuation of low frequencies, which may result in making voices sound "boomy." In this respect, the use of the velocity microphone differs greatly from that of the condenser microphone with which the speaker or soloist has usually worked at a distance of 4 to 6 inches.

The placement of a speaker or musical instrument off from the center line of the microphone will in no way affect the quality of pick-up, but will merely attenuate the direct sound pick-up, thereby raising the ratio of reverberation to direct "pick-up".

For the most satisfactory results, the microphone should not be placed closer than 3 feet to any solid reflecting surface. This statement is, of course, general and specific conditions may require otherwise.

In order further to eliminate adverse wind effects, it is advisable to employ a suitable wind screen when the microphone is used out-of-doors.

The diagrams referred to in the subsequent paragraphs and the discussion concerning them can only serve to indicate some of the possible placements under particular conditions. The final decision as to what constitutes the proper placement must rest with someone who is competent to judge the quality of the results as reproduced by the monitor speaker.

It is recommended that the side of the microphone OPPOSITE the cable entrance bushing, always be turned toward the source of desired sound.

(c) SOLOIST WITH PIANO - Interesting effects may be obtained by changing the angle of the microphone with respect to the piano, thus changing the ratio of reverberation to direct "pick-up". The distance between the soloist and microphone should be determined by the strength of his (or her) voice, and the piano should be placed accordingly. The general arrangement is shown in Figure 8. Under no conditions should the soloist be less than 2 feet from the microphone.

(d) DANCE ORCHESTRA - The ditgram (Figure 9) is self-explanatory, the only precaution necessary being to keep the soloist at least 2 feet, and preferably 3 feet, from the microphone.

Due to the fact that artists cannot work close to the microphone, some difficulty may be experienced in obtaining the proper balance between the artist and the orchestra. This difficulty can be overcome quite satisfactorily by using two microphones, one to pick up the orchestra and the other to pick up the artist. The artist's microphone should be located so that its "dead zone" is toward the orchestra. By properly setting the mixing controls, the level of the orchestra can be controlled so that a satisfactory back-ground accompaniment of music is obtained.

In locating the microphone with respect to an orchestra, care should be taken to avoid reflected "pick-up" from hard surfaced floors. Such reflections can be avoided by the use of carpets or similar material on the foor.

(e) LARGE ORCHESTRA - An arrangement for a large orchestra is shown in Figure 10. Two microphones may be used to advantage for such an assembly. See also paragraph (d) above. The arrangement shown in Figure 10 was used successfully in the RCA recording studios in Camden, N. J. It must be borne in mind, however, that this arrangement will not necessarily be the best in all studios because of differences in their acoustic properties. Changes in this arrangement should not need to be very extensive in order to give excellent results.

(f) "LONG SHOT" AND "CLOSE-UP" SOUND - The nearer a microphone may be placed to the subject within the limits of the foregoing paragraphs, the more natural will be the quality of recorded sound. This statement is made without regard to "long-shot" sound which is deliberately made poorer in order to produce the desired match between picture and sound. An indefinable quality of "presence" is the principle difference beween "long-shot" and "close-up" sound and this quality is rapidly lost as the microphone is moved farther from the subject. In many cases, two cameras are trained on the subject simultaneously and at least that portion of the sound used with the close-up picture should have "presence" to match the picture. The increased field of view of

the long-shot camera precludes the possibility of placing a microphone close enough to the subject to give the desired close-up sound except through the use of the velocity microphone and by taking full advantage of its directional characteristics and increased sensitivity.

(g) UNI-DIRECTIONAL PICK-UP - Should it be found desirable to utilize pick-up from but one direction, pick-up from the opposite direction may be made ineffective by placing a baffle or shield of heavy sound absorbing material, such as felt, approximately 3 feet from the microphone on the side from which the sound is to be blocked. The felt should be approximately 6 to 10 feet square.

(h) BI-DIRECTIONAL PICK-UP - The bi-directional characteristic of the microphone may be used to its fullest advantage in some cases by grouping the artists about the microphone at such positions that their voice levels match to form the desired composite.

When the microphone is used by a speaker located at a table or desk, the microphone should be so placed that it picks up direct sound from the speaker rather than reflected sound from the surface of the table, desk or manuscript.

In most cases of this sort, it is necessary to conceal the microphone.

8. OPERATION. - In general, the microphone will operate satisfactorily and require very little attention. It should give the normal output listed in section 3.

