VALVE

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VALVE

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for tube audio eXperimenters

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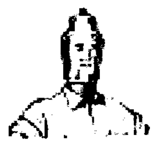


editor's thing

Yo Bottleheads,

Well, since my shoulder is held on with stainless steel staples, I'll try not to injure it by patting myself on the back too much.

Yes, your hero, Doc "get a haircut, and cut back on the beer" Bottlehead smoked 'em at the $100 speaker contest, with the talented help of able cabinet builder and finish consultant John Carey.

You guys who couldn't make it missed quite a show.

We knew it would be a bit more of a challenge when those sand fleas from the PAS showed up with a Conrad Johnson PV-12 preamp and an Audioprism Debut amp to power their entries. See, when the stakes are high, even the most devoted sand fleas go vacuum state!

Anyway, it was a very fun evening, with six very estimable speaker systems.

We had so much fun with the PAS guys that we'll have another meeting or two with them this year, that is, with those who don't end up joining VALVE instead....

How was WCES? Nonstop fun, from the moment of rising in the morning to the sound of Smoothplate Tucker shaving, to the introductions to all those people you've only read about (did you know Michael Green really looks like that?), to the evenings spent struggling to find a decent meal. A highly recommended audiophile's vacation.

As you can see we've received another great set of photos of recently completed projects. If you have completed a system, or built S.E.X. amps or any of our other projects, please send us a photo or two and a note about how the project went, and we'll help make you famous by printing it.

As ever I try to be available to folks for to answer their burning questions. If you have sent me correspondence in the last couple months, I apologize if I haven't gotten back to you yet. Business has really been, well, busy. Give me an e-mail or leave a message to jolt my memory about your letter, and I'll try to get a lucent answer for you.

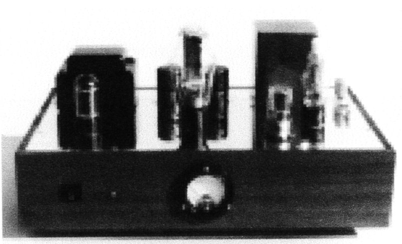
If you have questions about articles by our brilliant contributing authors, please mark your correspondence to their attention, care of VALVE. Don't let the blue smoke out - *B.*

on the cover

New member Robert Root and I had a nice conversation the day he called to subscribe. We got talking about amps he had built, and it was obvious this guy was no newbie. He started describing the appearance of the amps and I realized I had to have some photos.

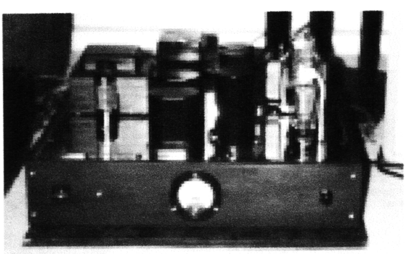
The amp on the cover is Robert's favorite. It is based on Arthur Loesch's 417/10Y/211or 845 circuit, with four GZ37s in a full wave bridge. The finish on this amp and those below is superb, a highly polished brass chassis plate on a mahogany colored base.

The amp above is WE 262B/6J5/300B, with



a GZ37 rectifier and Tango XE-20S output trans. This has also been modified to a 6J5/6J5/300B configuration. Robert says Arthur Loesch likes the 262-B, but that it must be shielded to avoid hum pickup.

The next amp is 328A/300B, ala Joe Roberts,



(if you haven't ordered your *Sound Practices* back issues and seen circuit gems like this, you're missing out big time, homes) using a 5AR4 rectifer and DS-025 output transformer. This amp has since been modified to 262B/6J5/300B. Robert says "This amp sounds better than (the other 6J5/6J5/300B amp). I have ruled out the OPT's by testing, so it must be in the power supply or the WE 262B triode."

Maybe I can get Robert to send some photos of the exotic speaks that were peeking out of the corners of the original photos too....

did you just tune in? here's what's happened so far...

Back Issues

Volume 1 - 1994 issues - $20

a Williamson amp; Dyna Stereo 70 mod bake-off; converting the Stereo 70 to 6GH8's; a QUAD system; triode input Dyna MkIII; MkIII vertical tasting; smoothing impedance curves; Altec A7; Ampexes Nagras and ribbon mikes; Triophoni, a 6CK4 amp; audio at the 1939 World's Fair; books for collectors and builders; V.T. vs. R.M.A. cross reference; FM tuner tube substitutions; Big Mac attack - the MI200; 6L6 shootout; a vintage "audessey"; more FM tuner mods; vintage radio mods; Heathkit rectifiers; PAS heater mod.

Volume 2 - 1995 issues - $20

Rectifier shootout, tube vs. solid; FM 1000 recap and meters; single ended 10 amp; triode output W-4; Optimus 990 - speaker for SE?; star grounds; tuner shootout; Living Stereo, vinyl or CD?; World Audio SE integrated; firin' up - smoke checking; Brook 12A schematic; 6C33 vs. 3C33; Heathkit power transformers; 6B4's + Magnequest = SEcstasy; W5 mods; triode operating points; Dyna restorations; Marantz 7,8 and Scott LK150 impressions; hackable vintage gear; Quasimodo - PP 805 amp; restoring a Scott 340 in 75 minutes; a dream system for 78's; cartridges and styli for 78's; Restoring a Lowther, Part 1&2; easy tube CD output hack; 6ER5 phono preamp; 304TL & 450TH SE operating points; hypothetical DC ESL amps.

Volume 3 - 1996 ($25):

Single Watt, Single Tube, Single Ended, an amp for Lowthers; the Vintage Speaker Shootout of 1996, QUAD vs. Lowther, vs. A7; the Voigt Loudspeaker, the Single Ended eXperimenter's kit; cathode coupled SE 6AS7 amp; how to build the Superwhamodyne; refoaming AR woofers; mesh plate tubes; rebuilding QUADS; QUAD amp filter surgery; single gain stage amps; the Brooklet, and Brookson, choke loaded PP 6080 amps; transformer coupled PP 6DN7 amp; the Iron Maiden; Building the Lowther Club Medallion; the TQWT, a tapered pipe enclosure; IT 300B amp.

the $100 speaker contest winner - Whampipe

When they agreed to let us bottleheads into their $100 speaker contest, the PAS didn't know who they was messin' with.

After several abortive attempts at a single driver design in the Voight pipes that John Carey built, I decided to squeeze the Superwhamodyne array into the enclosure.

My previous attempt, outlined in last month's "etters" (oops), had ended up being a little tubby and midrangey.

