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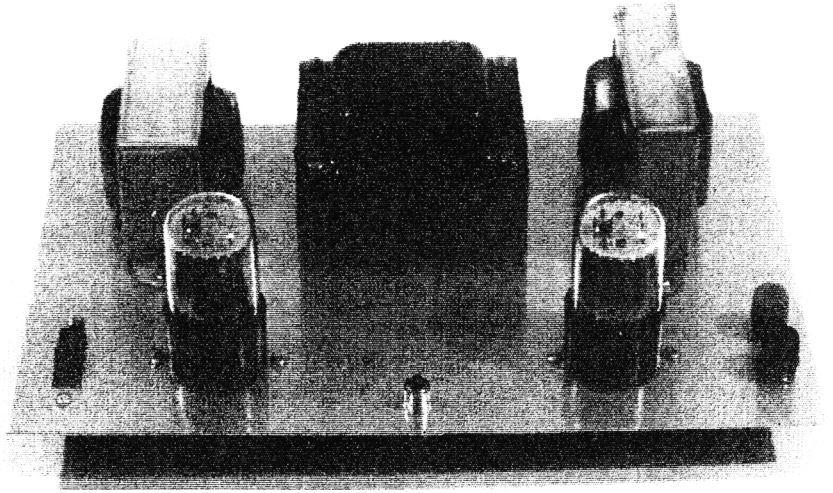

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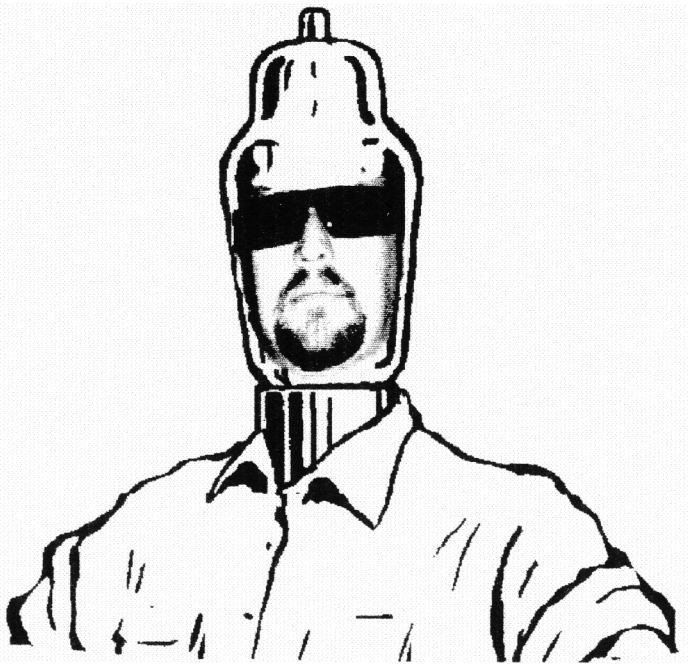
VALVE

in this jam packed, action filled issue:

the Iron Maiden and the Brookson
John Levrault's 5687 linestage
TQWT - tapered quarter wave tube
Baby O. mods, S.E.X. changes, SGS amp stuff
more PP6DN7 fun
investigating Harmonic Cancellation
A2 anyone?
cool Websites



If this man asks you to "Hold this wire," run away,
and tell your parents, your teacher, or a grown up you know...

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VALVE

the monthly magazine
for tube audio eXperimenters

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editor's thing

Yo, bottlebuds.

Been getting a record number of phone calls from all youse enthusiastic vachackers this month.

This charms and coddles the ego greatly, but alas, I must request a few ground rules for such repartee:

- Please limit the calls to 9am-7pm Monday through Saturday. Believe it or not, I may not seem overly enthusiastic hearing about your latest find at the swap meet at 10:30 on Sunday night.
- The guys who do best with me have a list of questions to ask. I answer the best I can, and the conversation and phone bill are both cost effective.
- My preference is to discuss nuts and bolts tube audio, what sounds good, how it works, etc. My attention wanders when someone calls me to rag on somebody else in the industry.
- I am more than enthused about answering questions concerning the S.E.X. kit, the Whamos, and stuff authored by me in VALVE. I may not have the information you seek concerning an article written by someone else. You may have the best luck getting an answer to that type of question by writing a letter to VALVE.
- The most thoughtful answers I give are by e-mail or fax. Subscribers always get a higher quality answer than non-subscribers!

I hope no one feels singled out by this stuff. I am not thinking of particular individuals in regards to any of these requests, and I intend to stay as accessible as possible as we grow. I do answer messages left on the anwering machine. It may be a while before I get back to you, but I will respond.

And if you live in, or are visiting the Puget Sound area, my offer is always open for you to stop by. Just give a call ahead of time to be sure I'm going to be there when you want to come by.

There's new stuff coming through the old listening room all the time. Right now I've got a Tango interstage coupled 300B amp here (nice!) and a new Marantz CD63SE CD player ("Jeezus", you say, "Bottlehead bought something brand new! I better go out and buy one without even listening to it!")

Thanks in advance, music in arrears,

the five stages of becoming an audiophile

from member Steve Martin at Antique Electronic Supply

DENIAL: "A 'friend' of mine is looking for 2 Telefunken 12AX7s. He wants smooth plates, with the diamond on the bottom - whatever that means."

ANGER: "Yes, gold pins. Open every box and look. Yeah, I'll wait, but you should have an 800 number."

BARGAINING: "Do I get a discount if I buy the only two you have?"

DEPRESSION: "It's imperative that you check your shipping records... the UPS truck just drove right past my house!"

ACCEPTANCE: "Those tubes accentuate a disciplined, firm lower end. The midrange is confident without being pushy. The highs are sweet and creamy, yet nutritional."

two hot and cheap CD players

Got the chance to listen to Gary Dahl's 'Stan Warren modified' TEAC PD-1200 player against my new Marantz CD-63SE. Wow, both of these give bang for the buck !
The Marantz has a very sweet top end and upper midrange, a bit less bass definition and speed, and a digital output.
The "Stan" player gave a bit more dynamic presentation, was a bit more aggressive on top, and surprisingly, is a carousel player.
This made the CD-63SE more suited to the brighter presentation of the Ultimate S.E.X. amps, and the Stan player more suited to the softer bass and warmer treble presentation of Gary's IT coupled 300B amp.
Gary, Tom Vetromile and I agreed that the differences were subtle enough to make either machine a great choice for the money.
The CD 63SE came from Nuts About HiFi, and lists for $499 (definitely $100 better than the CD63MkII). Stop by on a weekend and ask for VALVE member Gill Loring to give you a demo.
The Stan Warren modified TEAC is about $500. Check with Stan about availability, as he has a very limited supply of PD-1200s. Stan can be reached at 541-344-3696

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.