The microphone may also be mounted on a program or floor stand (MI-4056) or on an announce or desk stand (MI-4058-A). An adapter (MI-3033) is required when using either type of stand. The program or floor stand is adjustable as to height. The center of the velocity microphone may be located at any height from 56 to 81 inches above the floor. In order to raise or lower the stand, the vertical column clamping screw should first be loosened. If it is desired to raise the microphone, all that is necessary is to lift it to the desired point and there it will lock itself automatically. Usually, it will remain fixed at this position unless there is vibration or the microphone and stand are moved around. This movement may cause the stand to slide slowly downward. The clamping screw is provided in order to prevent this. However, if the microphone does not tend to creep, then it is not necessary to use the clamping screw. When it is desired to lower the microphone stand, the clamping screw should first be loosened, then the inner tube of the microphone stand should be raised slightly while pressing the sliding column latch which projects at the side of the locking device. This will release the lock and allow the microphone to be lowered to the desired position, at which point the latch should be released and the stand will automatically lock itself. Then the clamping screw may be tightened if desired.

It is not recommended that the customer attempt to repair the microphone, but, rather that it be returned to the RCA Manufacturing Company, Inc. for repair. This may be done by writing to the RCA Manufacturing Company, Inc. for a "RETURNED APPARATUS" tag and "REPORT BLANK." Before doing this, however, make absolutely certain that the trouble is in the microphone and not elsewhere in the circuit.

9. LIST OF PARTS AND ACCESSORIES.---

ACCESSORIES

Description	Type	Stock No.
Velocity Microphone (with Suspension Fitting) . . . (see Figure 1)		MI-3027
Program Stand (see Figure 2)	AZ-4090	MI-4056
Announce (Desk Type) Stand (see Figure 4)	AZ-4191	MI-4058-A
Adapter, for Program and Announce Stands (see Figure 3)		MI-3033 (or 16831)
Suspension Fitting (for MI-3015-B)	UP-4212-A	MI-4071-A
Cable and Plug (18-inch cable with a Cannon Type P3-CG-12 plug)		MI-3056
*Cable (2-conductor, shielded extension cable) . .		MI-62
Flush Type Wall Receptacle (see Figure 12)	Cannon Type P3-13	MI-4622
Surface Type Wall Receptacle (see Figure 12) . . .	Cannon Type P3-17	MI-4621
Flush Type Wall Receptacle (see Figure 12)	Cannon Type P3-35	MI-4625
Female Cord Connector (see Figure 12)	Cannon Type P3-CG-11	†MI-4620 ‡MI-4620-A
Male Cord Connector (see Figure 12)	Cannon Type P3-CG-12	†MI-4630 ‡MI-4630-A

NOTES:- *Length of cable must be specified when ordering

†Aluminum, Bronze finish.
‡Aluminum, Natural finish.

REPLACEMENT PARTS

Description	Stock No.
Microphone Screen	16825
Swivel Clamping Nut	16826
Washer - Used under swivel clamping nut	16827
Transformer - Microphone Output Transformer . . . Type RT-435	16828

