Home-Made Parabolic Microphone

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Constructional details for a device useful in making microphone pickups under difficult conditions.

THE INCREASING POPULARITY of magnetic recording equipment is due in part to the fact that with tape or wire recording apparatus almost anyone can do a creditable recording job with relatively little experience. Add to this the fact that the equipment is low in price, and it is easy to see why thousands of audio enthusiasts have started to do their own recording.

If the recording neophyte confines his activities to recording radio programs, or recording Junior's voice for posterity he will run into very few difficulties. It is only when he attempts recording on a more professional scale that he finds his experience inadequate.

An attempt at recording the work of the church choir, or the high-school orchestra may bring out quite forcibly the fact that microphone technique is an important part of recording. A single microphone, regardless of its quality, can be placed in only one location and the sounds picked up may be entirely different from the overall effect desired. If the acoustics are good it is possible to use a single microphone at a distance and get a somewhat balanced effect, but audience noise becomes an immediate problem. Further, greater gain is required in the preamplifier circuits if the pickup point is some distance from the performers.

A battery of boom-mounted microphones is out of the question for the beginner. In addition to the economic angle, the beginner is faced with a manpower problem. It takes time to install a complex pickup system with its multiple cables, connections and mixing equipment. Further, and perhaps even more to the point, the tyro is interested in doing a good job in as simple a fashion as possible.

Faced with these problems the beginner may well consider the use of a parabolic microphone. It is easy to construct and has many advantages. It may be placed at a relatively great distance from the performers and yet maintain good sensitivity because of its directional qualities and effective gain. Because it is capable of good pickup from a distance one can avoid an unsightly array of microphones close upon the performers.

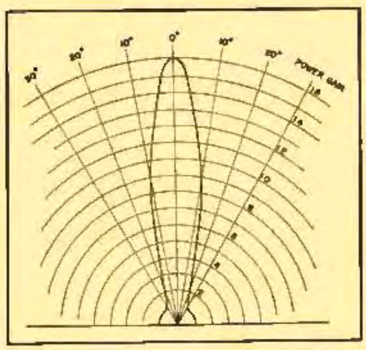

Fig. 1. Polar plot of the power gain characteristic of the author's parabolic microphone. Measurements made out-of-doors to simulate, as close as possible, a free-space pattern. Frequency of measurement: 1000 cps.

Also, because the pickup pattern is relatively sharp the microphone may be placed so that much of the audience noise and room echo is eliminated. *Figure* 1 shows the power gain pattern of the parabolic microphone to be described. Swinging the microphone five degrees each side of the maximum gain position brings about a one db drop in power. In the practical sense this means that the microphone can pick up sound with a plus or minus one-half db variation within a circle having a ten-foot diameter at a distance of approximately seventy feet. From the same distance the variation would be plus or minus three db for a thirty-nine foot diameter circle.

Construction Considerations

A parabolic microphone in its simplest form is comprised of three parts: the parabola, the pickup element, and a means for controlling azimuth and elevation.

Practically any microphone will serve as the pickup element, although velocity microphones are less desirable because they are more sensitive to mechanical shock than other types. Crystal microphones are satisfactory, but it is possible, while recording, to run into conditions of excessive temperature or humidity which might permanently damage a rochelle salt crystal unit.

The best compromise is undoubtedly a high-quality dynamic microphone. The unit employed in the parabolic microphone pictured is an Electro-Voice Model 630. This microphone is rated to have a relatively flat response from 60 to 11,000 cps, which is adequate for most recording work.

The Model 630 is classed as a non-directional microphone, although it is somewhat directional with frequency (above 1000 cps). This characteristic is a function of the diameter of the microphone case. When used with a para-

Fig. 2. The complete parabolic microphone unit mounted on a tripod.

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Fig. 3. Front detail view of the parabolic microphone.

bolic reflector there will be some additional directivity effects at the higher frequencies, but these effects are small compared with the effect of the parabolic reflector itself.

No attempt was made to make a frequency-response measurement of the completed parabolic unit. The on-axis high-frequency response is relatively unaffected, while the low-frequency response is a function of the diameter of the parabolic reflector. With the 27-inch reflector, the response is probably good as low as 150 cps. For applications where full bass fidelity is desirable it will be necessary to reinforce the low frequencies by the use of another microphone, as is explained later.

Other features which caused the 630 to be chosen include its ability to withstand hard usage, both indoors and out; its ability to stand extremes of temperature and humidity; and, of some importance, its shape, which allows it to be clamped easily and located at the focal point of the parabola.

The parabola itself should be purchased. It is possible to make a parabola, but inasmuch as they are currently available on the surplus market at less than $5.00, there is but little incentive to build one. Some of the available parabolas are made of metal mesh which, of course, is not suitable, as a continuous surface parabola is required.

The parabola pictured has a usable diameter of just under 27 inches. Smaller diameter units would give a directional characteristic but the power gain would be decreased.

Attaching the pickup element to the parabola is a simple matter for anyone who is handy with tools. One important point to keep in mind is that the pickup element is somewhat sensitive, acoustically, to mechanical shock, so the mechical construction of the clamp and supporting arms must be such as to minimize the transmission of shock to the pickup element.

Spring suspension is probably not necessary. The author's mount, with reference to *Fig.* 3, is a half-circle removable clamp, felt-lined, which is fastened to a half-circular section, also felt-lined, formed in the horizontal support bar.

The horizontal bar is made of aluminum tubing of ⅝-in. diameter. The middle section is flattened, bent into a half-circle, and drilled to take the mounting screws. A short piece of the same aluminum tubing is flattened and formed into a half-circle and also drilled. Each arc of aluminum is lined with ⅛-in. felt. Wing nuts used on the machine screws for this clamp expedite removal of the dynamic microphone.