What we hope to have in 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, a choke loaded PP 6080 amp, transformer coupled PP 6DN7 amp, and a whole lot more!

the Iron Maiden and the Brookson

By Paul Joppa

Dan-

At the September meeting, we saw the ad for the new "Brooklyn" line of air-gapped push-pull output transformers. One that caught my eye (and yours!) had a primary impedance of only 1500 ohms CT. We both thought immediately of the 6AS7G/6080 family of twin power triodes, which would be better suited to this value than the 3k to 5k usually available. (Yes, Hammond has some at 1900 ohm CT which might also be suitable, though they are huge, not cheap, and not air-gapped.) I couldn't resist the temptation to work up a couple circuits for this combination, even though I won't get around to trying them for a while (Dave and I are still working on the "Brooklet", I'm thinking of a "Brookson" variation too). If anyone tries these, I'd sure like to hear them, though!

The first step is to select an operating point for the output stage. I haven't yet worked out push-pull triodes to my satisfaction, but my present rule of thumb is plate load equals 0.4 times (plate volts / plate current), per tube. That works out to 150 volts at 80 mA per triode for a 1500 ohm CT transformer and 12 watts per section.This is a pretty low impedance, which among other things helps keep the high frequencies safe from capacitive rolloff. The B.A.T. people like low impedances too; they even wrote a white paper on it. Looking at the plate curves (Eric picked up a Tung-Sol manual which has the data at the swap meet - thanks, Eric!), the grid bias is about -60 volts.

Power supply can be a problem, you can't use just any surplus transformer to get 150 volts at 200 mA (400 mA for a stereo pair). Also, few rectifier tubes will handle the current, and they will be pretty inefficient. The simplest idea I came up with is an isolation transformer with solid-state rectifiers. A cap-input filter would give 150 volts. You'd need a separate bias supply, but that amp could be pretty efficient. An alternative might be two isolation transformers, or a 240 volt converter transformer. Used with a choke-input filter, you can get 210 volts for cathode bias.

My wildest circuit uses the first option. I call it the "Iron Maiden" (see diagram). There are 8 big chunks of iron - per channel. Sort of a poor man's Marantz Project T-1. Impedances are very low throughout the circuit, it should handle overdrive and grid current easily, and *there are no capacitors in the signal path.* Of course there are some potential negatives: 1) the spec sheet does not approve of fixed bias for the 6AS7G; the transformer drive should help that but be sure the bias supply is on before applying plate voltage (there's an LED to help), 2) you need to cherry-pick a balanced 6AS7G (or find a 6520?), and 3) with all that iron in the signal path, you can't expect the greatest bandwidth in the world.

Antique Electronics has two PP-PP interstage transformers fairly cheap; I chose the cheapest one (PT-20D89) of course, partly for the very low 7k ohm CT primary impedance. This calls for a very low plate impedance in the driver tube. A pair of 5842's (plate resistance 1800 ohm) would be perfect, but it seems a waste to build a 5-w amp just to drive a 10-w amp so I suggest a 6922 or 6DJ8 (2800 ohm). You could use the other transformer, PT-20A14 at 15k ohm CT, which matches well with anything up to 4k ohm plate resistance. I chose not to, partly because to use all the secondary means a high output impedance, and using the taps risks more leakage inductance and more loss of highs. Perhaps some VALVE member has another suitable transformer in their junk pile. The driver tubes are run at 10 mA per side, so there's plenty of drive power available to push some grid current if needed for transients. The fixed bias means freedom from operating-point shift when grid current is drawn, which is always a consideration with cathode bias. The transformer interstage also means the driver can generate plenty of drive voltage, which the very low-mu 6AS7G really needs.

The input transformer is the AES nickel-core unit that Dave has used so successfully with 6DN7's (see his article elsewhere this issue). You may need to eXperiment with the output loading resistors on both input and interstage transformers to optimize the response at high frequencies.

The test points TP1 and TP2 are for bias adjustment and tube selection. Set bias for 0.8 volt at TP1 or TP2, then check the voltage between them. If it's more than 0.15 volt,

then the DC imbalance exceeds the 15 mA spec for the output transformer and you need to try another tube. If the output transformer were not air-gapped, this balance would be much more critical, probably making this circuit impractical. Check the bias and balance periodically, especially for the first 100 hours on the output tube. And remember - never turn on the B+ until you see the bias supply LED glow!

Of course the truly tweaky will wire up a 60 volt battery for bias supply. If you do, just use a shared 180 ohm cathode resistor for the 6922/6DJ8 triodes; they want about 3.7 volts which doesn't match any battery.

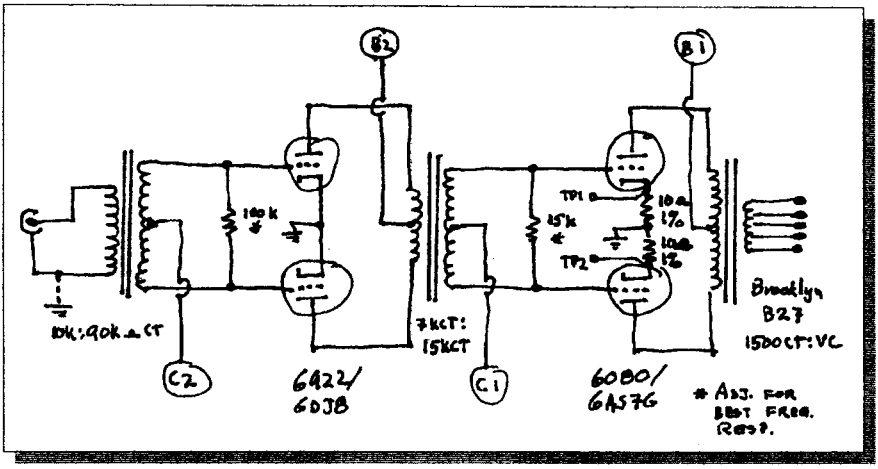
My second design is a little more conventional, basically a Brooklet variation I call the Brookson. It uses cathode bias and a 210 volt power supply. Even with the extra driver supply voltage available, the 6AS7G needs a lot of drive voltage, so I've used the tapped choke driver load. Of course you can keep

(Continued on page 8)

