at home with AUDIO

LEWIS C. STONE

Hi-Fi Segregation

Second in the series "There Is No Hi-Finality." Filter network and separate power amplifiers for tweeter and woofer replace conventional crossover with gratifying hi-fi results.

It may be that the hi-fi turnabout we aim to describe this month may point to a trend. Or it may seem to some of you to be as necessary as a hole in the head. But the reader whose system we are about to embed in the striated amber of this department's rhetoric feels, on the contrary and perhaps justifiably, that if hole there be, it is of the hole-in-one variety. The point is that the subject reader, owner of as fine a hi-fi rig as you will find east or west of ol' man river (as described here in its darkling splendors June, 1955) decided recently to switch from his conventional dividing network to a filter-type system, with an additional power amplifier—all speakers aboard and intact.

The filter network (*Fig.* 1) to which reader Crofford has switched contains in its system one preamplifier with cathode-follower output stage for low output impedance; high-impedance filter network with low- and high-frequency outputs: and the original 60-watt amplifier plus a newly-built 40-watt unit. A block diagram of the filter network system, compared with a conventional crossover, is seen in *Fig.* 2.

No Fractured Frequencies

The new network feeds to these amplifiers, each fitted with a ½-megohm level control at its input. This means you can adjust the level of the tweeter without using expensive T- or L-pads inserted in the speaker line to hold correct impedance and create aural balance. Since tweeters are fitted with comparatively fragile elements, and must necessarily be kept within a maximum peak of one or two watts (higher power tweeters can be had, but at higher cost)—the crossover should be arranged so that the very high-frequency unit (in a 3- or 4-way system) reproduces only the harmonics of the upper tones: calling for crossover at 5,000 cps. By and large, the acoustic level of the harmonics is much smaller than of the fundamentals, which is why the power rating of the tweeter and mid-range amplifier is smaller than the low-frequency unit.

The high-frequency section can be handled with a low-power stage and by the same (inverse) token, a high-power output stage handles the mid- and low-frequency range. Then the two stages are put in balance, and held so permanently.

Our reader reports that he thus achieves a currently "hot" audio goal: not nearly stereophonic, obviously, but a something approaching a sonic stereo-sensory feeling is there. And because the values of the components seen in the schematics, it is to be expected that neither tweeter nor woofer nor mid-range will be likely to break up at their respective ranges of frequency. The filter network components have

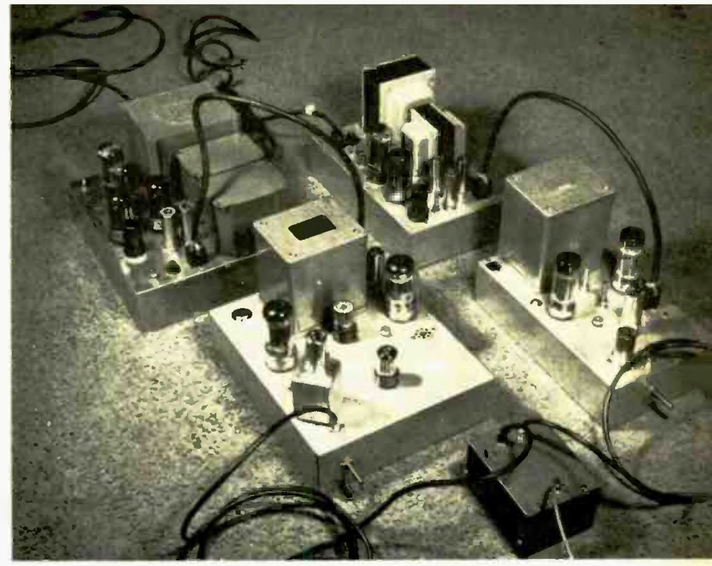


Fig. 3 (above). Dual amplifier system interconnected with filter network (small chassis in foreground). Left, array of 60-watt low-frequency power amplifier with power supply; right, 40-watt high-frequency array. Note two Mullord EL34's on this power amplifier.