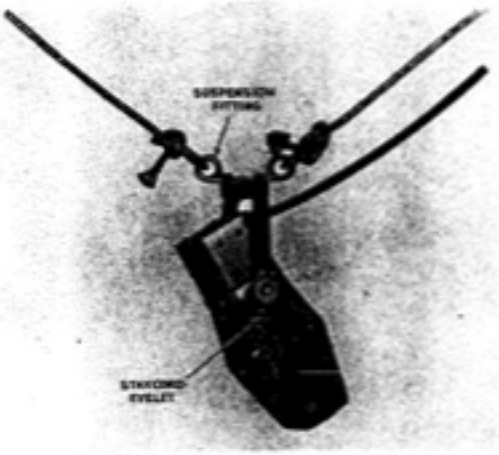


FIGURE 1—TYPE PB-144 VELOCITY MICROPHONE SUSPENDED

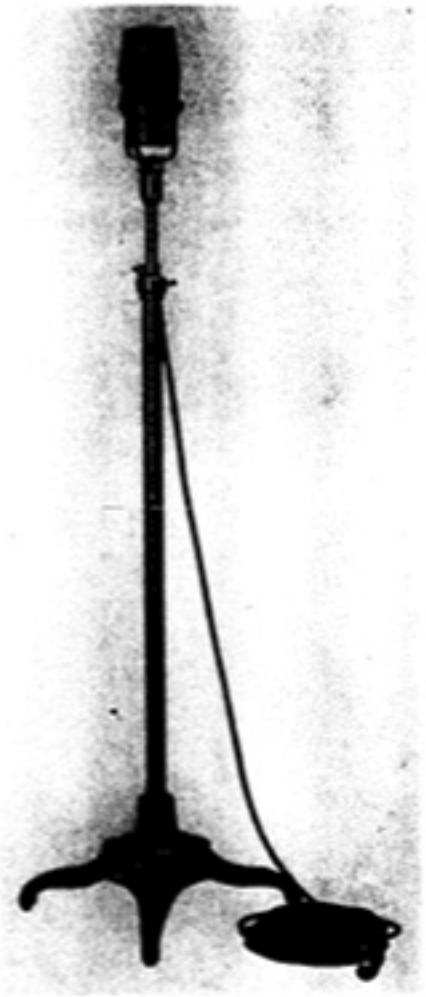


FIGURE 2—TYPE PB144 VELOCITY MICROPHONE ON PROGRAM STAND

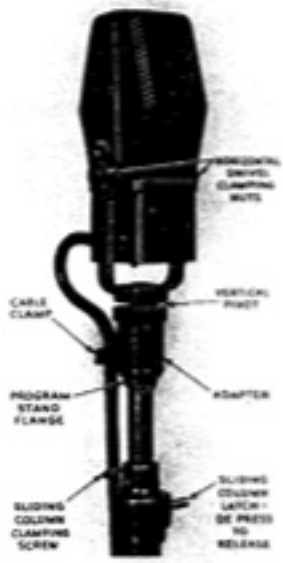


FIGURE 3—CLOSE-UP OF MICROPHONE ON PROGRAM STAND, SHOWING CUSHION ADAPTER

FIGURE 4—MICROPHONE ON ANNOUNCE (OR DESK) STAND.

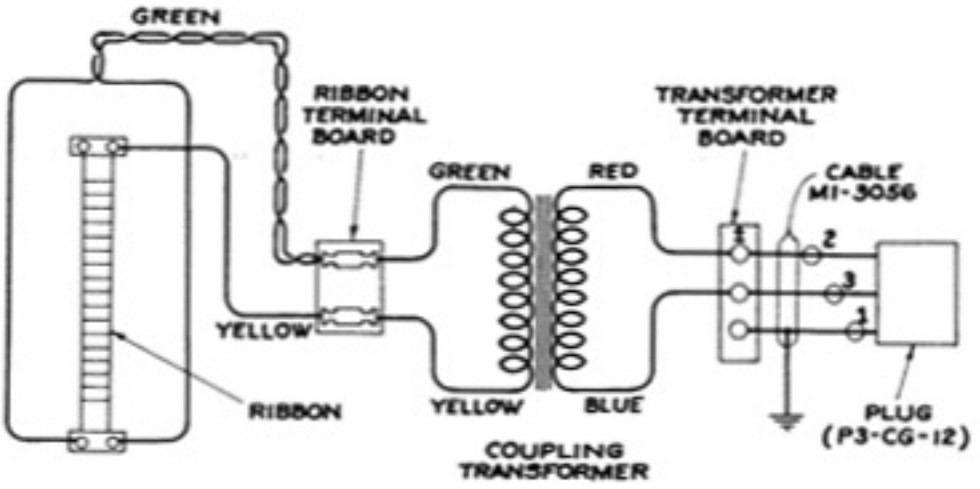


FIGURE 5—SCHEMATIC WIRING DIAGRAM OF MICROPHONE AND CABLE

ρ = LOSS IN DB BELOW RESPONSE OBTAINED ALONG AXIS NORMAL TO PLANE OF RIBBON.

α = ANGULAR POSITION IN DEGREES OF SOURCE OF SOUND WITH RESPECT TO AXIS NORMAL TO PLANE OF RIBBON.