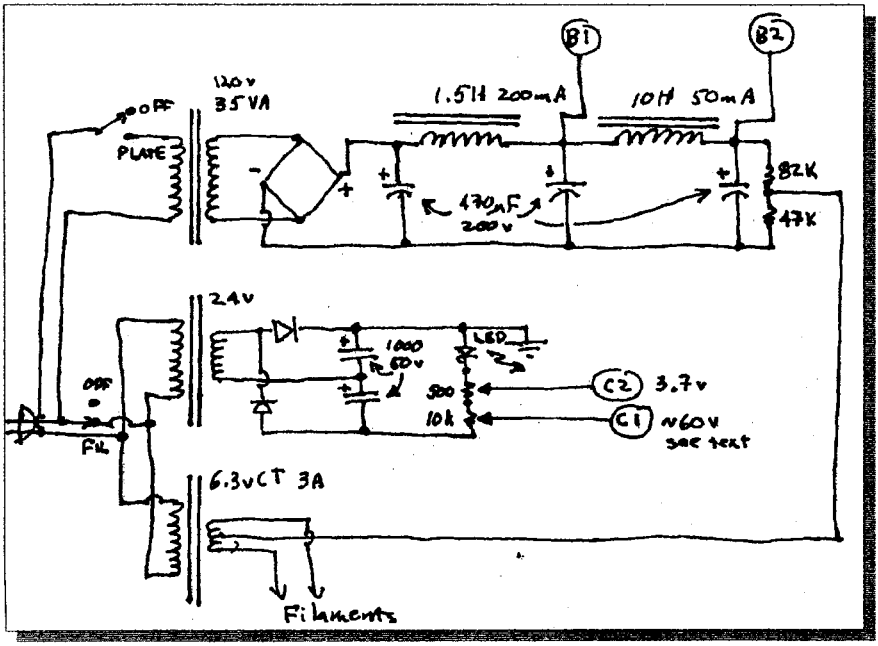
editor's note: CCS's

Got my hand lightly slapped on the Joenet the other day. By virtue of the backward way in which we declare current flow through a circuit (remember, the electrons really flow from the ground, through the cathode, to the plate, that plate being the point of highest positive 'potential' in the tube, but we say current flows from plate to cathode), and therefore which side of a potential difference is the 'supply side', a device which creates a constant, or near constant current flow from the high potential side of a voltage amplifier, such as the "top" half of a mu follower or mu stage pair, is called a constant current source. A device which creates a constant current through a voltage amplifier, and which is located on the low potential side of the amplifier, such as Paul's LM317/LM334 circuits, should be called a constant current sink. Good thing they are both abbreviated CCS. Could these devices be lumped together under the title of current regulators? Does this distinction really matter?
"I don't know, go ask your Dad"- Dr.Suess

the iron maiden

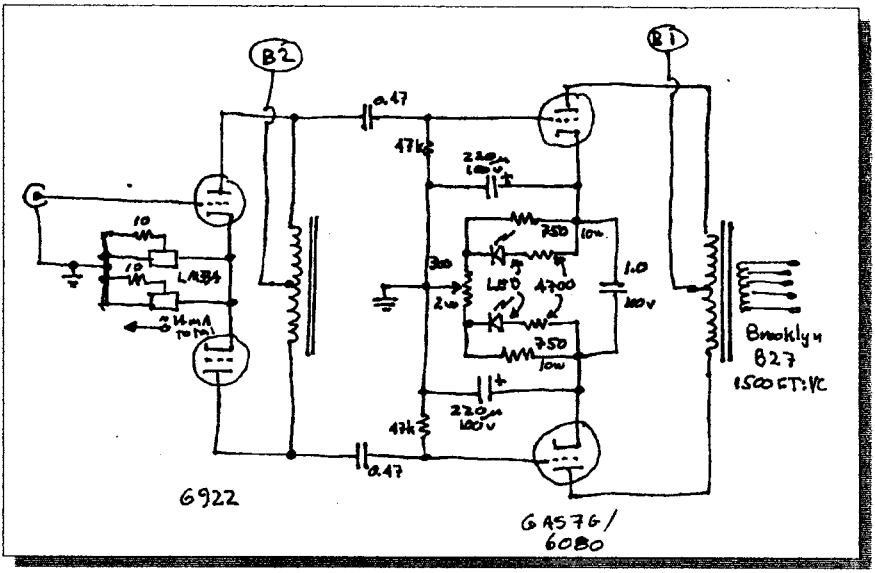


amplifier



power supply

Brookson



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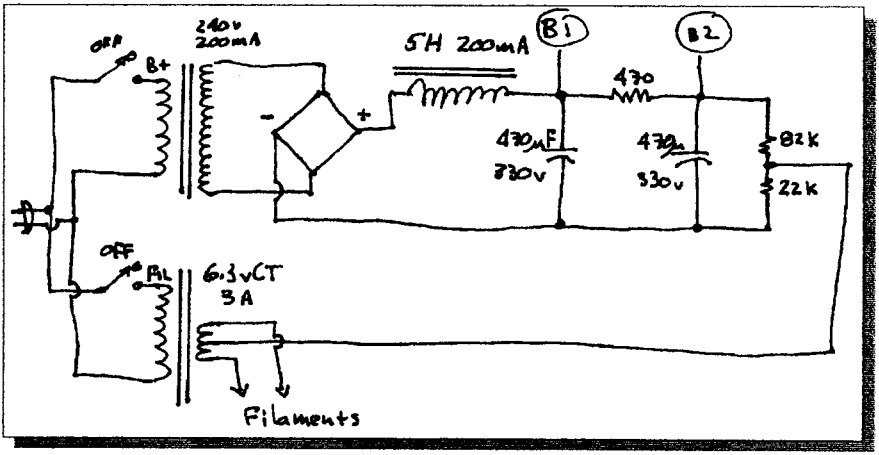


power supply

he 6U10 compactron driver circuit from the Brooklet (if you do, reduce the drive pair current to 5mA per triode, 10mA total). But the reduced plate voltage, and reduced gain requirement, opens up the possibility of a single stage driver using a high-mu low-impedance twin triode. I chose the 6922 again - don't use a 6DJ8, it's not supposed to see more than 130 volts on the plate. Anything with less than about 8k ohm plate resistance should work; the 6414 is another possibility. But you need the gain. Even with these tubes (mu = 33 and 42 respectively) you'll need at least 2 volts RMS for full power. The cathode bias voltage for either tube is too small to get away with the TL-317 current source, so I used a pair of LM334's (see Schoonmaker's article in Glass Audio v7n1 p.16 for details).

