

# Audio Aids

## DAVIS UPDATES HEIL

I'D LIKE to offer a few bits of information I've gathered about building the Heil type tweeter since my article appeared in *TAA* 2/787, p.15.

First, the easiest way to make the diaphragm is to etch the foil pattern with ferric chloride (standard circuit board etchant). I've been able to make several diaphragms in just one evening with this technique and have saved myself many hours of nervous frustration.

To etch the diaphragm, glue a sufficiently large piece of foil, with the two sides folded over for reinforcement, onto the .5 mil polyethylene. Protect what will be the short (horizontal) lines of the pattern by burnishing on etch resist such as the Datak Dry Etch transfers. Protect the long lines of the pattern with drafting tape of the desired width.

Before etching the foil, add the top and bottom reinforcement strips, covering them and the side strips with a layer of rubber cement so they will not be attacked by the etchant. Then lay the foil and plastic in the etchant to remove all foil not protected by tape, polyethylene, or rubber cement. When the etching is complete, remove the tape from the long runs but don't bother trying to remove the transfers. Glue on a top layer of polyethylene to complete the diaphragm.

You must etch the diaphragm in a diluted etchant solution, since full strength ferric chloride will actually harden the plastic from the intense heat of its reaction with the aluminum, and bury the diaphragm in a flurry of bubbles. If the etchant is too weak, the water will eventually seep in under the tape and attack the pattern. Adjust the solution to thoroughly etch the foil in about one half hour; you'll find you need somewhere around one-quarter strength.

I've made a number of diaphragms with this technique, and found it especially easy to take advantage of the .1" spacing between IC pads on the Datak ER14 sheet. By using every other pad and using .100" drafting tape, a 2" x 8" diaphragm can be laid out in less than an hour. The diaphragm will be approximately two inches square when folded and will require a  $\frac{3}{16}$ " magnet gap, making it midway in size between the full size and mini versions described

in my article. This smaller magnet gap allows high performance with fewer magnets, and the diaphragm is still large enough to be crossed over at 1500-2000Hz.

The mini-Heil can easily be laid out using half these dimensions, but the  $\frac{1}{8}$ " tape does not always flawlessly protect the foil. The etchant will occasionally work its way under this narrow tape and etch very fine cracks across the foil to destroy the current path. Two out of six that I etched failed for this reason, but I am confident a little experimentation will give a better yield for the mini-diaphragm.

Second, I've found things go much smoother if one builds the tweeter with a removable front grid. Several beads of silicon glue can then be run along the magnet structure inside the gap to keep the diaphragm securely positioned. This way the diaphragm has no chance to rattle against the pole pieces, and initially establishing the individual pleat spacing is much easier. Use silicon glue to hold together the strips that will form the front grid, and lay this front pole piece in place *after* the diaphragm is secured to the magnets and rear pole pieces. Silicon glue and a simple wood or aluminum frame will keep the assembly rigid.

Third, I'd like to stress again that there are many good ways to build a magnet structure; I stress this point because the high cost of magnets and metal may force the experimenter to improvise in order to keep down expenses. For quick, low-cost experimenting, a surprising amount can be done with a little imagination, salvaged magnets from defective speakers, and odd sizes of hardware.

Since the price of 2" x 5" x  $\frac{3}{4}$ " solid bar magnets puts the total cost for a stereo pair of Heils at over \$300, it is absolutely necessary to use a number of smaller magnets glued together. However, I'd hesitate recommending the extreme Mike Hamill suggest in his letter (*TAA* 4/78, p. 50), since gluing 384 repelling magnets could be a messy, sticky, and difficult job; but I certainly applaud his resourcefulness. The  $1\frac{1}{2}$ " x  $\frac{7}{8}$ " x  $\frac{3}{8}$ " magnets from Edmund are probably still the best way to go if you have no other choice, but the least expensive course is to salvage magnets from defective speakers and design the magnet structure and diaphragm around your magnets. This approach is especially worthwhile if your goal is to get a Heil up and going for an inexpensive audition.

And fourth, I'm curious to know if anyone has tried constructing the mini-Heil, which is not, as Hamill suggested, a laborious form of gilding the lily. The

commercial Heil unit, as I pointed out in my article, is non-directional in the horizontal plane, this of course is because the diaphragm opening is a  $\frac{3}{4}$ " slit. However, the Heil is extremely directional in the vertical plane, since the opening is near 5"—and anyone who has listened to this speaker is immediately aware of the enormous difference between listening on the tweeter's horizontal plane and listening out of this plane.