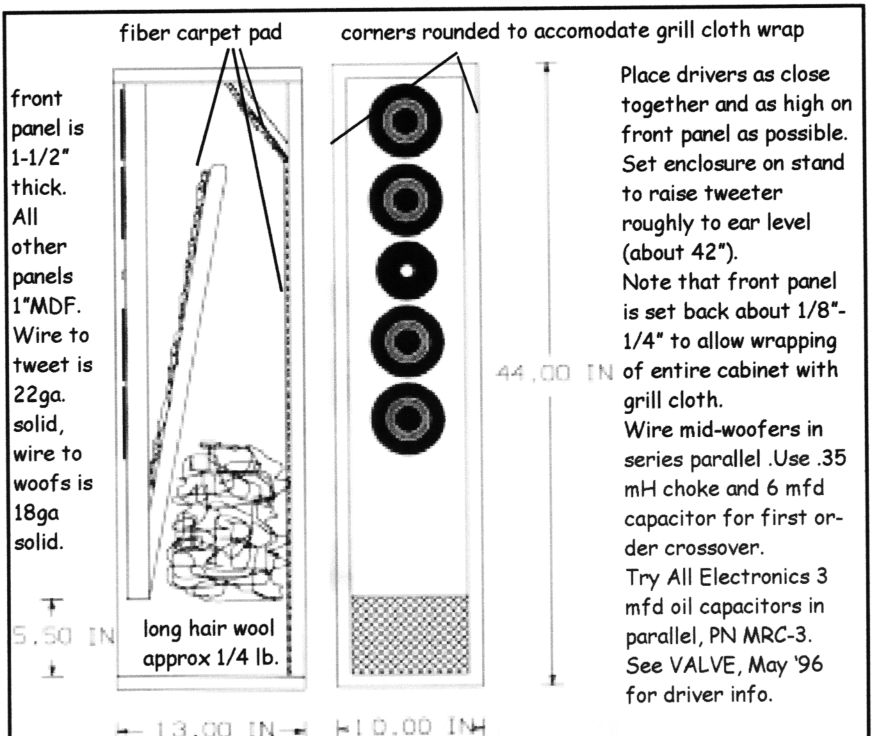
The solution to this problem was to give up on the cheap fiberglas and polyester damping materials and go for fiber rug pad on the back walls, and gen-you-whine long hair wool at the mouth of the pipe.

With this new damping in place the sound is tighter in the midrange, mellow, and smoooth. Horns now come up close and have proper weight. My only real complaint about the Whamo vented towers was the slight lack of this weight.

Bass is still a bit uncontrolled, so I use the Whampipes with the subwoofers in my system. I call this new Whampipe/Whamosub system the Hyperwhamodyne. I'm still optimizing the overlap between pipe and sub. See page 19 for my latest sub ideas. Don't panic if you just built the original vented enclosure, the difference between it and the pipe is fairly small, and can be made even smaller with judicious application of carpet felt inside the vented tower, in place of the fiberglas. The vented boxes are a bit more present and snappy, the pipes a bit more mellow and full.

Note in my drawing below that I did not specify the length of the internal divider. I forgot the dimension, and getting at it now would require tearing of several square feet ($) of grill cloth. The distance between the top of the cabinet and the top of the divider should be roughly the same as the distance from the divider to the front or rear panels, maybe 4". I think the gap may actually be somewhat bigger in my pipe, but this was originally optimized for a bigger driver.

The cross sectional area of this pipe is slightly small, relative to tapered pipe "theory". Read David Weem's articles on tapered pipes in *SB* to design a more "perfect" pipe.- Doc B.



winding your own single ended output transformer part two

by Jim Flowers

This month Jim discusses parasitics, and the physical layout of the transformer

Parasitics

The parasitic capacitance formed in a multi-layer coil of wire should be easy to visualize. Think of each winding layer as one plate of a capacitor. An adjacent winding layer serves as the other plate, and whatever is between these adjacent winding layers (magnet wire insulation, kraft paper, air space) is the dielectric. The windings will also form a capacitor to ground, to the core, to other windings, electrostatic shielding, whatever. Stray capacitance is a promiscuous fellow; it'll form a circuit with just about anything.

Capacitance is a function of the plate size, the dielectric constant of the insulation, and the distance separating the plates. Therefore, to reduce the interwinding capacitance, the winding layer width should be short, and thick insulation with a low dielectric insulation should be used.

The total self-capacitance of the primary winding is the sum of all the parasitic "capacitors" formed by each pair of adjacent winding layers. These capacitors are in series, not parallel; the total self-capacitance of the primary winding will be less than the value of a single adjacent layer pair.

For example, consider a 3000 turn primary constructed in two different coil layouts. The first layout is two layers of 1500 turns each (a long, narrow coil). The second coil layout consists of 30 layers of 100 turns each stacked upon one another. The second coil will have far less self-capacitance than the first (more than 400 times less). See references 1,2,3,4,6,9,11 for calculations of coil capacitance.

Leakage inductance may be harder to visualize. I think of it this way:
In the ideal transformer, all of the flux produced by the primary winding is intercepted by the secondary winding. In a real transformer, less than 100% of the flux generated actually reaches the secondary. This loss is represented by a parasitic inductance known as the leakage inductance. This leakage inductance occurs because of the physical distance separating the primary winding from the secondary winding. Windings in close proximity exhibit less leakage inductance than windings separated by a greater distance.

The bifilar winding technique uses two wires side by side (they are wound on the bobbin at the same time). Because the windings are separated only by the insulation on their wires, they are very close together, and therefore, there is very low leakage inductance. Unfortunately, this technique has limited use when a high potential difference exists between the wire pair for fear of arc over.

A popular coil layout method, the one that I used, involves inserting layers of the secondary winding in between layers of the primary winding. When layers of one winding (the secondary) is distributed evenly among layers of another winding (the primary), the leakage inductance is reduced because the windings are effectively closer together. This coil winding technique is called interleaving.

Consider two coil layouts for a transformer. In the first layout, start by winding 3000 turns of wire onto the bobbin forming the primary. Put on some required insulation, and then wrap 119 turns of secondary on top of that. In the second layout, wind 1500 turns of wire (half of the primary), insulate, wind 119 turns of secondary, insulate, and finish with 1500 turns on top of that (second half of the primary). The two half primaries will need to be connected together in series to form the total 3000 turn primary.

In the first layout, turn #1 of the primary (at the inner most layer of the coil) is far from turn #119 of the secondary (on the outer most layer of the coil). In the second (interleaved) layout, the secondary winding sits physically between the two half primaries. As compared to the first layout, the whole of the secondary winding is much closer to the whole of the primary winding - it will have less leakage inductance. This interleaving technique can obviously be extended to a greater number of divisions resulting in even less leakage inductance.

In general, reducing the self-capacitance of the winding involves separating the winding layers from each other while efforts to reduce leakage inductance require bringing the windings closer together. Efforts to conquer one problem tends to make the other one worse. As it turns out for the SE OT, leakage inductance is the larger problem, and greater efforts will be applied to its remedy.