Incidentally, this current-source phase splitter (I call it a "short-tailed pair") has nearly perfect balance if the tube sections are matched. The current source dynamic impedance is several megohms, so the few percent imbalance typical of a long-tailed pair is almost completely eliminated. The autotransformer action of the tapped choke also forces balanced drive. The only real disadvantage of these phase splitters in my mind is that you lose half the gain of the tube.

If you really want to use a lower-mu tube like a 6SN7 or 12AU7, you'll need either another gain stage like the Brooklet or at least an input/phase splitting transformer like in the Iron Maiden. If you do this, you don't need the cathode current source - just a cathode resistor. As noted above, these tubes want to run at around 5mA if you only have 210 volts on the plate. I didn't suggest this in the fixed-bias case because 150 volts is a little low for these tubes as drivers - but if you want to eXperiment, try for 3.5 mA per plate.

Note the two LED's in the output cathode circuit. This is an improvement of the Brooklet circuit that lets you adjust DC balance visually by dialing in equal brightness. If the LED's are mounted close together, this can be a very sensitive and accurate adjustment. Also, I adopted George's small cap between the cathodes for better high-frequency performance.

OK, there's a couple eXtreme circuit ideas. Any takers? -Paul

5687 linestage

By John Levrault

Dear Dan,

As I mentioned a few weeks ago, I have a design for a linestage preamp that I'm happy to share with you and your readers. The schematic is attached. It's the result of many months of development, or rather "fooling around on Saturdays". It's simple, sounds good, and can be built up in just a few hours with junkbox parts.

I've been designing and building valve projects for the past couple of years. When I started on a linestage preamp, I wanted it all. I wanted the best performance day one. I read all the magazines, primarily Glass Audio, Audio Amateur, and Sound Practices. Based on all of this "objective" information, I built up a mu follower, trying different medium-mu triodes like 12AU7's, 6922's, 5687's. Despite its objective performance, like low distortion, good gain, and low output impedance, its sound left me cold.

I took what I felt was a technological step backwards and tried a "1+1 cascade", you know, a dual triode with one section as a simple gain stage and the other as a cathode follower. This was a big improvement in naturalness. I went through my box of medium-mu dual triodes and settled on the 5687 as being the most transparent.

I lived happily with this setup for several months until one Saturday when I had a few spare hours to kill. I figured I'd just wire the 2 triodes in parallel to see how it sounded. The improvement in transparency was startling! The sound was quick and detailed, had low background noise, and was very dynamic. I won't bore you with my perceptions of its attributes, only to say that to my ears this was the best I had achieved to date.

The circuit could not be simpler. It's just the 2 halves of a 5687 dual triode wired in parallel. The grids are driven through separate stopper resistors, but the cathodes and plates are tied together. I use a bypassed cathode resistor to keep the output impedance as low as possible. I run about 15ma of current through the pair. I use a fairly small plate resistor, 10K, and AC couple the output. The power supply is a 5Y3 driving a CLC into separate RC filters for each channel. The filaments are regulated with a low-dropout 3-terminal IC regulator.

After tweaking, I settled on the various components detailed on the schematic, but I hope that anyone attempting to duplicate this preamp will use their own favorite parts. Although I prefer the sound of Elna Cerafine electrolytics in power supplies, if you've got a stash of Black Gates or plain-jane Panasonics, give them a try. I suspect that the attributes of this simple design will show through. I prefer carbon composition resistors for stoppers, but if you prefer the zippier metal films, go for it! I like wirewound resistors for the plate loads, and have found that even inexpensive inductive types work fine. What's in the junkbox? And the output coupling cap should suit your tastes. I've had good luck with the MIT PPFX's and Hovlands, and the inexpensive Solen "Fast-Caps" sound great for the money. I would caution you, though, that an oil cap here can dull the sound a bit, so save your fancy oilers for the grid of your power tube! And watch out for noisy/spitty 5687's, especially those Philips JAN ones that are all over the place for cheap. Pay the extra dollar or two and go with a good GE.

Please note the input volume control. It's simply a resistor in series with the signal and a variable element to ground, a permutation of the classical L-pad attenuator. Resistor R1 will have a lot to do with the sound you achieve. I've tried Vishays and 2 watt carbon comps and like them both. They sound a little different, though, with the carbon comp winning for naturalness but the Vishay getting the nod for neutrality and balance. Let your pocket book be your guide! The variable element to ground can be as simple as a volume control like the 100K Alps jobbies available at your local Shaque de Radio or as complicated as a switched bank of resistors. Personally, I use the switched resistors.