Fig. 4 (left). Mockup of layout of components to guide cutting of chassis. Note three UTC units (LS Series power transformer, Special Series filament transformer and choke). Tube sockets and test pins along left rim. Tools shown: Greenlee punches, clippers, pliers, socket wrench, metal files. Carton upper left holds solder strips, used with Weller gun. Belden reels hold #18 solid insulated conductor.

been evaluated for adequate crossover operation in this speaker system—neither too sharp nor too gradual—and variable level controls are seen fitted to the early stages of the power amplifiers, where good practice requires that they should be. The interconnected array is shown in *Fig.* 3.

This could mean that you can play around with the speakers, holding them strictly to a fixed relationship or, if you will, ad-lib and improvise their response levels, depending on program or source, or the state of your hearing.

Transient's Fallout

It seems that reader Crofford locked onto the dual-amplifier, filter-network notion after a recent and lengthy bout with some stereophonic recording sessions (as a recording engineer with RCA Victor.) From then on, he claims that his pleasure-trove of ultra-satisfactory listening to his own hi-fi system somehow became false to his ears. The specific lack (to his newly stereo-sensitized perception) seemed to be mostly in the capacity of his home system to cope with transients: those leap-frog passages that are said to lend color and rhythm and texture to the music. Suddenly, what he heard held not the old illusion of realism for him. The quality of the output signals seemed somewhere along the route to have become vitiated. Questions of complete equipment replacement came to mind. But replace with what else better? The components in his hi-fi system certainly were as good as the industry had to offer.

We learned about the changeover to dual-channel amplification when we checked with owner Crofford about some inquiries sent in by readers, such as this one from L. B. Gettman (Washington, D. C.) from which we quote, blush or no:

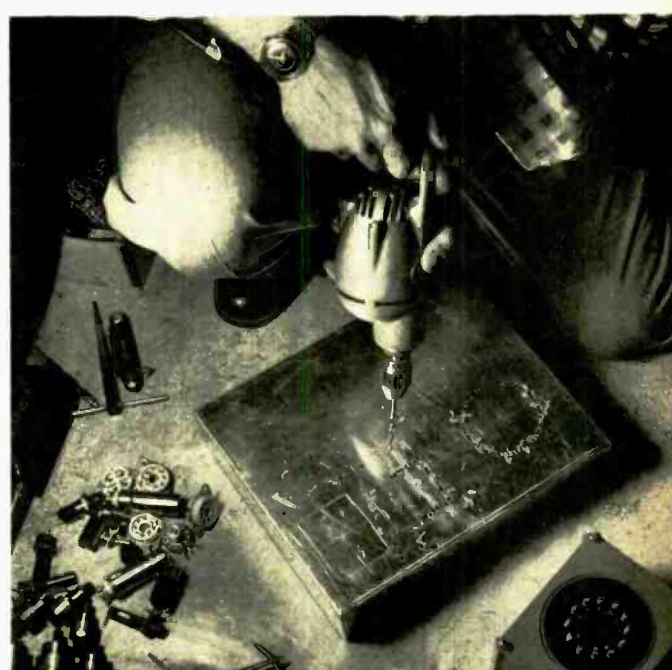


Fig. 5. Chassis cut-outs made by drilling holes in soft aluminum along perimeters of components, with ¼-inch hand power drill. Pocket-knife cut along perforations to complete openings.

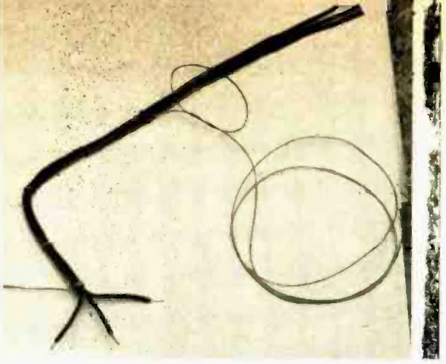


Fig. 6 (above). How wires are cable-tied. Use waxed facing cord for loops around bundles of related leads.

Fig. 7 (right). Bottom view of components assemblies, pre-wiring stage. Tube sockets, control, jacks, switches, fuses, transformers placed to require a minimum of wire. Allows neat and compact in-line wiring, as in accepted broadcast standards. Short lengths of contact-to-contact wiring give maximum freedom from hum due to ground loops.