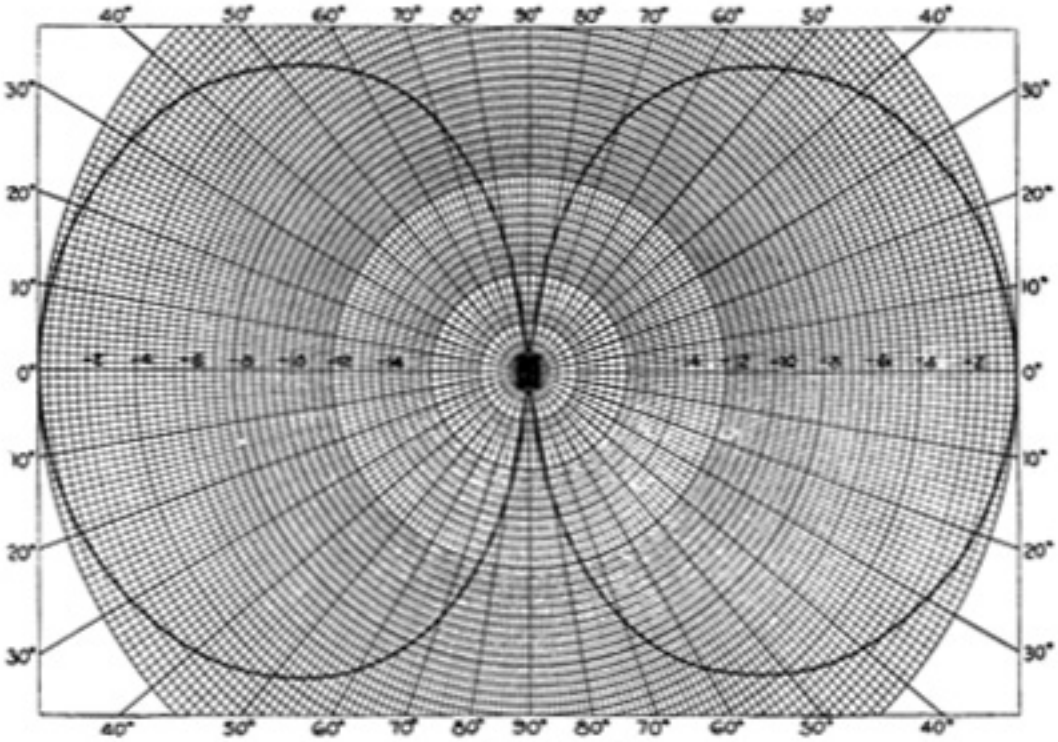


FIGURE 6—DIRECTIONAL CHARACTERISTICS OF VELOCITY MICROPHONE

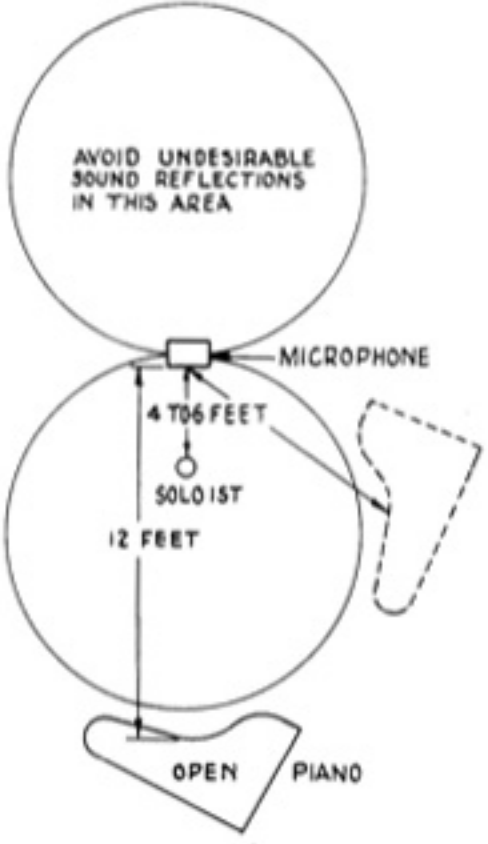


FIGURE 7—MICROPHONE SETUP FOR SOLOIST WITH PIANO

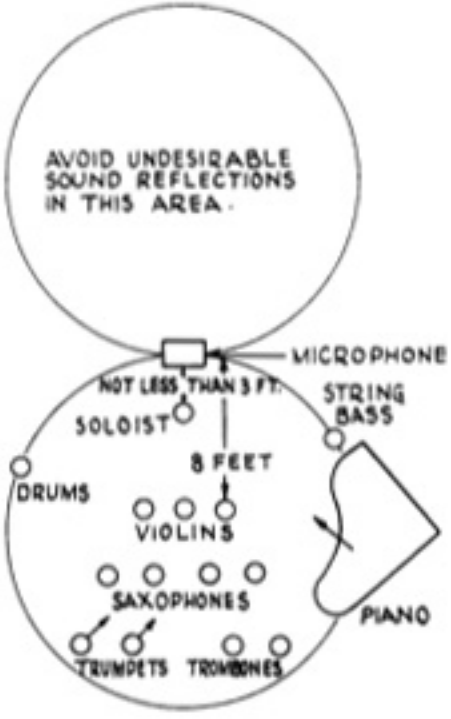
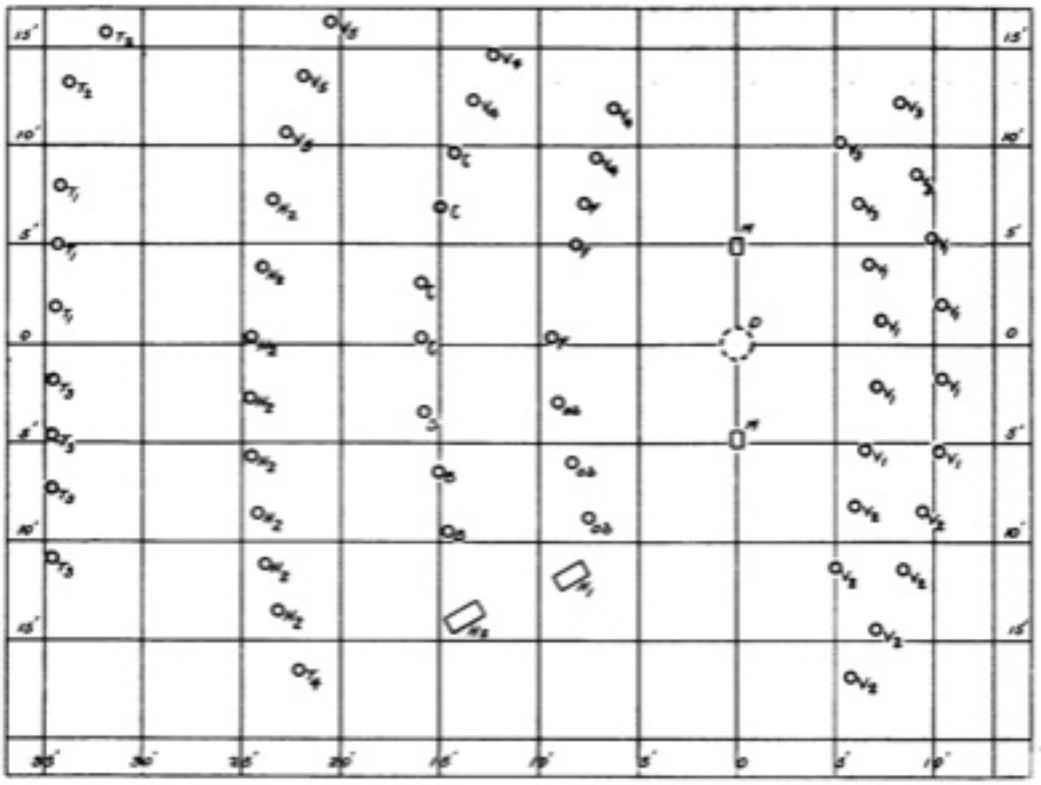


FIGURE 8—MICROPHONE SET-UP FOR DANCE ORCHESTRA



LEGEND

D Director
M 2 Velocity Microphones

V1 8 First Violins
V2 6 Second Violins
V3 4 Violas
V4 4 'Cellos
V5 3 String Bass
F 3 Flutes
Ob 3 Oboes
H1 2 Harps
H2 8 French Horns
C 4 Clarinets
B 3 Bassoons
T1 3 Trumpets
T2 2 Tympani and Traps
T3 4 Trombones
T4 1 Tuba
Total—58 Musicians