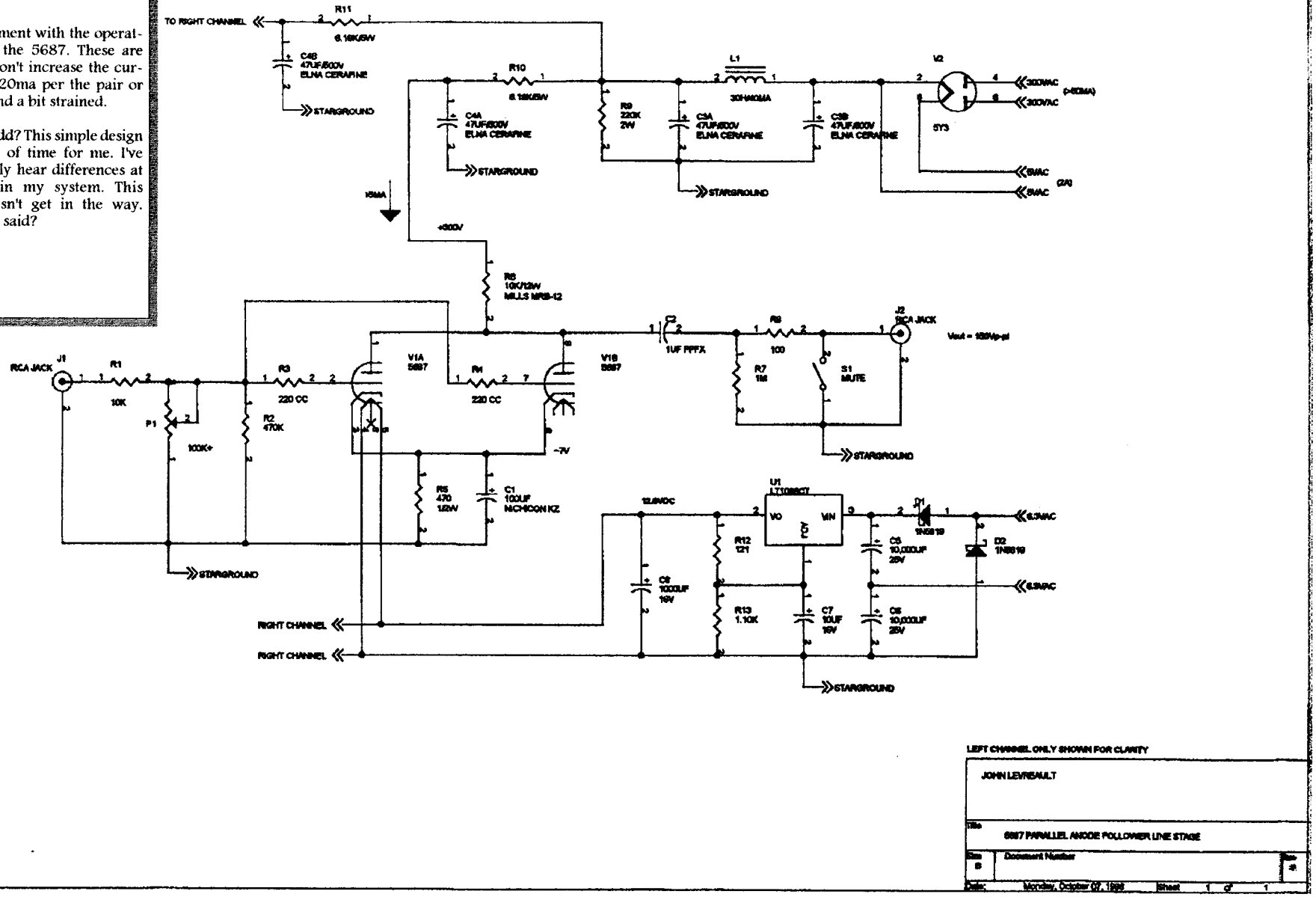
The schematic refers to "stargground". This is a screw strategically placed in the middle of the chassis with 4 solder lugs attached. Follow the wiring on the schematic: local ground connections that are grouped together on the schematic, like the input RCA, the attenuator, the grid return, and the cathode R/C, should all be connected to a common point, like an ungrounded terminal on a terminal strip. This point can then be connected to star ground with a single wire. The ground wiring detailed on the schematic works for me, but if you have another technique that has given

me, but if you have another technique that has given you good operation, don't be afraid to try it.

Feel free to experiment with the operating conditions of the 5687. These are beefy tubes! But don't increase the current much above 20ma per the pair or things start to sound a bit strained.

What more can I add? This simple design has stood the test of time for me. I've been able to readily hear differences at all other levels in my system. This linestage just doesn't get in the way. What more can be said?

Best regards,
John Levreault



tweak it 'til it bleeds

mods for Baby O., S.E.X. kit, and 417A/5842 amps, from around the World, and Poulsbo

The Story of (Baby) O.

Anthony Mills was kind enough to send us his recipe for mods to Gordon Rankin's "Baby Ongaku" SE 2A3 circuit, all the way from Oz-stralia:

- Changed Magnequest DS025 to Tango XE20S
- Operated the 2A3 at Vpk=305, Ip=55mA, giving 17W dissipation. "Don't worry," he notes, "these Chinese 2A3s can take it."
- Got rid of the 0.68 μF cap placed before the choke. "Now a real choke supply, don't have much of a problem with RFI in Australia."
- Changed 12AT7 to a 6AQ8. "Thinking of changing to a 6AQ8 mu follower. Might use your idea of diodes in the cathode."
- used a 15H choke followed by 200μF (100+100μF) Cerafine bypassed by a 20μF Solen for the power supply.
- Lead damped the chassis.
- Shielded the choke with TI sheild
- Used solid core silver wiring, Audionote tantalum films, Handmade oils, Audionote silver ceramic sockets, Cardas input/outputs, etc.

S.E.X. deviations

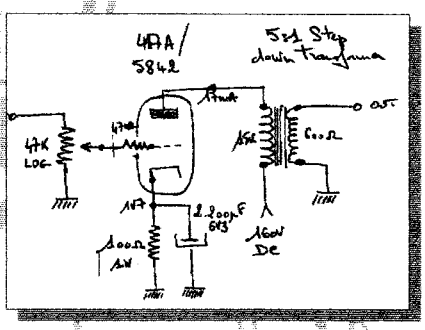
Here's some stuff I tried on the S.E.X. kit this month:

- Replace the "second" 10μF filter capacitor (the one after the choke) with a 47μF @ 450V. This is a help with speaks of 100 db or better efficiency, as it gets rid of the last wee bit of hum.
- Instead of the "diodes replace cathode resistor" mod of a few months ago, try this (NOTE; I have only tried this with the Ultimate Pleasure trannies - your results may differ with the stock trannies): Remove the 1KΩ and 200Ω cathode resistors, and the 220 μF electrolytic cathode bypass cap from the cathode of the mu follower (pins A6, 11 & 12). Connect a jumper from the junction of the remaining 2.2K (or 1.2K) feedback resistor and .047 mF feed back lowpass cap, at pin 11, to terminal A6.
- Now connect a red and an infrared LED in series, from pin A6 to ground (pin 12). Be sure to orient the diodes properly. This is your new constant current sink. The voltage drop across the diodes should be around 2.7V, close enough to the design goal of 3.2V to work fine. You may want to try other types of LEDs to close in on the 3.2V value a bit.

Bypass surgery

Marc Veyer sends us the following moral support from France:

Dan,
I have just received VALVE 3:9, and I am happy to see the interest aroused by the "one tube" concept.
Congratulations to Paul for his boldness. To use the 417A/5842 like a power tube! This guy is more daring than me!
If Paul is interested in a system "a ma facon", I would suggest the following 417A Transformer Coupled Line Preamp to use with his 417A Single Gain Stage Amp



With a SG stage amp, for many reasons, pay attention to use a 2,200 μF minimum cathode bypass condenser (1,000 μF is not enough). With two tubes in parallel the value reaches 3,000 μF. if you are planning to parallel four of these tubes, Ck will increase to 4.700 μF!!!
However , do not forget that if you use several tubes in parallel to increase the power, you betray the "one tube" concept.
In fact, I hate paralleled tubes, because none of them ever have exactly the same operating point. In my opinion, the only interest in paralleling (very well matched) tubes is to make on OTL.
Best regards and good research, Marc

TQWT- tapered quarter wave tube for the S.E.X. driver

By Marc Veyer

In VALVE Vol3 #8, within the fraework of the PAS speaker design contest, Dan gave an idea for a vented box design based on the MCM 55-1290

Here is another idea:

I think the MCM 55-1290 might be used singly in a TQWT (tapered quarter wave tube). This cabinet works well with 4 to 6 inch cone full range drivers.