"Your articles in AT HOME WITH AUDIO are most interesting and helpful to those of us who are planning initial high-fidelity rigs or the modification of existing installations. My only complaint is that you don't have an article in each issue of AUDIO.

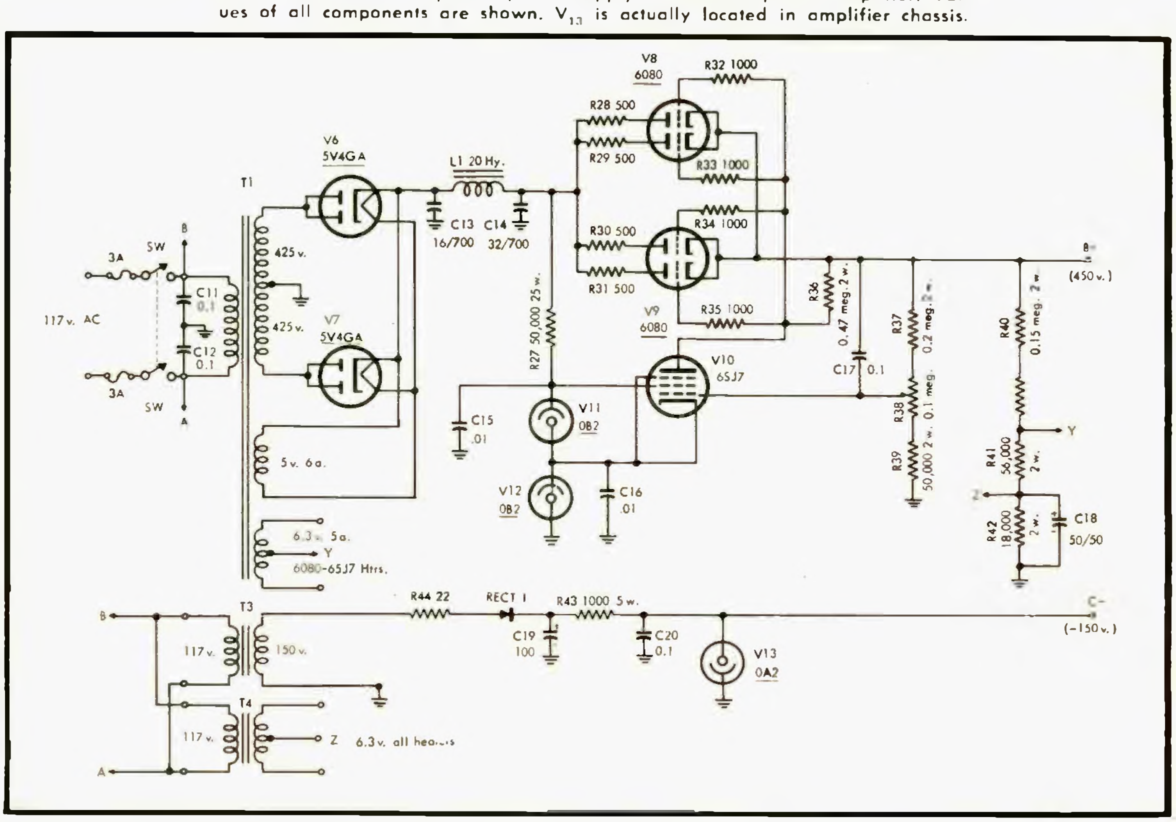
"Since I am in the process of planning major changes in my rig, your articles have been especially helpful. Of particular note to me was your article in the June 1955 issue. . . . Can you supply me with a parts list . . ."

This article got shaped up when reader Crofford told us how he went about making fi-perfection more hi-perfect. Or, at least, he anticipated such a result, by a "modification of existing installation," as letter writer Gettman so aptly puts it, above.

Kitchen (Floor) Mechanic

The Crofford kitchen is his hi-fi workshop and the floor his workbench. Working with the malleable-grade aluminum chassis, he avoided complicated tools. Cut-outs for the transformers were made with a ¼-inch hand power drill by perforating just inside perimeters and circumferences which he first outlined in crayon around each component, arranged loosely in mockup of the final layouts. (*Figs.* 4 and 5). He

Fig. 8. Schematic of separate power supply for 60-watt power amplifier. Values of all components are shown. V_{13} is actually located in amplifier chassis.