Another issue that may not be obvious from the above concerns the total number of turns of wire required for the primary. All else being equal, a transformer that requires 5000 turns of wire will have greater parasitic losses than a transformer that requires only 2500 turns. The 5000 turn transformer will tend to roll off sooner in the high frequencies than the 2500 turn version. Transformers for high plate resistance tubes (211, 811) need higher inductance in the primary to maintain the low frequency response than do transformers for lower plate resistance tubes (2A3, 300B). More inductance implies more turns which implies more parasitic losses which (you guessed it) results in earlier roll off of the high frequencies. What this means is that high impedance, wideband transformers are considerably more difficult to design and build correctly than low impedance ones. This may also give a hint as to why good interstage

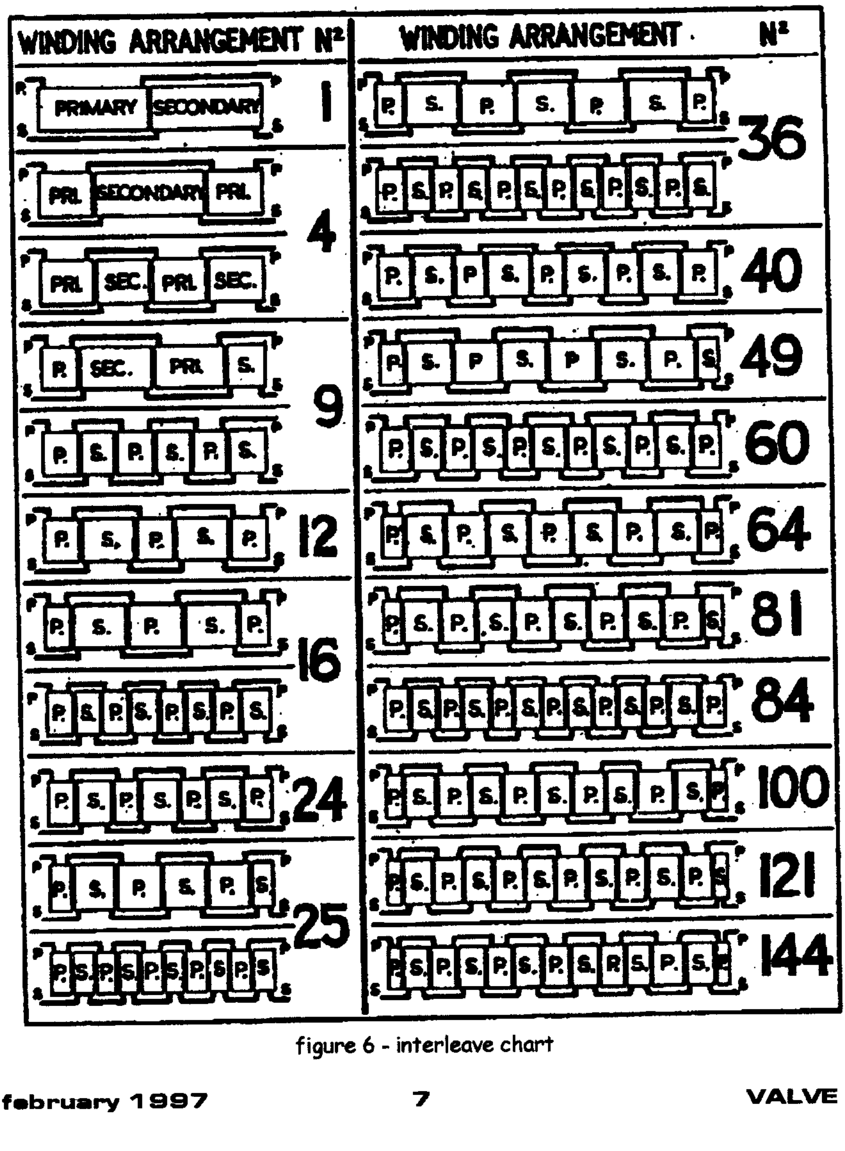


figure 6 - interleave chart

transformers are hard to come by.

Here's a thought for you bi-ampers out there. The OT for the bass amplifier doesn't need an extended high end. Wind all the turns you can squeeze in for lots of inductance and extended low end and parasitics be damned! What do you care when it rolls off? The OT for the other amp doesn't need an extended low end. Use fewer turns to better manage the parasitics resulting in an extended high end. Maybe if you get good at this, the OT rolloffs (high and low) can be incorporated as part of the loudspeaker crossover. I haven't tried this yet (or even thought it through completely), but isn't experimenting what this is all about?

Physical Design

Figure 6 shows coil layouts utilizing increasing levels of interleaving. This table of winding arrangements was taken from Crowhurst's excellent article on leakage inductance (see reference 5 in last month's installment). The drawings show cross-sections of only one side of the coil and also have omitted the bobbin. Notice the "N-squared" values assigned to each arrangement. Recognize that the leakage inductance improves (gets smaller) as "N-squared" gets larger. The two coil layouts previously described (leakage inductance examples) are the first two arrangements shown at the upper left of the table. This implies that a 4x improvement resulted from a simple splitting of the primary. The actual improvement also depends on the insulation thickness and a factor of 4 may not be realized. Crowhurst's article provides a chart for calculating the leakage inductance. See references 1,2,3,4,5,9,11 for calculations of leakage inductance.

Examine the two arrangements shown for N-squared equal to 16 (winding arrangements #7 and #8 counting down from the upper left). Layout #8 uses a more complex arrangement (more sections) than layout #7 to achieve the same leakage inductance factor. I think this is due to the improved symmetry of layout #7. The center section of the primary winding in #7 has twice as many turns as its outer sections; whereas, #8 splits the primary into four equal sections. The secondary sections in layout #7 are each sandwiched between two equal sections of the primary; i.e., one-fourth of the primary borders on the outside and another one-fourth of the primary (one half of the center section) snuggles up along the inside. The center section of the primary is equally shared by both secondary sections surrounding it.

The drawings in Figure 6 might appear inappropriate for the SE OT coil layout. After all, the drawings show equal cross-sectional areas for the primary and secondary windings, whereas the SE OT under design has 3000 turns for the primary and only 119 turns for the secondary. But this is actually correct. The secondary while having fewer turns will be wound with a much heavier gauge of wire. For a transformer, power in the primary equals power in the secondary, which means equal cross-sectional areas for equal power densities.

Winding the turns of wire onto the bobbin is done by two methods. In the layer winding method, each turn of wire is neatly placed next to (side by side, not on top of) the previous turn moving across the bobbin in one row. At the completion of the row, a layer of insulation is wrapped around it, and the next layer of wire is wrapped on top of this. (A spool of solder often looks like this minus the insulation of course). The random winding method is less orderly, think of a spool of fishing line. The winding shouldn't been done too haphazardly; a uniform buildup should be maintained throughout the winding process. Insulation is not used between layers (but still used between windings). Subsequent turns will fall into spaces left by the previous turns below.

I used the layer winding method. Although more tedious, I think it is mechanically and electrically more sound. Maybe one day I'll try a random wound version for comparison.