Thanks to the column shape of the box, the driver is well positioned for a seated listener. The resonant frequency of the box is about 48Hz. The height of the vent must be tuned by ear, and may vary between 1/2 to 4 inches, depending on the Fs of the driver.

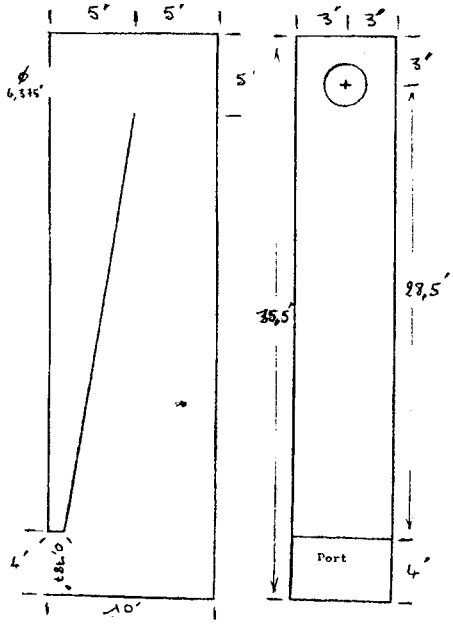
The three views show the general makeup and *internal* dimensions of the enclosure.

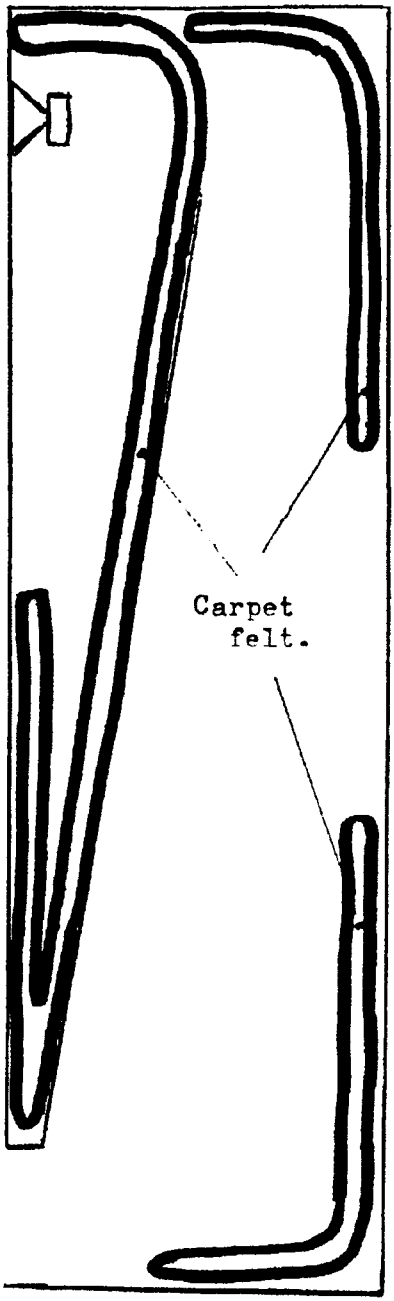
Material, 3/4" plywood

Sound Absorbent, 3/4" carpet felt

The internal width may be changed to suit various driver diameters.

(Note: I am experimenting with a similar enclosure for my PM6Cs. So far, not so hot for the Lowthers. Should work lots better for the 55-1290. Merci, Marc - Doc.B.)



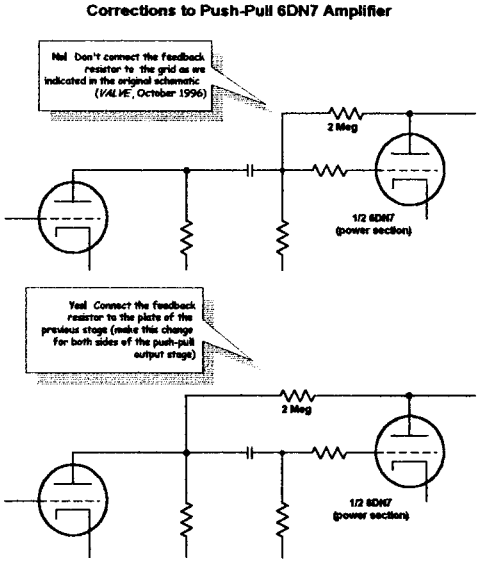


Corrections/Clarifications for Double Push-Pull Fun

by Dave Dintenfass, VALVE

Schematic fixes

Those of you with sharp eyes may have noticed a small error in my schematic (**VALVE**, October 1996). The 2M feedback resistors should go the plate of the previous stage, not the grid of the output stage. If you already built the amp as shown, don't worry. Connecting the plate of the output tube directly to its grid won't harm anything -- all it does is put a minor bit of dc bias on the grid, causing the tube to run warmer. Blame for this little error is solely my own -- my technical reviewers saw only an advance copy (which of course had no errors!).



Feedback suggestions

If you want to try adding feedback to your double push-pull amp, I've included a connection diagram and some suggested component values (this information comes to us courtesy of George Wright and Paul Joppa). Remember, I haven't tried this so you'll need to experiment. Also, this arrangement is for unbalanced inputs only (if you're fuzzy on the concept of unbalanced/balanced inputs, see the original article).

Brook output iron

After going to press, I borrowed a copy of John Newitt's "High Fidelity Techniques." This is an exceptional book; very detailed yet with lots of practical information. Curiously, Newitt says that the output iron in the Brook amp was a custom job, with lots of interleaving. The photo in the book shows a rather squat, wide output transformer (since the book was printed in 1953, we can assume the amp pictured was probably made in 1952 or perhaps 1951). Now I don't know how long the Brook was in production, but the Brook I saw had a much smaller output transformer. Anybody out there who can verify if Brook switched output iron at some point? In light of this, my somewhat flippant remark that "output iron in the Brook was nothing special; almost certainly an off-the-shelf unit" may be incorrect. Prove me wrong!