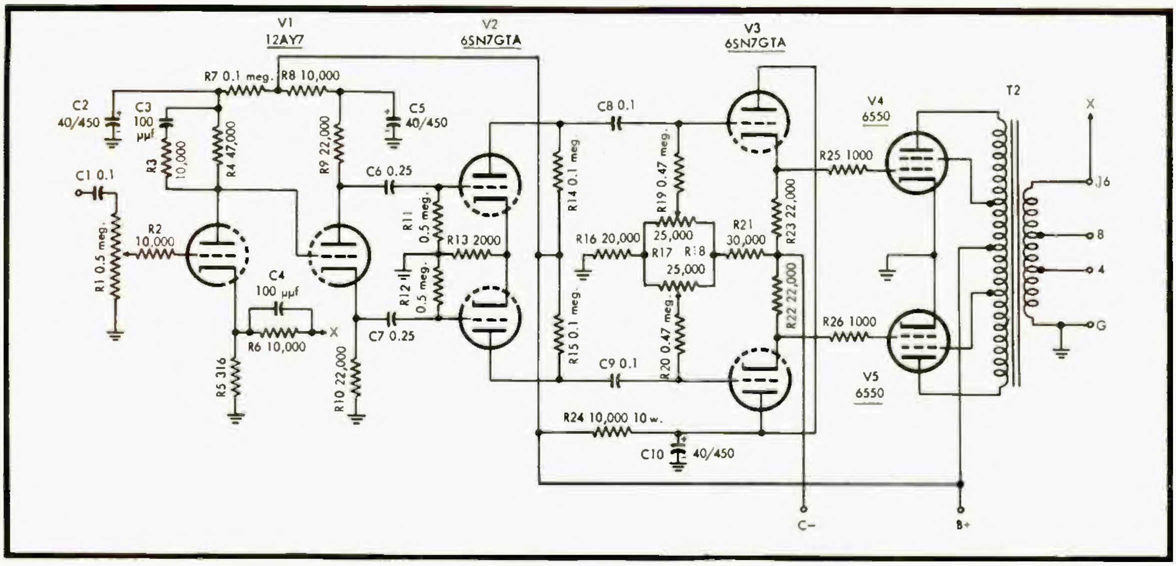


Fig. 9. Schematic of 60-watt power amplifier, component values given. 40-watt unit is similar, but with one less 5V4GA and one less 6080 in power supply.

used a heavy pocket knife to cut along the drilled perforations to complete the openings. Areas for tube sockets and Vector turrets were cut out with Greenlee and Pioneer chassis punches. The rough edges of each opening were then filed smooth to their net sizes and so readied for fitting and mounting the respective components.

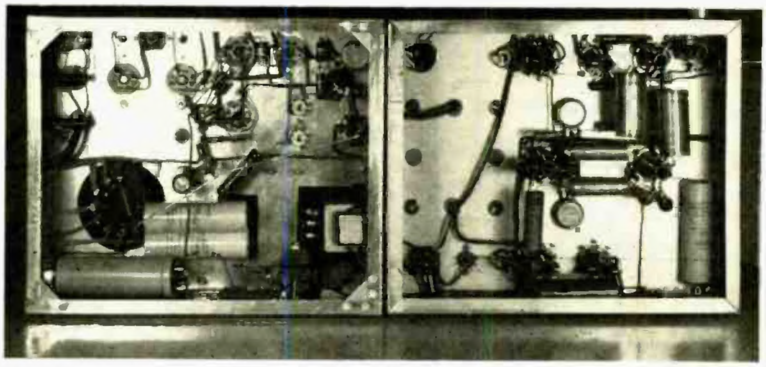
The steps followed in "filling" the chassis can be seen in the photographs, *Figs.* 4, 5. 7 and 10. Although the wiring is completely out of sight on the undersides of the four chassis, the job is a neat one, with cabled leads and bus-bars. The procedure for cabling leads is indicated in *Fig.* 6. All of it is therefore uncrowded and accessible, not to say easily identifiable for tracing and checking purposes.

