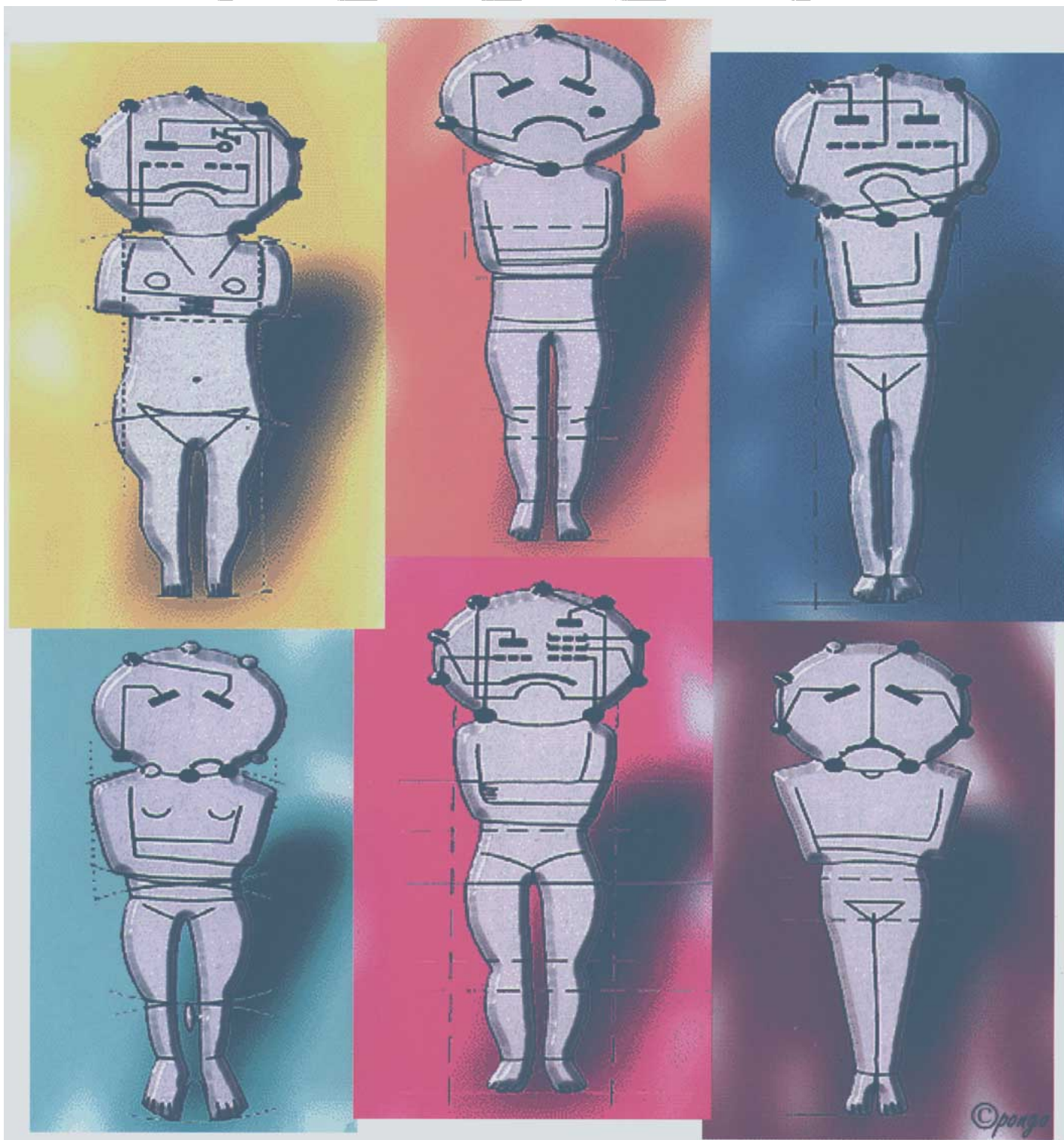


# SOUND PRACTICES

THE JOURNAL FOR AUDIO EXPERIMENTERS

FIVE DOLLARS



Options and Preferences

Issue 15

# The B-52

Parallel-fed VV-52B SE  
with triode-wired 7788  
transformer-coupled driver



by Grego Sanguinetti, Sanguinetti Design

A while ago Ron Welborne announced a close out pricing deal on the VV labeled VV52b power triodes. After hearing so much about these tubes, I couldn't help taking advantage of this special offer.

Upon opening the box I immediately fell in love with this tube. Like the 808, 833, and 845 amps I had to build simply because of the looks of the tubes, I was driven to create an amp around the VV52b.

I proceeded with a few primary goals in mind:

1. Elegance by simplicity, i.e. low device count, especially in the signal path.
2. Adequate power for wildly varied tastes in music in my 900 square foot family room.
3. Good visual and aural appeal.
4. Oh yeah, the chassis(s) had to fit between the rails of a standard EIA relay rack.