The ends of the horizontal aluminum bar are flattened and split to produce a "U" shaped opening which slips over and fastens to the two side supports. These side pieces were made of ¾-in. duralumin. The length depends upon the focal point of the individual parabola. A quick way to check for the focal point is to place the parabola so that you look directly into it. Experimentally place a lighted match near the focal point and move this light source back and forth until the entire face of the parabola is illuminated. This point is the focal point, and you can now decide how long to make the side pieces, although final focusing is accomplished by sliding the microphone back and forth in its clamp. The rear ends of the thick dural pieces are drilled and tapped to permit mounting on the flat front edge of the parabola, while the front end of each side piece is drilled so that the horizontal bar may be attached by machine screws.

Gimbal Construction

The gimbal is made from half-inch thinwall conduit. A standard conduit bender—lent by an electrician friend—made the two necessary bends. This gimbal is brazed (a fifty-cent job at most welding shops) to a piece of ¼-in. brass, 3 inches in diameter. This metal plate acts as a bearing on the top of the tripod, and is drilled and tapped to take the tripod mount screw. A piece of 1/16-in. felt of the same diameter as the metal plate fits between the plate and the top of the tripod to provide a noiseless bearing.

The parabolic mount (without gimbal) is next checked for its center of gravity with the microphone in place. A hole is drilled in each side piece at the center-of-gravity point and the gimbal fastened to the side pieces with machine screws at this point. Use felt washers backed up by steel washers to provide a noiseless friction bearing. Wing nuts used here are useful in obtaining the proper amount of friction.

Damping Requirements

When the parabolic unit is completed and mounted on a tripod, you will notice that the whole unit is relatively "live." This is, of course, undesirable. It was found necessary to deaden the gimbal and the parabola proper.

The gimbal was made sufficiently dead by wrapping with two layers of 1-in. cotton tape and applying a coat of paint over the tape. The parabolic reflector (see *Fig.* 4) was deadened by cementing a layer of ½-in. felt on the rear face.

It is essential that the microphone cable be fastened to the horizontal support bar, the gimbal and one tripod leg so that its motion against any of these elements is eliminated. Friction tape may be used for this job or the cable may be securely tied with cord.

Accessories

Two useful accessories (necessities from the author's point of view) are the sights and the handle.

For accurate alignment of the parabolic microphone a sighting arrangement of some sort is necessary. *Figures* 3 and 4 show clearly the arrangement used. Both the front and rear sight are made of welding rod of a size that can be threaded with a 6-32 die. The front sight is a straight piece six inches long. The rear sight extends out the same distance and is provided with a circular opening made by bending the welding rod around a pipe in a vise. The inside diameter of the circle is approximately one inch.

The handle shown in the photographs is most convenient. It is made quite simply by flattening a piece of ⅞ or 1 inch diameter tubing at one end, drilling two holes, and mounting it on the dural side pieces with machine screws. The bicycle handle-bar rubber grip is not a frill. Any abrupt motion of the hand while it is in contact with the parabolic microphone unit is quite easily heard by the microphone. The rubber hand grip makes it possible to move the unit noiselessly.

When the unit is completed connect the microphone to an amplifier and arrange for a source of constant-level sound to be set up at least twenty feet from the parabola. To avoid unwanted reflections, make this test out-of-doors if possible. Aim the microphone at the sound source and then, watching an output meter on the audio amplifier, adjust the pickup element so that it is at the exact focal point of the parabola. Once this has been done to your satisfaction mark the microphone position so that you will be able to remove and replace the microphone at will.

Another interesting test at this point can be made while using high quality earphones on the output of the amplifier. Move the parabola mount in azimuth and elevation and listen to what the microphone picks up. Check the various parts for liveness by touching with your hand, and listen carefully to be certain that none of the pivot points squeak or make any audible noise.

Performance

Until you become familiar with the capabilities of this unit you may be in for some surprises. The author first tested his unit on the front porch of his home. The slightest chirping of birds, if in line with the microphone, gives the effect of using the microphone in an aviary.

Fig. 4. Rear detail view of the parabolic microphone.

Later the author was puzzled by the sound of children's voices, with no children in sight. Taking a bearing in the direction the microphone was pointed, the author walked the equivalent of a city block before coming across four children playing in the rear of a neighbor's home. Four solid hedges were interposed between the children and the parabolic microphone. This event, perhaps even more than the directional pattern taken later on, was convincing proof that the parabolic microphone really worked.

For recording any sort of stage presentation the author recommends that the parabolic microphone be installed in the front row of the balcony, preferably at the extreme right or left. In this connection it might be well to point out that the parabolic unit may be used in either a right-handed or left-handed manner. Merely move the parabola 180 degrees in elevation to change the handle from the left to the right side or vice versa.

The advantage of balcony placement is that audience noise pickup ahead of the microphone is relatively low due to the directional characteristic of the parabola, and audience noise in the balcony is attenuated by virtue of the front-to-back ratio of the power gain pattern.

With the parabolic microphone alone it is possible to do a good recording job, although it is probable that a better job can be done with two microphones, one a parabolic unit and the other a general coverage microphone.

Most of the author's recording experience has been gained by recording the work of the Schenectady Light Opera Company. In all cases two microphones were used, the parabolic unit balcony-mounted and a velocity microphone placed in the center of the theatre suspended below the balcony. This arrangement requires the services of two men, one to handle the parabola and the other to ride gain and mix the two microphone outputs.

The velocity microphone was used for general coverage pickup in order to get the full effect of the orchestra or chorus. The parabolic microphone was used to pinpoint vocal soloists in the midst of a large chorus. The latter microphone is also invaluable because of its ability to effect "presence" in the pickup of spoken continuity.

Acknowledgment

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