Even more startling is comparing a directional Heil with an entirely non-directional one. The intense brilliance of the directional Heil completely disappears in a non-directional version, and is replaced by a subtlety and realism which are at first hearing rather unimpressive. Amplifier hiss is still there and all high frequencies are for a fact being reproduced, but the speakers seem to have an altogether different character. I hope other readers will experiment more with the non-directional configuration of Heil-type tweeters, since the difference is, at the very least, quite interesting.

I'd also like to encourage readers to attempt building a Heil of any size, especially if they have spare magnets from scrapped speakers. Of course, being able to etch a diaphragm, rather than having to perform microsurgery on an uncooperative slice of aluminum, greatly simplifies the project. This amateur's version is quite amazing in terms of quality; and controlling directionality, efficiency (basically, the number of magnets used), cost (size and number of magnets, and physical dimensions, while still maintaining low distortion and flat response, can be a rather exciting freedom for the audio amateur.

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## A 3dB LADDER

THIS CIRCUIT PRODUCES a series of reference voltages separated by 3dB increments. Such a circuit is useful, for example, as part of a digital VU or power level meter using LED's for display.

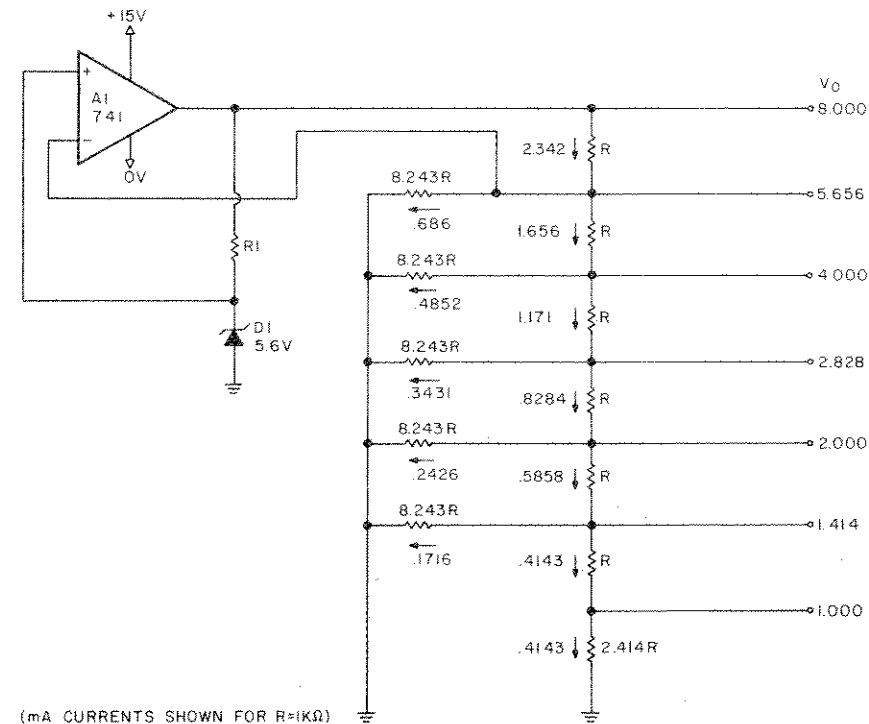
If one attempts to produce these voltages by a straight divider string, the resistors take on oddball values which make it hard to implement accurately. My circuit uses a variation on the familiar "R-2R" ladder network commonly found in D-A converters. "R" represents any convenient value of resistance, and the other resistors in the ladder are scaled accordingly.

The diagram shows exactly calculated ratios, along with currents in mA through the ladder for R = 1k $\Omega$ . Any

number of steps or voltages may be produced by simply including extra resistors within the ladder in the pattern shown. If one chooses 5% resistors, then 1k, 8.2k and 2.4k are a logical choice for

the ladder resistors. These values are within 0.5% of the calculated ratios, insuring good accuracy, especially if the resistors are selected or checked.

If extreme accuracy is required, then



1% resistors may be used with values 1k, 8.25k and 2.43k. For general use, an op amp and zener diode produce a regulated voltage source. The voltage at the top of the ladder will be 1.41 times the zener voltage. Of course one may connect the ladder to another regulated voltage if one is available.

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## HEADSHELL LEVELING: SME 3009 III

WHEN SETTING UP A TONE ARM, one of the most difficult adjustments is setting the top of the headshell parallel to the record surface. Most manufacturers call for this adjustment to be made by eye, which is not very precise: because the headshell is so small, one can err greatly in guessing whether or not the headshell is parallel to the record surface. Fortunately an objective way to make the adjustment is not difficult to invent and implement.

A spirit level provides a simple way to determine if the top of the headshell is level in playing position. Use the following procedure with a small spirit level encased in a block of plastic 3"x1"x $\frac{1}{2}$ ".

1) First set up the arm completely ac-

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