Electro-Voice

MICROPHONE FACTS

FOR THE OPERATING ENGINEER

ELECTRO-VOICE, INC. • BUCHANAN, MICHIGAN • PHONE OXBOW 5-6831

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UNIDIRECTIONAL MICROPHONES

In comparing bidirectional and unidirectional microphones, little difference in random noise and reverberation pickup will be noticed. However, should the unwanted sounds have direction, the unidirectional type will prove superior, since it accepts sound at front aperture only and therefore can be more easily oriented to reduce pickup of directional sound.

Any type of unit may be used in a unidirectional microphone: carbon, crystal, ceramic, ribbon, condensor or dynamic. The first cardioid microphone produced commercially employed two microphones - a nondirectional dynamic and a bidirectional ribbon combined in one case. Here, sound arriving on axis is picked up by both units. Since both are in phase the result is a gain in level of 6 db over either unit used separately.

With sound arriving from 180° off axis a reverse condition exists. Now the ribbon unit is 180° out of phase with the dynamic and sound cancels. The degree of cancellation, however, depends on how well matched the level and response of the two units may be. If well matched, reasonably good rejection may be expected.

This old original method has been largely discontinued because of the practical impossibility of keeping the two units matched. Any degrading of either produces a mismatch sufficient to cause each to operate as a separate microphone with the disappearance of the cardioid pattern.

The modern cardioid microphone uses only one unit, thus eliminating the possibility of mismatch. Here the problem of design is to create a rear sound path in a nondirectional unit that will be 180° out of phase with the front, thus causing the cancellation of sound arriving from the rear. With variations in this rear aperture any degree of directivity may be produced.

Figure 1 shows the transition of the polar pattern from nondirectional to bidirectional through modified bidirectional to unidirectional. You will note that when the polar pattern is unidirectional it is cardioid (heart) in shape. In Europe it is usually called "kidney pattern," but cardioid or kidney, they are both unidirectional. All unidirectional microphones in common use are cardioid in pattern. The above statement was made to clear up a more or less general misconception that there is a distinct difference between cardioid and unidirectional units. Some microphones for special applications that are unidirectional but teardrop in pattern will be taken up in a future letter.

I want to clear up another rather common misconception, that of a cardioid microphone being dead at the back or in any other place. There is no make or type of microphone that will not pick up some sound from the back regardless of pattern. This misunderstanding can be laid at the door of microphone manufacturers, who, in describing a unit, have called the back of a cardioid "dead." This flat, unqualified statement of saying "dead," instead of "relatively dead," has caused all the trouble. It is only dead as related to the front or axial pickup of the microphone.

I would like now to discard the word dead; it is misleading. In place of it let us use ratio, expressing it in signal-to-noise ratio and front-to-back ratio. Here is something that can be put to use. Refer to the polar curve of a 666 microphone (Figure 4 in your E-V catalog). The same calibrating procedure was used here as that employed in calibrating the non-directional and bidirectional units. Refer also to the last two Microphone Facts Letters. The axis line (the vertical line) is divided in 5 db steps, starting at 0 at the outer end and decreasing to -25 db at the center. The curve shows that on axis all frequencies start equally at 0. At 180° on curve C the level is -20 db or a front-to-back ratio of 20 db. Due to the 3 db lobe the highest ratio is reached at approximately 135° and 225°. This rear lobe is due in part to the size of the microphone interfering with the pattern shape. Larger and less symmetrically shaped cardioids will have badly distorted patterns. Some are cardioid at only a few frequencies, bidirectional at some and nondirectional at several others. Uniformity of pattern around the microphone is essential to obtain the best signal-to-noise ratio. In this respect, as in others, E-V cardioids have found no equal.

On curve B and curve A, without the rear lobe, minimum point is now at 180° and shows the ratio to be around -23 at B and -22 at A, or an overall minimum of -20 db at 180°. As sound moves around to either side, this ratio decreases. When either 90° or 270° is reached, the ratio has decreased to 6 db. On the basis of random noise reduction we find the following: when compared to a pressure microphone the cardioid will reduce noise by three times. The result of this comparison is known as directivity index. This subject will be taken up at length in a future letter.