The window is the opening in the core where the turns of wire pass through. Unfortunately, not all of this area is available for copper. Approximately 25% or more of this space is taken up by the bobbin and insulation. (This is different from the true copper utilization factor sometimes referred to as "k" in the textbooks.) Figure 1 (shown last month) shows the dimensions of the available space for the coil build (0.706 inches by 2.125 inches).

Roughly one half of the available window area is used for the primary and the other half is used for the secondary.

Area available for each winding
=75% of (0.7 x 2.125) / 2
=0.558 square inches

For the primary, 3000 turns must fit into 0.558 square inches:

Area per turn of primary
=0.558 square inches/3000 turns
=0.000186 square inches

This available space per turn is shaped like a square. The circular wire diameter that fits in this square equals the length of one side of the square:

Primary wire diameter
= sqrt(Area per turn)
=sqrt(0.000186) =0.0136 inches

According to the wire table in Figure 7 (references 1,2,11) 28 gauge wire could fit. Similarly, for the secondary:

Area per turn of secondary
= 0.558 square inches / 119 turns
=0.00469 square inches

Secondary wire diameter
= sqrt(Area per turn)
= sqrt(0.00469) =0.0685 inches

Again referring to the wire table, there's enough room for 14 gauge wire. This size wire is rather stout and quite challenging to wind. Two or more paralleled, smaller gauge wires could be substituted as an electrical equivalent. A wire gauge rule of thumb: moving 3 numbers in gauge changes the copper cross-sectional area by a factor of 2; i.e., two 17 gauge wires in parallel are roughly equivalent to a single 14 gauge wire. Additionally, four 20 gauge wires in parallel add up to a single 14 gauge wire. These wire splitting strategies allow flexibility in the coil layout design for the secondary winding.

For example, one secondary coil layout consists of four sections each of 14 gauge wire. Each section is a single layer of 30 turns. These four sections are connected in series totaling 120 turns (30 + 30 + 30 + 30).

An alternate layout uses 20 gauge wire. The 20 gauge wire has half the diameter (one-fourth of the area) of 14 gauge wire. Bifilar winding of 20 gauge wire fits 30 turns in one layer just like the single layer of 14 gauge wire but with half the cross-sectional area. To get the same copper area requires another bifilar layer. Combining two bifilar layers in parallel results in four 20 gauge wires of 30 turns each all in parallel. This combination has the same cross-sectional area as the single layer of 14 gauge wire. Four of these double-layer sections are connected in series as before. Note that when connecting sections in parallel, it is important that each section contains the same number of turns.

Wire Size AWG	Circular Mils	Diameter (in) Single Insulation	Diameter (in) Heavy Insulation	Resistance ohms/1000 ft.	Weight lbs/1000 ft.	Random Winding Single Turns/in²	Random Winding Heavy Turns/in²	Layer Winding Single Turns/in	Layer Winding Heavy Turns/in	Layer Winding Layer Insulation (in)	Layer Winding Edge Distance (in)	Wire Size AWG
10	10384		.106	.999	31.7	86	75	9	8	.010	.250	10
11	8226		.094	1.26	25.2	108	95	10	9	.0100	.250	11
12	6529		.084	1.59	20.1	133	130	11	11	.0100	.250	12
13	5184		.075	2.00	15.9	162	159	12	12	.0100	.250	13
14	4109	.0658	.067	2.52	12.6	212	193	14	13	.0100	.188	14
15	3260	.0587	.060	3.18	10.0	255	248	15	15	.0100	.188	15
16	2581	.0524	.054	4.02	7.95	324	316	17	17	.0100	.188	16
17	2052	.0468	.048	5.05	6.32	405	394	19	19	.0070	.188	17
18	1624	.0418	.043	6.39	5.02	525	487	22	21	.0070	.125	18
19	1289	.0373	.039	8.05	3.99	641	596	24	23	.0070	.125	19
20	1024	.0334	.035	10.13	3.16	850	792	27	26	.0050	.125	20
21	812.3	.0298	.031	12.77	2.51	1055	982	30	29	.0050	.125	21
22	640.1	.0266	.028	16.20	1.99	1340	1210	34	32	.0050	.125	22
23	510.8	.0238	.025	20.30	1.59	1370	1260	38	36	.0050	.125	23
24	404.0	.0213	.022	25.67	1.26	1730	1550	42	40	.0020	.125	24
25	320.4	.0190	.020	32.37	1.01	2150	1940	47	45	.0020	.125	25
26	252.8	.0170	.018	41.02	.799	2990	2700	53	50	.0020	.125	26
27	201.6	.0152	.016	51.44	.634	3700	3550	59	55	.0020	.125	27
28	158.8	.0136	.014	65.31	.504	4680	4180	66	62	.0015	.125	28
29	127.7	.0122	.013	81.21	.401	5900	5180	73	68	.0015	.125	29
30	100.0	.0109	.012	103.7	.318	7500	6560	82	77	.0015	.093	30
31	79.21	.0097	.011	130.9	.254	9270	8090	91	85	.0015	.093	31
32	64.00	.0088	.010	162.0	.202	11400	10000	100	94	.0013	.093	32
33	50.41	.0078	.009	205.7	.161	14500	12500	113	105	.0013	.093	33
34	39.69	.0070	.008	261.3	.127	18800	16250	128	119	.0010	.093	34
35	31.36	.0062	.007	330.7	.101	24000	20800	144	133	.0010	.093	35
36	25.00	.0056	.0060	414.8	.0803	29650	25000	158	145	.0010	.093	36
37	20.25	.0050	.0055	512.1	.0641	37400	30900	177	161	.0010	.093	37
38	16.00	.0045	.0049	648.2	.0509	46700	39300	198	181	.0010	.062	38
39	12.25	.0039	.0043	846.6	.0403	62700	51500	226	205	.0007	.062	39
40	9.61	.0035	.0038	1079	.0319	[illegible]	[illegible]	[illegible]	[illegible]	.0007	.062	40

figure 7 - wire chart

he first coil layout consists of four layers while the alternate coil layout consists of eight layers. The ability to divide a winding into multiple layers helps make interleaving practical.

So far the secondary only has connections for a 8 ohm load. Often, an OT has multiple connections available for different loads. This is accommodated by offering multiple taps on the secondary winding. Depending on the series/parallel combination of taps chosen, the secondary operates as if it has a different number of turns.

Consider the secondary coil layout above that used four sections of series connected 14 gauge wire. If only two sections are series connected (30 + 30 = 60 turns) and this pair is paralleled with the other two sections connected in series (30 + 30), then the total winding becomes a 60 turn secondary ([30 + 30] // [30 + 30]). Since the original 120 turns was for an 8 ohm load, then 60 turns reflects a 2 ohm load.