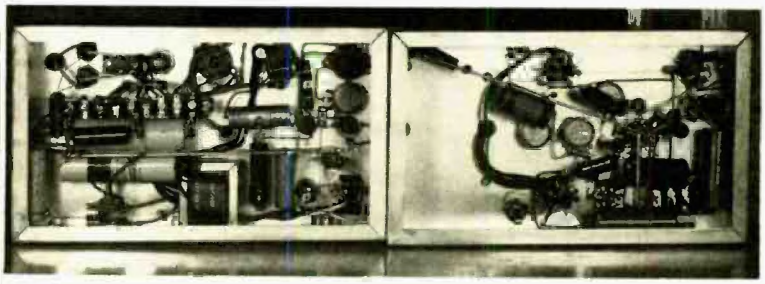
To fall into line with letter writer Gettman's and other similar requests, we now take space (elsewhere in the article) to list all the parts that went into the self-made 60-watt power amplifier and its separate power supply, as seen in two schematics. *Figs.* 8 and 9. As to the new 40-watt unit, that tweeter-nurser is twin to its elder brother except, we are told, for one less 6080 high-current dual triode and one less 5V4GA rectifier. Both arrays are shown, bottoms up, in *Figs.* 11 and 12.

As to investment, the cost of the additional amplifier is offset somewhat by the savings in the cost of the conventional crossover, which has been replaced by the filter net-

(*Continued on page 74*)

Fig. 10 (below). Some resistors in place, solder-connected to Vector turrets. Filament wiring is kept snug to top and side of chassis frame to avoid induced hum in amplifier. Fig. 11 (upper right). Completed wiring of 60-watt low-frequency amplifier on 12 x 10 x 3 inch chassis. Note bus-bar in power supply (left), selenium rectifier on stand-off insulator, electrolytic capacitor, resistors mounted vertically on Vector turrets. Coupling capacitors bridged from voltage amplifier stage to output stage are clear of chassis "floor" to minimize stray capacitance affecting high-frequency response. Level control in upper right corner. Fig. 12 (lower right). Completed 40-watt high-frequency power amplifier on 12 × 7 × 3 inch chassis, with power supply. Wiring procedure identical with bigger unit.





work. Savings can be even greater if, like our reader, you build it yourself. Furthermore, amplifiers in filter type systems need not be high power. In a binary channel such as this, two 10-watt amplifiers are about as effective as one 30-watt unit would be in a conventional crossover system.

The over-powered amplifiers are for overpowering perfection at the peaks. As wife is (supposedly) to husband, so is the really dedicated buff to his hi-fi system: best friend, severest critic. A blastout at an unruly peak point, and the power vested in the watt is at once invoked. The "watt-of-it" really matters.

Our reader's self-made amplifier amply supports and underpins any of the tweeters flights along the highly directional orbits of the high-frequency octaves. Giant woofers have been known to respond adequately to the urgings and proddings of a 10-watt rated amplifier. But the hi-fier knows that it lies ever on the verge of distortion, the louder and more massive the passages get.

In the present state of the art of speaker engineering we all know that separation of speakers as to low high ranges is a sound method of avoiding distortion. In fact, its advantages are measurable and mentionable. But you ain't heard nothing yet without a level control to balance the parts of the speaker system to fit the room.

Ear-Conditioned Fanfare

This is not to say that this reader's gambit rules out the conventional audio separators. For are not these, below, the knowns of the benefits of the crossover network's functions in the two- or three-way or more, speaker system? As G. A. Briggs points out (and what follows has been adapted from his book, *Sound Reproduction*), we know that three-speaker systems are easily set up and a fragile h. f. unit is shielded from the onslaughts of high-amplitude low-frequency input. The chances of intermodulation distortion between bass and treble when combined in one speaker are largely avoided. And then, the bass speaker and treble unit can be designed and housed separately for maximum efficiency in the performance of their intended functions.

Moreover, they can be placed suitably for room-tempered listening; the bass near the floor, the treble unit some feet higher. Further, speakers of different impedances may be tried, as 16-ohm bass and 8-ohm treble, with attenuation or increase of output, in either case, as may be needed for the room or space of their location. (End of "quote" from Briggs).

The comparative virtues of the multiple speaker system stand. The advantages ascribed to the conventional crossover are simply augmented by those few claimed by reader Crofford.