Interstage transformer loading

VALVE member Alan Douglas pointed out that I incorrectly stated that the 10K/90K transformer used in my amp is "45K from each leg of the secondary to the centertap." I was wrong indeed. The secondary impedance from each side of the secondary to the grounded centertap is 22.5K -- and just to be sure, I checked it with an impedance bridge across the secondary (after hanging a 10K resistor on the primary side).

The impedance ratio is the square of the turns ratio. The overall turns ratio is 1:3, which is an impedance ratio of 1:9 (that's why the transformer is spec'd at 10K/90K). And if the turns ratio from the primary to half the secondary (each side of the secondary to the centertap) is 1:1.5, we have an impedance ratio of 1:2.25 since 1.5 squared equals 2.25, and 10K times 2.25 is 22.5K.

In fact, I danced rather lightly over the subject of proper loading for the interstage transformer. This called for some background reading in Chapter 8 of Howard Tremaine's *Audio Cyclopedia* (on the reference shelf in

ence shelf in the **VALVE** library).

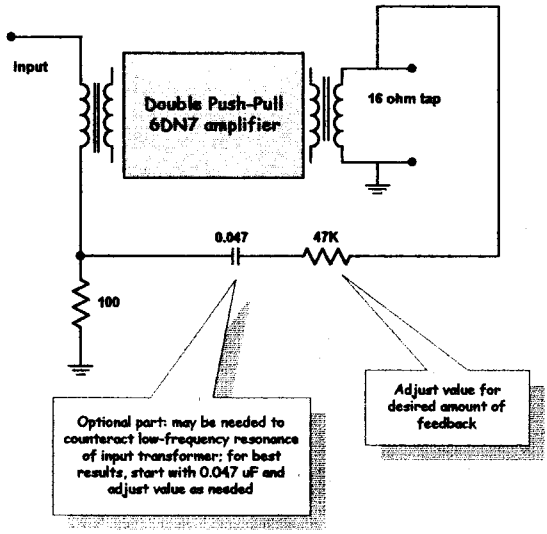
There are basically two types of audio transformers -- terminated and unterminated. Most of us are familiar with terminated types -- for example, an output transformer. Termination is important here since it reflects the proper load to the output tubes. For maximum power transfer, the source impedance should match the load impedance, hence the practice of connecting an 8-ohm speaker to the 8-ohm tap!

On the other hand, unterminated transformers are designed to operate directly into the grid of a tube (or a pair of grids), with or without a grid resistor. The idea here is to develop a voltage at the input to the next stage, not transfer power to it. And since a grid resistor is usually at least 100K or more, the transformer secondary sees practically no load at all.

Microphone input transformers are unterminated devices. Historically, dynamic and ribbon microphones needed to operate into very light loads to avoid damping the motion of the diaphragm or ribbon element. The exact behavior of all this is rather complex, but let's just say that early on, very wise engineers realized that damping was a bad thing for this application. So even though a typical mike transformer (for vacuum-tube circuits) is characterized as having a 150-ohm primary and a 15K secondary, nobody actually hangs a 15K resistor on the secondary. To do so would roll off the high end and cause uneven frequency response. If the transformer secondary looks into a 150K grid resistor in the next stage, for example, a microphone with a 150-ohm impedance (which is typical) would see an impedance of 1500 ohms, not 150 ohms. Some older microphones required even lighter loading, while certain European microphones required heavier loading.

Interstage transformers fall into an intermediate category. You want some loading but not too much. According to Tremaine, unterminated transformers are prone to develop a high-end resonance when fed from non-ideal source impedances -- that's because the source impedance provides the only termination the xformer has (and since source impedances vary, they're not likely to be ideal for that transformer). To avoid this, some loading of interstage transformers is generally required.

Adding feedback to the Push-Pull 6DN7 Amplifier (for unbalanced input configuration only)



George Wright, one of my technical consultants, suggested 47K as a starting point to load the interstage secondary. In his experience, this provides an optimal load for an interstage transformer (though the exact value varies with the transformer used). Remember, the intent here is *not* to terminate the interstage secondary, but rather to tame the transformer funnies. Heavier loading will roll off the high end.

Incidentally, if you think this gets complicated, I've only scratched the surface. Entire books have been written on transformer design and proper application. Also, now you can see why adding a buffer stage (such as my original 6J5 stage) before the interstage transformer can be helpful since it removes any worry about source impedance to the interstage primary!

what's all this about harmonic cancellation?

I read with interest the article in Glass Audio about harmonic cancellation, by **VALVE** member Reid Welch.
Reid and I have spoken a few times by phone and on the Joenet. Through the course of these discussions, Reid mentioned that he only had equipment on hand to measure 'dumb' total harmonic distortion, that is, a total for all harmonics combined.
What Reid did was reverse the leads on the secondary of his interstage coupled 417A/300B amp.
In doing so he measured quite a reduction in total harmonic distortion, and a subsequent increase in available power.
I offered the services of the trusty HP dynamic signal analyzer, on long term loan from Dave, to analyze the breakdown of distortion at each individual harmonic, to determine if only second order harmonic distortion is cancelled by this scheme, or if all harmonics are reduced the same degree, and if spurious higher frequency harmonics are generated . Each of these theories had been put forth, based on the existing data.
A very generous **VALVE** member Gary Dahl offered up his amps for evaluation. They too are 417A/300B amps, IT coupled, although by Tango NC-18s instead of Reid's Southeastern Transformer model.
The results were most interesting.
The point to emphasize here is that lead 'reversal' does not appear to be the correct topology for the lowest THD at high power levels. Apparently Reid's transformers were not clearly marked, and he had some difficulty discerning which lead was which.
In fact, it appears that the standard, 'non reversed' connection was what appeared to be the 'reversed' connection on Reid's interstage trannies, yielding the better THD figure.
This was certainly the case with Gary's amps. Here are the results of some tests with the HP:

THD was measured with an HP dynamic signal analyzer in 'THD' mode, using continous averaging. The fundamental frequency was 1kHz, and an 8 ohm load was used on the 8 ohm tap of the Tango XE20S OPT. I used a range from 1kHz to 6.4kHz to read the harmonic content. Overall gain of the amp is around 18 dB. Frequency response is +/- 1 dB, 20Hz-20KHz, with a 2 dB peak around 40 kHz.

BTW, this amp sounds very nice! Gary will be giving us the story on it's creation soon.

With the interstage transformer secondary hooked up in the 'reversed' configuration (Tango includes a detailed data sheet showing various connection topologies) I got a baseline of 1.25% THD at 1 W.