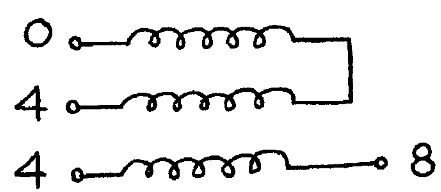


figure 8 - three layer secondary

Figure 8 shows a 3-layer secondary section consisting of three layers of 40 turns each. When all three layers of the section are connected in series (jumper the 4 ohm terminals together, speaker load on terminals #0 and #8), the 120 turns reflect an 8 ohm load. Connecting the speaker load to terminals #0 and #4 exercises only 80 turns of the secondary reflecting a 4 ohm load (3.6 ohms actually). When connecting sections in series, it is important to observe correct polarity to avoid bucking the windings.

With this secondary coupled to a 3000 turn primary, the transformer could be identified as a 5 kohm OT with a 0 - 3.6 - 8 ohm secondary, or a 5.6 kohm OT with a 0 - 4 - 9 ohm secondary.

Another consideration is the ohmic resistance of the wire that make up the windings. Less resistance is better, but that means thicker wire. Thicker wire might not fit in the allowed space without reducing the total number of turns. Increasing the allowed space requires different laminations having a larger window area.

A goal for the ohmic resistance of the secondary is one percent of the load it drives. Too much resistance adversely affects the insertion loss and damping ratio. For an 8 ohm secondary, the goal is 80 milliohms or less. The wire table provides resistance per foot for each gauge of wire. To calculate the length of wire in the winding, multiply the number of turns by the average length per turn (ALT). Determine the average length per turn in the same way that the MPL was calculated.

ALT = 2 x Tongue Width + 2 x Stack Height + 4 x Coil Build

Substituting:

ALT = 2 x 1.5 + 2 x 2 + 4 x 0.7 = 9.8 inches

Because the shape of the windings is more of a rounded rectangle, an alternate formula is sometimes used:

ALT = 2 x Tongue Width + 2 x Stack Height + pi x Coil Build

Substituting:

ALT = 2 x 1.5 + 2 x 2 + 3.14 x 0.7 = 9.2 inches

And as if that wasn't enough, according to a laminations datatable (see reference 3), the average length per turn of a 2 inch high stack of EI-13 laminations is 9.63 inches.

The resistance of 120 turns of 14 gauge wire at 9.63 inches perturn and 2.52 ohms per 1000 feet:

Rsec = 2.52 x 120 x 9.63 / 12000
= 0.243 ohms

This value is three times greater than the stated goal. The wire's resistance is a function of length (turns and length per turn) and width (gauge). To get to 80 milliohms, the secondary can have three times fewer turns, or three times as many sections to add in parallel. Using only 120/3 = 40 turns in the secondary requires the primary to be cut to 3000/3 = 1000 turns to maintain the same transformer ratio. The primary inductance is now lowered drastically. To make up for the lowered turns count, the core cross-sectional area can be increased by adding more laminations to the stack. The larger cross-sectional area results in a greater length per turn which partially offsets the decrease in winding resistance achieved by using fewer turns.

To get a three fold increase in wire gauge will require three times the allotted window area reserved for the secondary wiring. Whether this is accomplished by using thicker wire or more sections in parallel, the window must be larger, which means a larger set of laminations. It is not good practice to increase the area used by the secondary at the expense of the primary.
The ohmic resistance of the primary winding contributes to the insertion loss as well. If the insertion loss is to be split equally between the primary and the secondary, then the primary winding resistance should equal the reflected secondary winding resistance. The Radiotron Designer's Handbook suggests a primary winding resistance of twice that value. (I don't understand why it should be twice the value.) Based on the ambitious target of 80 milliohms of secondary winding resistance, the primary winding resistance should be:

$R_{pri} = 2 \times N^2 \times R_{sec} = 2 \times (25.3)^2 \times 0.080 =$ 102 ohms

If both targets are met, then the total loss due to winding resistances is only 3%. When 97% of the power passes through the OT, the insertion loss is only 0.13 dB.

Realistically, the maximum copper insertion loss should be well below 0.5 dB. While half a decibel doesn't seem like much, this is equivalent to a 10% power loss that only serves to warm up the OT. In other words, only 9 watts actually reach the loudspeaker from an output tube pumping out 10 watts.

Also, the copper losses were ignored when the turns ratio was determined. This results in an impedance error equal in magnitude to the power loss. The turns ratio will appear higher than when measured under the no-load condition.

For a point of comparison, resistance readings taken from several commercial SE OT's reveal an approximate range of 120 ohms to 400 ohms in the primary, and 0.1 ohms to 0.8 ohms in the secondary. Remember that these are guidelines and design goals.
If an OT that you are presently using measures outside these ranges and still sounds good, then don't sweat it. Don't presume the worst without first taking a listen.

Either way, lowering the insertion loss results in a larger transformer. A larger transformer coil will have greater parasitics causing an earlier rolloff in the high frequencies. Compensating for the rise in parasitics requires a more complex coil which could mean more interleaving which adds to the total insulation thickness in the coil which requires a larger window, ad nauseum.

Keeping losses low and fidelity high in the SE OT requires a large, carefully designed, and painstakingly assembled transformer. This becomes even more critical when both the transformer impedance and dc bias current go higher. Good engineering practice comes at a price. This is another reason why the best transformers cost several hundred dollars or more.

Well, we're about halfway there, bottleheads. Next month we'll pick up with insulation, choosing a winding layout, and discussion of building the coil.

Doc B.

Robin Watson and the myth of the 301

Dear Dan,
The latest craze to hit my brain has been to aquire an old turntable. Due in no small part to helpings of SP magazine and your Thorens ravings. So I decided to write off to this company in England - Technical and General. Who sent me this reply which I thought was very honest, down-to-earth and frankly, a bit surprising.

Robin Watson, Tokyo

"Dear Mr. Watson,

Thank you for your enquiry and apologies for the delay - the works were closed for the annual winter holiday.
We regret that we are unable to assist as we do not supply complete turntables as our specialty is the supply of spares and advice and instruction on keeping the classic turntables in good order.
Frankly, unless you are a collector, we don't know why you should worry about trying to get a Garrard or an early Thorens as you would probably be as well, if not better, served by a more up-to-date unit fitted with a decent cartridge.

P.T.O.

