sion the islands may be cut from a flat sheet of one-inch plywood with a band saw. The top, bottom, and flange for mounting the driver are cut from ¼-inch plywood and the transition from circular to rectangular cross section near the throat is accomplished by means of plastic wood.

The type of finish is unimportant acoustically; the one shown in *Figs.* 1 and 2 was finished with orange shellac to better illustrate the construction. If the horn were to be mounted on top of the cabinet, or otherwise exposed, it could be made of one of the veneered plywoods. If it is to be mounted within the cabinet no finish would be required.

Plywood is a very satisfactory material for the horn; it provides adequate strength and contains sufficient mechanical resistance to damp any resonances and prevent appreciable motion of the horn walls. Thus, the performance of the horn is strictly a function of the geometry. Since the cut-off frequency, determined by the rate of taper, is well below the lowest frequency for which the horn is intended to be used, the dimensions of the islands are not critical. (Slight variations in the rate of taper of an acoustic horn only affect the performance near the cut-off frequency.)

If the horn is to be mounted within the cabinet, the top and bottom pieces need not be cut off along the arc but can be extended to the walls of the cabinet without impairing the performance of the horn. In this case, however, the inside width of the cabinet should be equal to the maximum width of the horn. (See *Fig.* 6.)

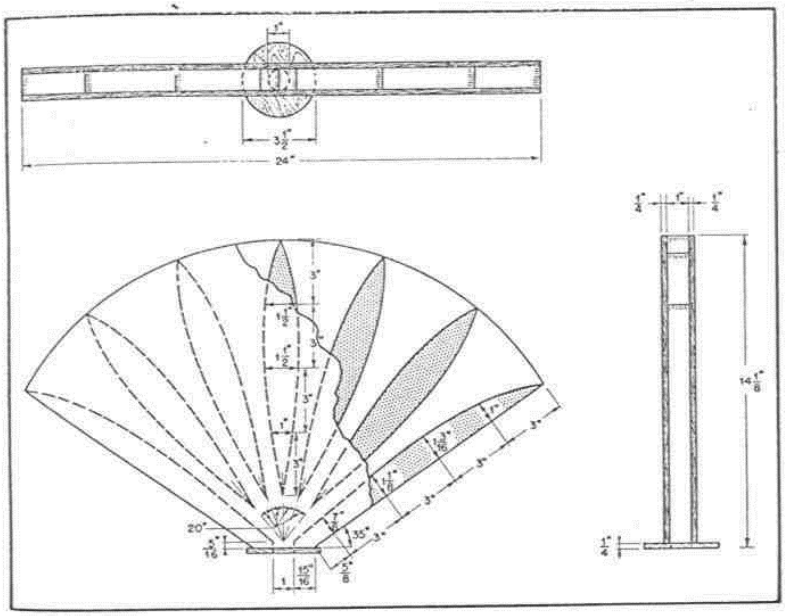

Fig. 5. Construction of the DSH is extremely simple since there is no vertical expansion.

Fundamentally the design considerations are the same as those for any exponential horn—i.e., the mouth area must be large enough to prevent reflection at the lowest frequency for which the horn is intended to be used and the rate of taper must be chosen to provide a satisfactory low-frequency cut-off. In addition, there are the directivity considerations which are primarily a function only of the geometry of the mouth of the horn. They are: (1) The smaller the vertical dimension the broader will be the vertical directivity pattern. (2) The larger the arc of the mouth the broader will be the horizontal pattern. One is limited in the first case by the fact that if the vertical dimension is made too small the viscosity losses will be appreciable. Since they are proportional to the square root of the frequency, attenuation may occur at the higher frequencies. In the second case difficulty may be encountered in exciting each of the horn throats equally at the higher frequencies if the arc is made too large. Experimental investigation indicated that neither of these difficulties were appreciable for the horn described in this paper.

The required mouth area is given by the following expression:

$$S_m = \frac{\pi}{36}\left(\frac{c}{f_o}\right)^2 = \frac{1.6 \times 10^7}{f_o^2} \text{ sq. in.} \qquad (1)$$

where f_o is the lowest frequency for which the horn is to be used and c is the velocity of sound.

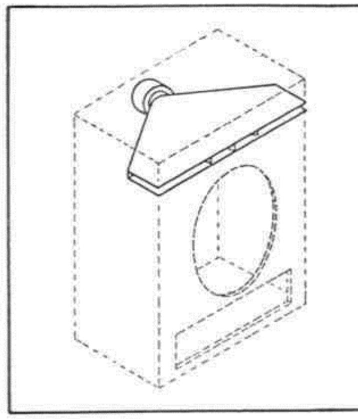

Fig. 6. The top and bottom pieces need not be cut along the arc, but may be cut off at the edges of the cabinet without impairing the performance of the horn.

The length of the horn is given by:

$$L = \frac{5}{\theta t}\left(\frac{c}{f_o}\right)^2 = \frac{9.2 \times 10^8}{\theta t f_o^2} \text{ inches} \qquad (2)$$

where θ is the angular arc of the mouth in degrees, and t is the thickness of the mouth in inches.

The cut-off frequency f_c must be less than or at most equal to f_o, and is given by:

$$f_c = \frac{\theta t f_o^2}{20\pi c} \ln \frac{S_m}{S_o} = \frac{\theta t f_o^2}{3.7 \times 10^5} \log_{10} \frac{S_m}{S_o} \qquad (3)$$

where S_o is the area of the throat.

The distance in inches for the cross sectional area of the horn to double is given by:

$$d = \frac{750}{f_c} \text{ inches} \qquad (4)$$

The design procedure is as follows:

1. Choose f_o, S_o, t, and θ.
2. Calculate S_m from equation (*1*).
3. Calculate L from equation (*2*).
4. Calculate f_c from (*3*). In the event that f_c is greater than f_o choose a smaller value of t.
5. Calculate d from equation 4.
6. Draw a straight exponential horn starting from the cross section S_o and doubling the area each d inches.
7. Choose the number of cells required to fill the chosen arc θ without allowing the mouth of each cell to have a dimension greater than about 5 inches.
8. Draw the center lines of each cell.
9. At equal intervals along the axis of the straight exponential horn measure the cross sectional dimension. Divide this equally between each of the cells, thus determining the dimensions of the islands. (i.e. superimpose this information on the center lines of step 8).
10. Complete the drawing of the horn.

Sometimes vertical expansion is nec-

[*Continued on page 44*]