When unwanted sound has a definite direction you can anticipate the following from a well designed cardioid: with someone talking at 10 feet on axis and someone talking at the same level, but at 180° off axis, the voice on axis would be recorded 20 db louder. Now have the person at 180° move up to one foot and both will come through with equal intensity. If the one at the rear now moves to 90°, the voices will be equal if he stands at 5 feet. At 10 feet the 90° voice would be approximately half as loud as the axis voice. This will be true of any 90° position around an E-V cardioid but will not be true of cardioids of non-symmetrical shape. Almost all competitive cardioids have this serious fault. Several cardioid type units in common use show favorable polar curves when they are run from axis, around to the side and then the back but when we shift the orientation by 90° and run the curve from axis to bottom and then to the back we find these microphones to be essentially nondirectional at the bottom and often at the top. A well designed microphone, symmetrical in shape, will have a symmetrical polar pattern in all positions around the microphone, and the pattern must be symmetrical to produce the best reduction of random noise and reverberation.

Generally speaking, a 666, 666R or 667 can be used at around twice the distance from the sound source as most other directional microphones due to the excellent uniformity of polar pattern.

For a different picture of front-to-back ratio, refer to the axial response and 180° off axis curves of the 666 and 666R (Figure 2 in your E-V catalog). You will note that the 180° curve follows very closely the axial curve maintaining a 20 db average separation or better. We know of only one competitive unit that will come within 5 db of matching this ratio from 200 cps down. This is the range where you need the highest ratio to reduce low frequency rumble pickup. The others will vary from 10 db at best to no discrimination below 100 cps.

Our patented variable D cardioid principle and Acoustalloy diaphragm have made it possible for E-V cardioids to solve problems that the best of the rest can only approach.

More on polar patterns to follow in a few weeks. In the meantime let me hear from you. Certainly this letter is not so complete and all inclusive that it leaves no questions to ask. I would like to be of further help if I can.

I want to thank James Valentine and Donald Wheatley for their interest and suggestions in regard to my Microphone Facts Letters. Both of their ideas have been applied to this letter and will continue in the future.

The two letters appear below.

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Cordially yours,

ELECTRO-VOICE, INC.

Lou Burroughs

L.R. Burroughs
Vice President
Broadcast & Recording Equipment

WJOY
1230 on your dial
FRANK BALCH, MANAGER

Vermont Broadcasting Corporation....an ABC affiliate
633 MAIN STREET · BURLINGTON, VERMONT · TELEPHONE UN-4-5774

October 23, 1959

Mr. Lou Burroughs
Vice President
Broadcast & Recording Equipment
Electro-Voice, Inc.
Buchanan, Michigan

Dear Mr. Burroughs:

I have found the sheets on "Microphone Facts" quite worthwhile. Keep them coming. One thing that I would like to suggest is that sheets be numbered so that we can quickly tell if we are missing any sheets when putting them into booklet form.

I had a microphone experience several years ago which might interest you. Many of my ribbon mikes suddenly went sound and upon investigation I found that they all had the ribbons stretched out almost smooth. At first when one or two went bad I thought that they were being handled roughly, but after I sent seven back for repair in one onth I began to look around for some other reason. The only thing that I came up with was that the jet aircraft were causing it. We have a airforce base very close by and at that time the air traffic pattern was around the station. It was summer time and the windows were open.

Sincerely,
Donald M. Wheatley
Donald M. Wheatley
Chief Engineer WJOY

"The Liveliest Station in Town"

From VALENTINE SOUND, 4253 Farmdale Ave., No. Hollywood, Calif.

Sept. 16, 1959

Dear Mr. Burroughs,

Thanks very much for your latest Microphone Facts letter. As usual, it is most interesting - and will be kept in our file along with your earlier letters.

A suggestion. Save some money for Electro-Voice, and file space for those of us who wish to keep your letters in a binder - how about printing on both sides of your paper? You're using heavy enough stock at this time to still present a good looking double sided letter.

Again, thanks for bringing some much needed news to our attention.

Cordially,
A. James Valentine

Figure 1. Polar Patterns.