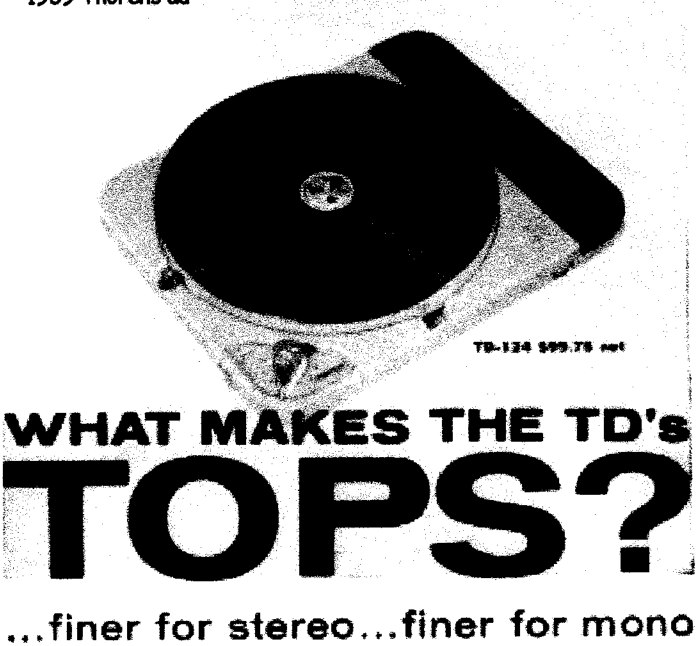
"This may seem like heresy but we have been in this business for many years - we were selling the Garrard 301 when it was the latest thing out from the Swindon factory - and our approach is that, if you have one of these machines then don't get rid of it and we will help you keep it running to its original peformance but forget all the nonsense in the magazines about the so-called superior sound quality and remember that people are trying to create myths and mystiques with a view to making a sale of some sort.
To put it in car terms - if you have an old Bentley or Alvis in your garage then look after it and enjoy it, but for normal transport you'd be well advised to get a Ford or a Nissan, etc.
Hoping the above might be of some interest and assistance.

Sincerely,
(illegible signiature)

"PS Sorry if this seems like a "put down" - it wasn't meant to be, but it's as well to tell the truth some times."

Wow. Must say that I agree. I'd like to clarify here that I raved about the Thorens specifically as a great turntable for 78's. I've had two TD124s through the years (owned one of them since I was 18), and the one I have now plays second fiddle to the big old Denon DP 6000, which whups it on bass tightness, flutter, and that ever elusive quality of pace. I will be doing some more serious Ttable diddling in the next few months, as I try different arm and cartridge combinations (considering a Koetsu Black/ SME 3009/DP 6000 combo for

1959 Thorens ad



my next trial), and the Thorens will get it's crack at being number one again during these trials. But I don't guess this will happen.
My first observation with all this table and arm swapping is that the DL 103 is much better on the top end on the Denon table/ Denon arm combo than it is on the TD 124 SME 3009 combo. It has been suggested to me that the very first mod to do to an older SME is to get rid of the original tomarm wire and inteconnect. I shall try rewirng and see where this leads me.
Only one successful TD 124 mod has been thrown my way lately. Remove the aluminum top platter and replace it with a glass "mat", cut and drilled to fit by your local glass cutter. Supposed to cut down noise. - Doc B.

Another satisfied customer

Dear Dan,

Thanks for the S.E.X. speaks. Compare well with anything I've done. I'm running them with the Madisound 1052 DVC in a 23/75 bandpass alignment (1.1/1). Seems to match perfectly. I'm driving the setup with a baby Adcom (savin' for S.E.X.) and it makes mama want to rock and roll.

Alan Muyskens, Eureka Springs, AZ

OK campers, here's a tweak for the stock SEX speaks. Cut the dust cover off the just top driver on each speaker with a single edge razor blade.

* *Note: My insurance agent tells me that I need to say that you could accidently kill yourself fooling with a razor blade, so don't try this. By the way, I don't have any money to give to your bereaved relatives.*

Seems to bring the top end up and ease the midrangeyness (how's that for audiophile gibberish) a bit.
Wanna get really crazy? Try taking the cap from a marking pen, or some other phallus shaped object of the right diameter, and glue it to the pole piece for a phase plug.

* *By the way, my insurance agent wants you to know that you could accidently kill yourself with superglue too, so don't try this either.*

If you do the cutting carefully, and you don't like the sound, you can knock the pen cap off, glue the covers back on, pick up the pen, and write me that my mods suck.

bottlehead esoterica

Dear Dr. Bottlehead,

Please renew my subscription for one more year. The first few issues (of 96) really turned me off, as I thought the material too esoteric to be useful. You know... 6DN7 amplifier and S.E.X.

Actually I must thank you for introducing me to the 6DN7. I experimented with it as a driver for a VT-211 circuit in an "Ongaku" style amplifier. Obtaining 260V peak to peak into the 211 grid takes a very macho tube. After extensive listening, I settled on a paralleled 6BL7 as the 211 grid driver for sonic reasons. The 6DN7 provided the best electrical performance. More recent issues have been of greater interest.

Enclosed is a schematic of my most recent project using Bartolucci output transformers. I feel the Bartoluccis sound hard in the upper registers compared to the Audio Note transformers. Anyone have experience with this brand of output transformers? I am somewhat disappointed in the sonic results of this project, altough the amp is powerful and has great transparency. In the last two years I have assisted with or built four SE projects.

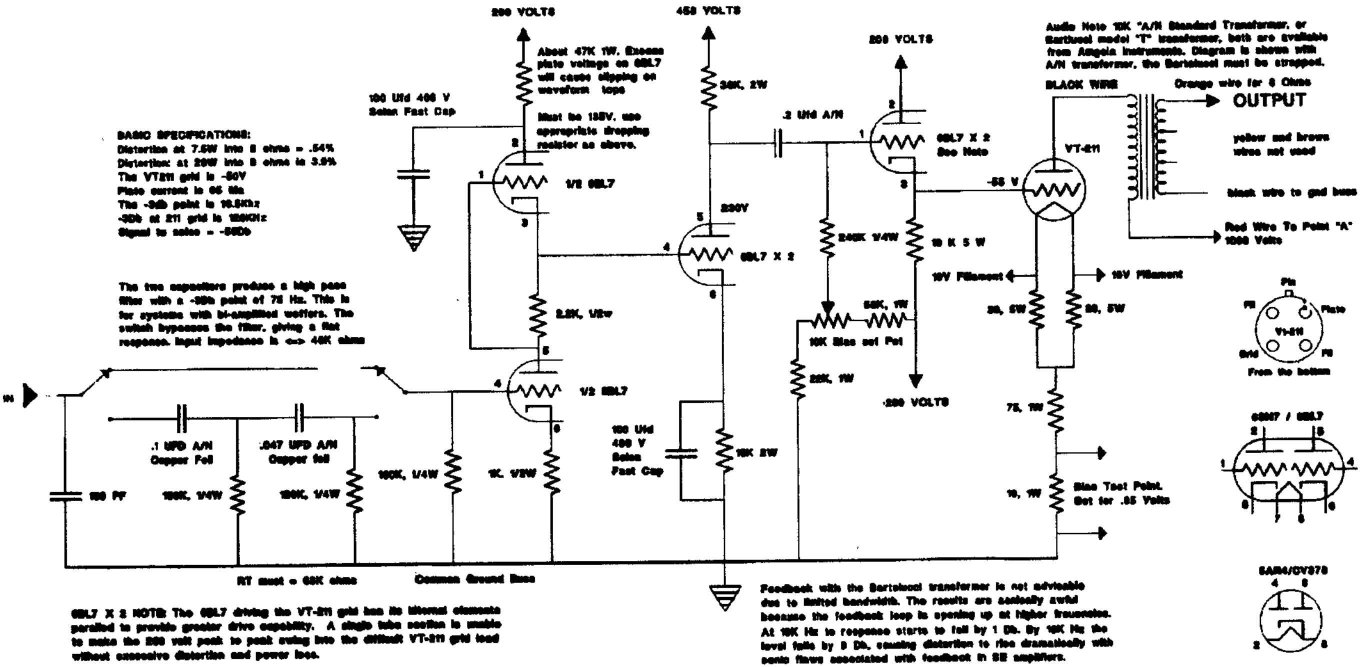
I would like to know more about transformer interstage coupling, evaluations of output transformers, design philosophy, discussions about feedback, interviews with designers, efficient loudspeakers with big sound, discussions of components and their appropriate use. I acknowledge that this is a big request.