He claims, for example, that with the conventional crossover network, speakers look back into the amplifier when in their pass band and see the correct impedance match. When they are outside their pass band, they look back into a reactive impedance; not necessarily disturbingly audible, but this is a condition or a liability that the filter-network system tends to eliminate.

Also, intermodulation distortion in the power amplifier is reduced with the filter network, as the low-frequency channel goes down from 300 cps, while the high-frequency channel goes up from the 300-

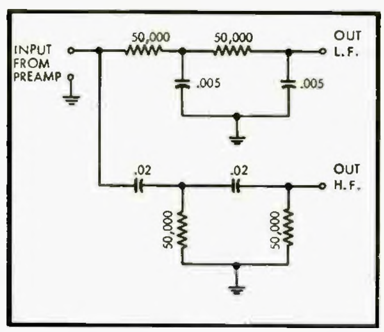
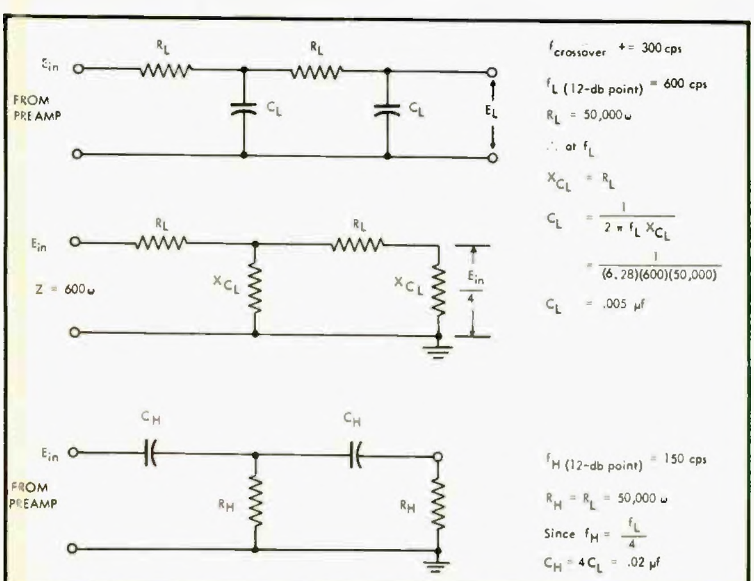


Fig. 13 (right). Configurations of filter network and the formulas by which they are calculated to produce (as in Fig. 14, below) completed filter network, as constructed and used in dual-channel system.



cps point. The speakers (he avers) are thus always loaded by the amplifiers and their distortion is therefore much less than with the conventional crossover. Also, the speaker damping factor in the filter system is more constant. All of this, in a manner of speaking, adds up to the equivalent of a polarized filter introduced to keep unwanted reflections and highlights from bothering and distorting the composition and balance of a "picture"—is sound, here. of course.

It would be doing our subject full and undeserved injustice to end this saga of the separate amplifiers right here. But in all fairness, we feel constrained to observe that the conventional crossover network is not exactly double-crossed out of consideration and use because of the turnabout to a filter network reported here. Nor are the many excellent all-in-one (concentric, co-, Diff- and Tri-axial) units relegated to unexcursioned neglect. The professional who built himself this filter system is not opposing the offerings of the market place. His job of conversion is, let's face it, just one man's way of taking his hi-fi hearings anew as he learns, essentially empirically, to live at home with audio. In sum: the better than his, his best became.

Readers who are of a mind to hone up on the subject before obeying that impulse to take their workbench aprons off the hook might like to dig into an article expatiating on the theory, design, function, and advantages of the filter network in home hi-fi systems, as set forth in "The White Powrtron Amplifier," by Stan White, and reproduced in **the 3rd audio anthology**. The subject is handled from another angle in "A Discussion of Dividing Networks," by J. P. Wentworth, page 84, same **anthology**.

See, in *Fig.* 13, the configurations of the filter network and the formulas by which they are calculated. *Figure* 14 shows a schematic of the complete filter network used here. as constructed from these configurations.

A Precedential Year?