At 2% THD we see 2.31W.
3rd harmonic, 36.9 dB down from 2nd
4th, 56 dB down
5th, 68 dB down
6th, 88 dB down
7th, 90 dB down

At 5% THD we see 8.06W.
3rd harmonic, 30.1 db down from 2nd
4th, 29 dB down
5th, 40 dB down
6th, 38 db down
7th, 45 dB down

With the interstage transformer secondary leads back to normal, I got 0.96% THD at 1W.

At 2% THD, we see 3.29W.
3rd harmonic, 33.7 dB down from the second
4th, 48 dB down
5th, 58 dB down
6th, 73 dB down
7th, 85 dB down

At 5% THD we see 10.37W, about a 29% power increase.
3rd harmonic, 41.6 db down
4th, 36.5 dB down
5th, 46.5 dB down
6th, 46.5 dB down
7th, 51.6 dB down

And so we see that lead reversal does indeed change the harmonic distortion, fairly evenly across the spectrum, without spurious upper harmonic generation (I looked at freqeuncies up to 50kHz), but for the *worse* at higher power levels.
This is not intended as a bashing of Reid's fine article, merely a contribution to further encourage study of this phenomenon. Reid is to be commended for taking the initiative to eXperiment! I hope that he continues his interesting contributions to our 'cause' (that would be Having Fun, for those of you who tend to forget!).

Dr. Bottlehead

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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
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B24	3,000 CT	15W	75	7.5	$125
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Try the B27 in the "Iron Maiden" circuits - Paul

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A2 Bruté?

In preparation for our $100 speaker competition, I have analyzed the possibilties and determined that we will need a bit of power to run our entries in the the very large listening room used by the Pacific Northwest Audio Society.

Now, we certainly need to expose these sandy fellows to the virtues of a vacuum state, and furthermore, I think they should hear what single ended sounds like.

How do we give them power *and* panache?

I sat down in the shop and surveyed the mess before me:

"Hmmm there's Quasimodo over there with its four hu-effing-mungous chassis and some 805s hanging off of it.....there's those Audionote 10K 150 mA OPTs up there on the shelf, that I'll own someday if I ever get Dave's jukebox cabinet restored..... there's all those 6080s in the tube cabinet, and those 5842s me and Paul bought.....

A few hours hovering over RCA TT-3 and RC-30 tube manuals had me hatching an idea. An 805 running class A2 single ended might be good for 30-40 watts. Damn, that's serious SE.

I call up the keeper of the triode knowledge, Brainiac Joppa, and explain what I'm trying to do. Luckily Paul is amused by my various mental deficiencies, listens, and helps me struggle to grasp A2 operation. I send him copies of the 805 curves and he calls me back a little later to tell me he thinks it will work, we can design **A2 Bruté**.

So what will it be?

Well, so far, a 5842 driving a 6080 cathode follower which is loaded by a choke. The 6080 will be direct coupled to the grid of the 805, which will run at about 1000V and 100mA. This baby will be in serious class A2, drawing **50mA** of grid current at maximum swing! How loud? 34 watts. Cool.

We'll let you know how this insanity develops. I have a few kinks to work out, like how to quiet the potted but noisy 2200 VCT power trannies, how to fit the four 16 mfd at 4kV oil filter caps on the power supply chassis, and how to carry these beasts around without mounting them on their own semi trailer.

If we survive the next few months of development, we'll let you know how it's going.

Doc B.

A2 how-to

by Paul Joppa

Here's a quick and dirty way to estimate Class A2 operating points. This assumes that the mu of the tube is fairly high, at least 10 - otherwise grid current will become unmanageable.

Set the load impedance equal to the plate voltage divided by the plate current. For example, to use a 10K transformer with a 100 watt triode use 1000 volts and 100 mA.

To go any furthur in general, you need the curve data for the tube. Draw the operating line on the curves and note the maximum and minimum grid voltage. (make sue the max grid voltage is less than the min plate voltage, otherwise grid current will go crazy).

Look up the peak grid current, which is the max grid voltage and min plate voltage. Now you know the drive requirements; to keep distortion in check the drive impedance should be less than 10% of (max grid volts divided by peak grid current)

Because the grid acts like a rectifier in Class A2, you cannot drive it with a capacitor. The most practical schemes are a choke-loaded cathode follower (direct coupled), transformer drive, or a Loftin White direct coupling scheme. Also, note that the source impedance without feedback is higher than Class A1 single ended, so speaker interactions are greater.

surf's up!

As the "web" becomes an ever increasing part of our everyday lives, I began to wonder, as other have before me, how I might utilize this limitless technological resource for S.E.X. What I'm referring to here is of course Single Ended eXperimentation. Well, boys and girls, wax'em up because I'm about to tell you about a couple websites I found surfin' which may change the way you look at your system and improve your listening experience forever.

The first websites are what I like to refer to as the Japanese ultra-fi porno pages. Found at: http://invalid.ed.no/~dunker/diy_hrn.html and http://invalid.ed.unit.no/~dunker/dr_hrn.html, these are the pages that Herb Reichert refers to in Sound Practices. Contained in these pages are pictures of equipment I probably would have never before seen let alone began to search for in hopes of owning. Do yourself a favor as I did and check out Western Electric, Onken, Goto Unit and other vintage equipment which you might not otherwise get a peek at. I'm with Herb on this one, I'll split the $20 with him if anyone can turn me on to another page like this! And if you find any of this equipment, call me ... collect! These pages are courtesy of Thomas Dunker who also puts up the horn speaker home page at: http://invalid.ed.unit.no/~dunker/horn.html.

The next page reaches out to all of you out there who have never surfed because you're afraid of shark attack or something. Or in audiophile terms, you're apprehensive about crackin' the case to mod your CD player because (1) it costs money, (2) you might screw it up for good, never to work again, leading to reason one, (3) all that stuff in there must be necessary, and (4) the designer always knows better than you. Well, this is your chance to be the Big Kahuna! So, proceed at your own risk and simply following Klaas' advice at http://cal003109.student.utwente.nl/klaas/audio_cd.htm by removing the output muting transistors from your beer budget CD player. Without spending a single red cent you'll be on your way tweeking everything in sight. I tried this mod on a Radio Shack home player which I couldn't stand to listen to in comparison to a CD-3400 and it took the player beyond the CD-3400 after the mod. Maybe this is why certain inexpensive CD players sound better than others. You see, the big dog units typically use relays rather than muting transistors.

Naturally, these are but a few of the vast number of audio related sights; however, I hope that this will increase your interest and further your zest for experimentation.

L. Dean Moore

cravings

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