I have an idyllic fantasy of your work: mossy homes deep in the trees with glimpses of Hood Canal and a Labrador retriever asleep on the front porch. It must be a great evironment for maintaining friendships and contemplation.

- Robert Henke, Los Angeles

Don't forget kids screaming in the background, the drain in the basement backing up again, and, uh, well, OK, we do have a bald eagle's nest in the backyard. - Doc B.

VT-211 "ONGOKU" USING 6BL7 TUBES



ROBERT HENKE 6/96

DAC attack

By L. Dean Moore, Audiogenics

This is the first in a series of articles, which will appear in these pages, covering the operation and modifications of a commercially available DAC or Digital to Analog Converter. The purpose of this series of articles is to share with the readers of VALVE the approach and associated techniques I have utilized as I have endeavored to improve the musicality of this DAC. Although the many of the component values utilized in the modifications are specific to this particular DAC, this series of articles will be presented in a fashion which will allow those who choose to endeavor as I have to follow the approach and utilized the associated techniques to arrive at the appropriate component values to modify any digital front end of similar topology. Furthermore, through communique with the esteemed editor of this publication, we have decide that the presentation of this material should be done in such a way that will allow both those who are inexperienced in electronics and those who have achieved some degree of knowledge or understanding to gain from this series. Therefore, as you read, please bear in mind that I am attempting to write for a rather broad audience.

Before we get started there are a couple orders of business which I must attend to. First, I will not specifically criticize individual digital products because I am not privy to the goals of these designs and, as a result, I will not state which particular DAC I have modified. This is in essence, a professional courtesy. So, please, DO NOT ASK. Second, much of what you will see is in large part, not audiophile approved; but, maintains a dictum of solid engineering fundamentals which are applied in a systematic fashion. Finally, do not expect any one of these modifications in and of themselves to transform your particular unit; but rather, follow the approach and utilized the techniques in a systematic fashion presented in this series of articles.

Some Midnight Oil

As I went out to purchase my first "real" digital front end, I was armed. I had read and understood the discussions of how jitter affects the sound. I had followed and studied the progression of the "latest and greatest" chip sets. And, most of all, I had saved some money for doing so. Although, as I later discovered, evidently not enough. I listened to everything, even took some home to try in my system. What I heard troubled me. Generally, there were differences between chip sets; even though, different DACs sounded different in spite of the fact that used the same chip set. Moreover, some DACs with what I believed to be inferior chip sets out performed some products with the latest chip sets. What I heard, could not be explained by jitter alone. Finally, I selected a DAC with a current chip set contained in what I considered many state of the art products and began to live with the selection. This lasted about 5 CDs. I was still troubled. I had to open the DAC up to see what made it sound different than the state of the art DAC, which I couldn't really justify purchasing. As I examined the circuitry with a spectrum analyzer, what I found scared me to death. Most of all, there was noise everywhere. Even with my limited knowledge of DACs, there were a variety of things that I could do to improve what I found. Following are a couple of the first things that should be done in an effort to reduce noise in a DAC.

Keep The Noise Out

It only stands to reason that the easiest way to reduce the noise floor of a DAC is to prevent any noise from getting in the DAC in the first place. The first line of defense against such noise is power supply EMI filtering. Another words, get yourself a pi filtered IEC socket and install it, if you don't already have one. Corecom makes a good quality unit which is readily available from a variety sources. This is the only component in the whole DAC whose sole purpose is to provide EMI filtering. My DAC without this device turned out to be a real nice little transmitter. If your DAC sounds better without the EMI filter, then it could very well be that the removal of the EMI filter generates so much radiated EMI the noise floor of the system rises and masks the signal correlated noise floor contamination generated by other components. However, install the filtered IEC socket anyhow, the effectiveness of other modifications in this series which address this problem depend on the inclusion of this device. Remember, this is a systematic approach.

Obviously, the next place for EMI to find its way into the DAC is the digital cable from the transport. The whole presumption of this circuit is that the transmission line is based on 75 ohm characteristic impedance. It would also be nice to have a little bandwidth and good connections too. This means BNC connectors and cabling which have a characteristic impedance of 75 ohms. No phono plugs, 75

Introducing Brooklyn.
Push-pull transformers that sound single-ended.

Recent developments have led us to an even better sound! If you've been waiting to try a Brooklyn transformer, wait no longer. This month we are incorporating improvements in the core construction that give even better bass response, making Brooklyn transformers the best entry level push pull transformers going.

PART #	PRIMARY IMPEDANCE	POWER LEVEL	MAX. PRIMARY DCMA PER SIDE	DCMA UNBAL	RETAIL EACH
B14	12,000 CT	10W	40	4	$100
B15	10,000 CT	20W	50	5	$125
B17	9,000 CT	30W	50	5	$140
B18	8,000 CT	15W	45	5	$120
B20	6,600 CT	30W	70	7	$140
B21	5,000 CT	20W	80	8	$120
B23	4,000 CT	50W	100	10	$150
B24	3,000 CT	15W	75	7.5	$125
B27	1,500 CT	30W	150	15	$135

Recent measurements reveal the B24 response to be -.35 dB @ 20Hz and -.8 dB @

Note: Above units available with Ultralinear taps for an additional $6.00 per unit
Secondary impedances far all units are 2,4,8,12 & 16 ohms.
Guaranteed minimum frequency response is +/- 1 dB, 30Hz to 20 kHz.
All units supplied with vertical bell end caps.
All prices herein are special introductory - prices subject to change without notice.