Exposed to this (perhaps) precedent installation, other hi-fi brethren may be expected to get into a "me-too" frame of go-getting, culminating (who knows?) in a spate of rig-conversions. It could be. This time it's the dual-channel amplifier with filter network workout; but, we dare ask. good for how many tomorrows before the next wave of what other kind of hi-fi retread jobs?

With some finality, we can say it is no skin off our nose to acknowledge that the complement of speakers in do-it-yourselfer Crofford's hi-fi rig owes its present format to some years' experience of making a living working with audio. As of now, there's a Jim Lansing DL175 tweeter atop of his enclosure; and enclosed in the folded-horn below are a Jim Lansing 375 mid-range unit, with an 18-inch Electro-Voice woofer. To these, the double amplifier-filter-network crossover combo (with filter between preamplifier and power amplifier to be sure) has brought improved transient response; greater flexibility of balance between the speakers; not to mention a clearing out of the cobwebs of intermodulation distortion—the filter network standing guard against invasion of the low-frequency amplifier by high-frequency signals, and vice-versa.

All of which adds up to a form of segregation that, in this instance at least, has turned out to be unquestionably beneficial to this (hi-fi) community.

Parts list, 60-watt power amplifier

R_1	0.5 meg level control
R_2	10,000 ohms, 1-watt
R_3	10,000 ohms, low noise
R_4	47,000 ohms, wirewound, 1-watt
R_5	316 ohms, wirewound, 1-watt
R_6	10,000 ohms, wirewound, 1-watt
R_7	0.1 meg 2-watt
R_8	10,000 ohms, 2-watt
R_9, R_{10}	22,000 ohms, wirewound, 1-watt, matched
R_{11}, R_{12}	0.5 meg low noise, matched
R_{13}	2,000 ohms, low noise
R_{14}, R_{15}	0.1 meg, wirewound, 2-watt, matched
R_{16}	20,000 ohms, 2-watt
R_{17}, R_{18}	25,000 ohms, 2-watt, bias balance control
R_{19}, R_{20}	0.47 meg 1-watt, matched
R_{21}	30,000 ohms, 2-watt
R_{22}, R_{23}	22,000 ohms, 2-watt, matched
R_{24}	10,000 ohms, 10-watt
R_{25}, R_{26}	1,000 ohms, 1-watt
R_{27}	50,000 ohms, wirewound, 25-watt
R_{28}, R_{29}, R_{30}, R_{31}	50,000 ohms, 1-watt
R_{32}, R_{33}, R_{34}, R_{35}	1,000 ohms, 1-watt
R_{36}	0.47 meg 2 watt
R_{37}	0.2 meg 2-watt
R_{38}	0.1 meg voltage control, 2 watt
R_{39}	50,000 ohms, 2-watt
R_{40}	0.15 meg, 2 watt
R_{41}	56,000 ohms, 2-watt
R_{42}	18,000 ohms, 2-watt
R_{43}	1,000 ohms, 5 watt
R_{44}	22,000 ohms, 1-watt
C_1	0.1 μf, 400 v.
C_2, C_3, C_{10}	40 μf, 450 v.
C_4, C_5	100 μμf, ceramic
C_6, C_7	0.25 μf, 600 v., matched
C_8, C_9	0.1 μf, 600 v., matched
C_{11}, C_{12}	0.1 μf, 600 v.
C_{13}	16 μf, 700 v.
C_{14}	32 μf, 700 v.
C_{15}, C_{16}	0.01 μf, ceramic, 500 v.
C_{17}	0.1 μf, 600 v.
C_{18}	50 μf, 50 v.
C_{19}	100 μf, 250 v.
C_{20}	0.1 μf, 600 v.
T_1	425-O-425 v., 275 ma; 5 v., 6 a.; 6.3 v., 5 a.
T_2	ACRO TO330
T_3	– 150 v. 50 ma.
T_4	– 6.3 CT. 10 a.
L_1	12 H. 300 ma.
V_1	12AY7
V_2	5692. 6SN7GTA
V_3	6SN7GTA
V_4, V_5	6550
V_6, V_7	5V4GA (or 5U4GB)
V_8, V_9	6080 (or 6AS7)
V_{10}	6SJ7
V_{11}, V_{12}	0B2
V_{13}	0A2
Rect.$_1$	180 v., 100 ma., Selenium