HEATHKIT TUBE AMP

After reading the excellent article "Upgrading Heath's W6 Power Amp" by Mr. Brown (March '06, p. 6), I can relate to the bias/stability problems that I had with these amps. The 12BH7 cathode-follower circuit was not friendly to the 6550 output tubes in regard to stable bias voltage, and when the 12BH7 aged just a little bit, everything was in limbo as to a possible "runaway" plate current situation.

I have enclosed a partial schematic of the driver circuit that I now use on my 120W power amplifiers. The 6BL7/6BX7 twin triodes are wonderful for this application, and no overall "nasty" feedback is needed for this circuit. Having the .22mF/600V DC capacitors in the signal path might be undesirable to some designers, but I have yet to have an output tube fail due to a defect in the cathode-follower circuit. Because the 6BL7/6BH7 tubes have large, massive cathodes, there should be no problems (tube driving, aging, and so on) as experienced with the 12BH7 in this application. However, you could modify this circuit for the W6 amplifier or any related circuit that uses tubes as the 12BH7, 6FQ7, 6CG7, 6GU7, and so on.

MOV/Genelex used direct-coupled cathode followers in several of their high-powered amplifiers using KT88 tubes in multiple pair format, with capacitor coupling before the output tubes. For applications with two output tubes, I have had excellent results with 6SN7s.

As always, you provide an excellent publication and I hope to contribute more during the year.

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CLASSICAL COAXIAL APPROACH

Mr. Koonce's excellent article on Driver Interference and Display Techniques (April 2006, p. 6) brought to mind the classic RCA LC1A loudspeaker of the '50s (**Photo 1**).

The LC1A was a 15″ coaxial driver, having a 2″ tweeter at its center. Harry Olson attempted to solve exactly the same problem described by Mr. Koonce: interference of the tweeter by a concentric ring. In the case of the LC1A, the concentric ring was the woofer itself.

Dr. Olson's innovative solution was the seven "diffractor cones" glued to the woofer cone. Close inspection shows that the seven diffractors are not uniformly placed on the woofer cone. This served to further randomize the distribution of reflections.

I wonder whether this strategy could be used to reduce the adverse effects of a rectangular grille frame. It should be possible to glue "diffraction disks" to the baffle in a semi-random pattern around the tweeter or near the grille frame.

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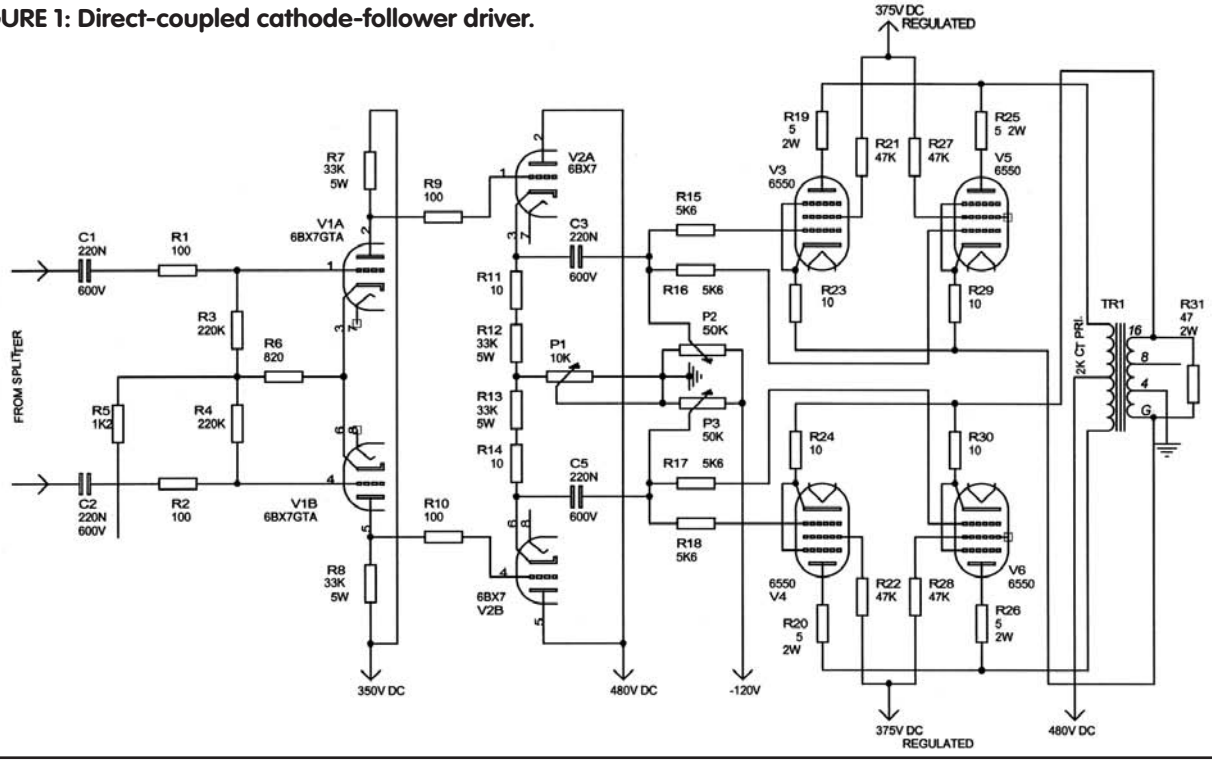
G.R. Koonce responds:

I thank Mark Rumreich for his interest in and comments on my article. Regarding the RCA LC1A loudspeaker, it mortifies me to admit I'm old enough to have listened to one; hi-fi was monaural in those days. Compared to

FIGURE 1: Direct-coupled cathode-follower driver.



popular drivers of the time, the RCA driver seemed to lack presence and high-frequency response. I don't know whether the driver was being used properly or was in some way defective, but after 50 years I simply remember being "unimpressed."

This driver is covered in Dr. Olson's book *Acoustical Engineering*[1]. Olson points out that the smaller conical domes were attached to the large cone to reduce the velocity of wave propagation in the large cone. Quoting Olson: "This broadens the directivity pattern of the low-frequency cone. In the high-frequency range, the conical domes attached to the surface of the low-frequency cone improve the performance in three ways: by decreasing the angle into which the high-frequency cone feeds, thereby increasing the output of the high-frequency cone; by diffusely reflecting some of the sound emitted by the high-frequency cone, thereby eliminating direct reflections; and by diffracting some of the sound emitted by the high-frequency cone, thereby broadening the directivity pattern."

This RCA driver was developed at a time when woofer cone excursions were rather limited. Today, when many large woofers have huge excursion capability, I would worry about Doppler distortion problems with a driver using the woofer cone as the "waveguide" for the high-frequency driver.

In general when attaching the "diffraction/reflection problem" with loudspeaker enclosures there are three basic approaches. The first is to eliminate the structure causing the problem with such methods as flush-mounting a tweeter to eliminate diffraction at the faceplate edge. In general this approach ultimately fails. As noted in my report, as soon as you mount anything else on the enclosure front panel, the response of that flush-mounted tweeter becomes compromised. Unless you are mounting the enclosure flush into a large wall (infinite baffle), you will eventually need to account for the box edges. Additionally for driver protection, you must also devise some way to accommodate a grille on the enclosure.

A second approach is trying to "spread out" the interfering structure. If you can do this sufficiently, then it is possible to reduce the interference signal to an acceptable level. The "Diffraction Ring" developed by David Weems and myself to smooth the response of a surface-mounted tweeter works this way. Its development and performance are covered in reference #3 of my article. As Mr. Rumreich indicates, this approach was used with the RCA driver and may be applicable to front panel treatment. I think such an application would require a rather large front panel to work with, but with sufficient work and testing could be successful.