Brooklyn, P.O. Box 967
Cherryville, PA 18033
(215) 288-4816

Where Push-Pull meets Single-Ended

ohm or otherwise. If you don't believe me on this one, just test a phono plug on a network analyzer before you argue with me. Trompeter and AMP make good quality BNC connectors which are available from Mouser (1-800-246-6873), Digikey (1-800-346-6873) or Newark (1-800-298-3133), to name a few. I like the wrench type connectors for the cable. Another tip here is that certain chassis mount BNC connectors are available with a surface mount capacitor between the body of the connector and the panel which decouples the braid directly to the panel. Depending on your application, you may be able to take advantage of such a connector. Be sure you use a good quality double shielded 75 ohm cable too. I chose Canare, which has excellent shielding at a reasonable cost. While you're at it, check to see that a 75 ohm terminating resistor was used on the circuit board. You may be surprised to find that some other value was selected in an effort to improve the impedance match with other components which were selected. If so, replace with a 75 ohm resistor, surface mount if possible, now that the correction has been made to the transmission line.

Summary

Now that measures have been taken to keep radiated noise out of the DAC, let me tell you a little bit about what to expect next in the series. Next month, I'll present a basic DAC topology, address noise in power supplies and local bypasssing of all active components in the signal path. I hope that you will continue to follow along. I would also suggest that it might be helpful to solicit a copy of the schematic of your respective unit from the manufacturer. For those of you who have questions which you're unable to resolve on your own, you may e-mail them to me at ldmo@cbmaila.lucent.com. I will address these questions in summary as well next month.

L. Dean Moore
Audiogenic

Try All Electronics for EMI filters. A good selection at diver's prices - 1-800-826-5432. Doc B.

a couple of ideas

In playing with integrating the new Whampipes with the existing Whamo subwoofers, I came across a couple of interesting results.
The first step was to build another pair of S.E.X. amps so I could biamp the system.
The main pair of amps was left in the configuration described last month, to run the towers, with only a change of value of the driver to output .47 mfd coupling cap to create a 100 Hz high pass filter. Calculations showed the value ought to be .05 mfd for 100 Hz rolloff, but reality stepped in, and sweeps run on the HP signal analyzer showed .01 mfd to be the closest match (-3dB@103Hz). Surprisingly, a Vitamin Q gave the best sound.
The amps for the subs were built with no feedback and the stock output transformers, which gave a gain of approx. 18 db, like the tower amps. To get the 16 ohm trannies to be happier with the 8 ohm subs, the 1K wire wound dropping resistor after the second filter cap was moved to a position between the rectifier diodes and the first filter cap, to lower power supply impedance.
A 500 mfd cap was paralleled wth the second (after the choke) filter cap.
The amp also received the LED cathode CCS treatment, and a wirewound 200 ohm output stage cathode resistor, with a 1000 mfd Black Gate cathode bypass cap.
I did not incorporate a low pass filter into this amp, as I had the gain matched to that of the tower amps. Instead I put some effort into rolling off the subwoofer's response as hard as possible by mechanical means.
The fiberglass lining the sub was ripped out, and the 3/8"-1/2" thick carpet felt that was used to line the Whampipes was applied to every interior surface of the subs, except the bottom panel.
The difference in top end rollof was very obvious, much less HF info now comes out of the subwoofer ports. This matches very nicely with the "beefed" upper bass of the Whampipes.
An interesting final observation:
I found the response of one sub was +10 dB @ 42 Hz and -10 dB @ 57 Hz!. Sounded boomy, as we have noticed the last few club meetings at my house.
The system now sits one foot forward from its old position, and woofer response is 37- 110 Hz +- 5 dB (there is still a slight peak at 100 Hz). The bass is rich and smooth.
This Whampipe/Whamosub biamped system makes me quite content! *Doc B.*

cravings

For sale:

- Premier FT-3k tonearm, with PIB and DB alignment protractor. Exc. $160
- VPI-19Jr., plinth (drilled for FT-3K), platter/bearing, Sorbathane suspension, dust cover and motor cover - add base, motor, and pulley for full 19 Jr. $150
- Scott 330D tuner $100
- Scott 130 preamp $75
  both with leatherette cases

All plus shipping.
Frank, 609-561-2086 7pm-9:30 pm EST

Wanted:

- Radio & TV News, 1950-1960
- Schematic for Bell and Howell Filmosound 202

Greg Izzi, 360-683-1744.

For Sale:
Precision Fidelity C-7 preamp. 12AZ7 phono, passive line stage, dual mono volume pots, nice stock shape. $175.
Doc B. 360-697-1936.

For sale:
Magnequest tapped inductors - unused $100 the pair. Nick Smurro, 916-663-9570.

hey, what happened to the Brooklet?

You folks who have been patiently waiting to hear more about the Brooklet circuits will now be asked to be patient a bit longer.
While the original circuit, with its antique output transformer sounded great, we've been having problems with the other variations we've tried.
Dave has been working to get the original circuit to perform with a Dyna MkIII output trans, and Paul is working up a circuit that will allow the switching in/out of interstage trannies vs. the tapped chokes, and input trannies vs. direct input, all running through the Brooklyn B27 output transformer.
If you are absolutely chomping at the bit to try some of the Brooklyn iron and the Magnequest tapped choke, your best bet at this point is to build a Brook 12A knockoff, with real live 2A3s.
Check out the specs for the Brooklyn B24 trannie in the Brooklyn ad this month. Damn good for an "entry level" trannie! This trans and the B21 should be great for PP 2A3 applications.

march

Well, the deal with Mo Fi has been indefinitley postponed.
That's OK, as I think it's time for one of our "run what you brung" meetings.
So on March 2, 12 noon, bring your latest project to the old clubhouse. We'll have the HP analyzer available for frequency and THD measurements, and lots of coffee.

news from Mikey

Mike Lefevre called to give me the latest on some pretty wild products he's releasing:

- The Brooklyn B7, a 15K single ended to 500 ohm center tapped transformer, rated -1dB @ 20Hz and 45kHz. This is a teeny 0 mA DC unbal trannie, requiring cap coupling. Suggested usage is as a preamp output, using a 6J5, 6P5, 1/2 5687, 56, 76, etc.
- If you have fallen into the "caps is poison" league, you can get the B8, same ratio, but air gapped and rated for 8mA DC unbal, with a lower -1dB point estimated to be between 40-60Hz.

If you heard the nifty cap coupled output SE amp running Bruce Edgar's horns at CES, you'd be willing to try some parallel feed (cap coupled output transformer) circuits. To do these you need a beefy inductor to load the plate of the output tube, since the cap coupled output trans no longer does this.Why cap couple the OPT? Because the output trans now has no current running through it to saturate it, and you can do cool stuff like using nickel cores and interleaved lams, which opens the door to killer SE bass with magnificent inner detail.
Yes, you need a good coupling cap, but there are Black Gates and really nice polypropylene in oil caps worthy of trying these days.
And of course you need the plate load inductor and the cool output trans.
Mike has 100H @ 10mA, 100H @ 20mA, and best of all, a 50H @ 60 mA (read 2A3 and 300B, folks) inductors coming out for plate loading applications.
And we are getting ready to try the coolest looking nickel core, and iron core TFA-204s you've ever seen, for parallel feed circuits with these inductors.
Give me a call for more info on these slick new toys.

Doc B.