FIGURE 9—MICROPHONE AND ORCHESTRA SET-UP FOR SYMPHONY ORCHESTRA

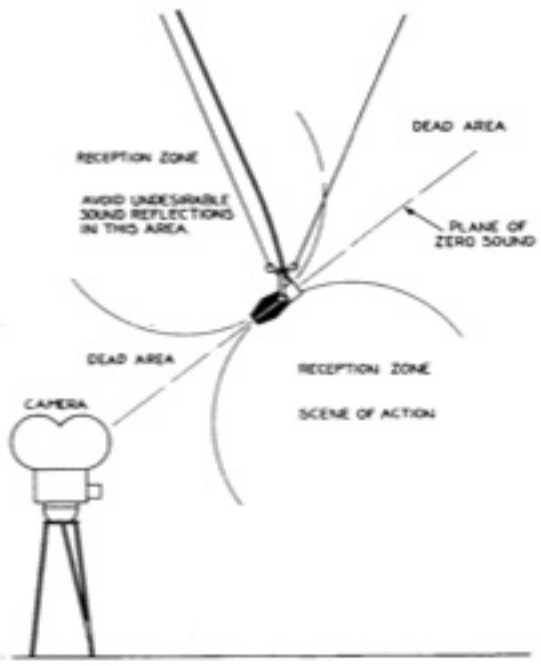


FIGURE 10—CAMERA LOCATION WITH RESPECT TO MICROPHONE

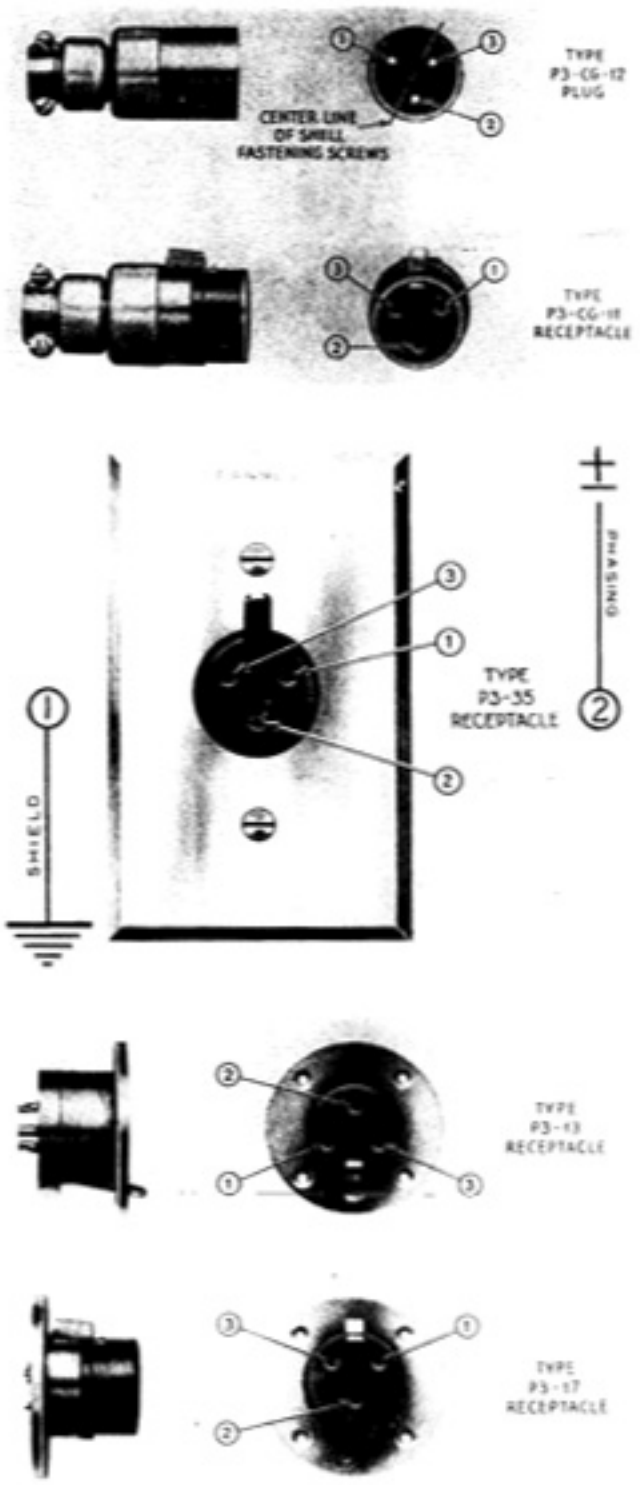


FIGURE 11—PLUGS AND RECEPTACLES FREQUENTLY USED FOR MICROPHONE CONNECTIONS