Someone suggested to me that painting the front panel with one of those paints that produces a very rough surface might be helpful. I doubt that this is effective, but have not yet tested it. As demonstrated in my article, avoiding symmetry in any diffractive structure is very important.

The third approach is to prevent the acoustic energy from getting to diffractive/reflective structures. This is generally done by attempting to absorb the acoustic energy via damping materials. Fibrous-tangle materials such as fiberglass and felt have shown to be effective, with limits, if properly applied. The literature indicates certain foam materials are also effective, but I have yet to identify one that is cheaply available to the home builder.

The best way to handle diffraction/reflection interference problems today seems to be by applying a combination of all three of the above approaches. Even then the in-system response of the drivers will probably vary somewhat from their anechoic response. Tweeters are especially sensitive to how they are mounted, what diffractive structures exist on the front panel, and the grille frame/cloth. The midrange driver is very sensitive to the chamber in which it is mounted, how it is coupled to that chamber, and again diffrac-

PHOTO 1: RCA's LC1A 15″ coaxial driver.

tive structures on the front panel. There is no such thing as taking too much care in these areas.

REFERENCE

1. Harry F. Olson, *Acoustical Engineering*, D. Van Nostrand Company, Inc., New York, 1957, page 139.

NOT-FOR-PROFIT

I found a copy of *Speaker Builder* (from several years ago) and was really fascinated by its contents. I've been collecting—and rebuilding—vintage audio gear since I was a teenager. . . everything: ranging from 1960s Acoustic Research speakers to (1973-era) AKAI, analog, quadraphonic (!) reel-to-reel tape decks.

What piqued my interest (in the particular copy I'd found—6/99 *SB*) was an article by Mr. Charles Hansen, concerning the restoration of an old pair of Lafayette "Criterion" bookshelf speakers. My view on such a project would've been this: Why waste $235 (the cost of the replacement parts—from Madisound—as quoted in the article) on a pair of speakers which were, undoubtedly, garbage to begin with? I mean, just a trip to your average weekend yard sale and/or flea market (where I get most of my wares) could land you (vintage) equipment (speakers, in this case) *far superior* to what Mr. Hansen chose to work with. Here are some examples of *other* two-way, 8″-10″ woofer/cone tweeter systems (like the Lafayettes, but better): AR-4x, Advent 1, Bose 301, Dynaco A25, JBL 96, KLH 17, KLH 22, KLH 33, Rectilinear XI, Rogers LS7, and Wharfedale W25 (to name a few).

I—with the help of one of your advertisers—rebuilt a pair of (1968-vintage) AR-2ax speakers. I use them with a (1971-vintage) Marantz 1060 integrated amp (on which I replaced all the filter caps as well as upgraded the internal wiring), a (1973-vintage) AKAI reel-to-reel tape deck (I've a substantial collection of pre-recorded "albums" in this format), and a (1977-vintage) Thorens TD-160MKii turntable.

James Hoone
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Charles Hansen responds:

Point well taken, Mr. Hoone. You must shop some pretty ritzy yard sales, and congratulations on your finds. I wrote the article on the Criterions [Criteria], which are still serving nicely almost 7 years ago, before I did anything with speakers at all (see p. 4 of that same issue). So it started out as a curiosity and turned into a valuable learning experience. To paraphrase the credit-card commercial:

Cost to refurbish two Criterions: $235
Lessons learned and experts I met as a result, especially GR Koonce: Priceless

I went on to do a couple more loudspeaker-related articles with GR, who showed me that there is indeed a science behind loudspeaker design. I agree that this kind of hobbying is indeed satisfying. I recently upgraded a Harman-Kardon HK-460i receiver (designed in part by John Curl) in the same way you described for your Marantz. If you restored any of those vintage loudspeakers, I encourage you to share the results with an article of your own. *aX*