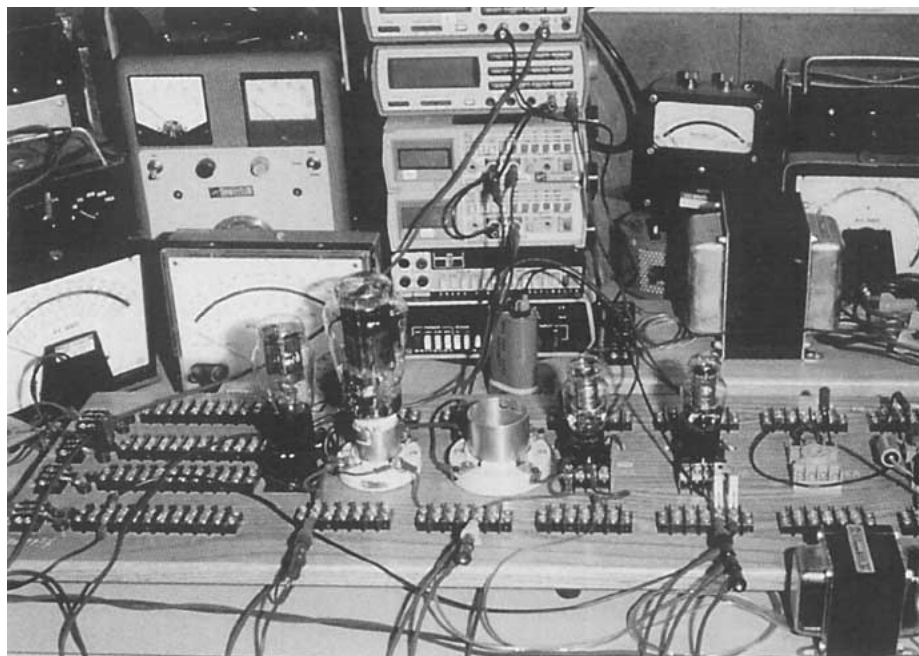
I ended up with a design that is really quite simple (except, maybe, the somewhat elaborate heater supply for the input tube). However, with the very low parts count comes the extra high sensitivity to component selection. At the same time, it makes the design that much more fun to play with! Aside from the expense of some of the components, it makes an excellent home brewer project.

Since the inspiration for this amplifier was the output tube, it seems appropriate to start with a discussion of the output stage.

My original output stage was completely conventional. But I found that the quiescent current (150 mA) of the VV52b greatly limited the selection of output transformers.

The solution was to shunt-feed (a.k.a. *parallel-feed* or *parafeed*) the output. Now I had seen this done with choke coupled stages on vintage radios and had experimented with parafeed choke and auto-transformer-coupled driver stages, but it had not occurred to me to apply this method to the output stage.

Some time ago I had a discussion about choke coupled stages with Mike LaFevre, of MagneQuest, who told me that he had been working on parafeed output stages with Dan Schmalte (a.k.a. Doc Bottlehead of Electronic Tonalities). The VALVE group in Seattle had been doing a bit of experimenting with these output stages (a lot since then!). It hit me like a hammer that these clever folks really had something here.



Shown here is the prototyping board set up for testing the original B-52. The extra sockets are set up for alternate driver tube evaluation.

Of course there are some obvious reasons *not* to embrace parafeed coupling; the first thing people object to is the big DC blocking capacitor, where none was needed previously. The capacitor and the plate choke form a rather nasty filter whose implications made my computer draw cartoons.

Fortunately, I had enough parts to go ahead and try it out for myself. It's funny how sometimes things just work out for the best because so far I haven't found any sonic problems that I can assign to the parafeed topology. In fact it works very, very well! So build and listen, then talk!

What doesn't just work out is the added size and cost of the extra transformer. You haven't just eliminated the problems of DC current in the output transformer, you have separated the tasks and moved the problem to the plate load choke.

This separation of duty is a good thing though. It allows the plate choke and output transformer to be optimized with fewer parameters. In addition, the output transformer is returned to a lower impedance, going directly to ground as opposed to seeing ground through the power supply.

When building a substantial output stage with parafeed, you quickly discover that suitable plate chokes are damn hard to come by. Plate chokes are quite a different animal than a power supply filter choke. The plate choke has to be a wide bandwidth device while coping with both a substantial DC current and AC swing. From an

AC point of view, it sits in parallel with the output transformer, hence the parafeed nomenclature.

I was not able to find an audio choke that would handle my specification of 150mA and 400v swing at 450vDC. So I had to commission a custom design (contact me for availability).

Fortunately, for designs of 80mA or less, Mike and Dan have come to the rescue with a line of plate chokes and output transformers to support us parafeeders. In fact it seems like lately, the VALVE bunch has become a parafeeder support group!

From a practical stance, the values of the plate chokes you can use are reduced to the very few available for any given current rating. The way I look at it, consider the inductance values to be fixed by the marketplace and build around what you can actually get.

For the output transformer, I chose the Electronic Tonalities custom MagneQuest TFA2004 "Pinstripe" version. The "Pinstripe" gets its name from the alternating laminations of nickel and M4 silicon steel.

Speaking of which, here's the main advantage of this parafeed thing; you see, now that you have unburdened the output transformer of DC current a number of design options open up. The core no longer needs to be air-gapped and the only saturation components are the primary voltage swing and output power. This means that you can now use exotic high-permeability materials, interleaved with steel or all nickel or whatever.

With a parafeed output stage you have another choice to make. You can place the DC blocking capacitor between the plate and the output transformer primary, or between the primary and ground. I found the differences to be fairly subtle but decided to go for the ground leg location. I really can't say if this was purely a sonic decision or biased by an intuitive feel that this configuration has the least influence on the signal. To size the blocking capacitor, choose a capacitance where the reactance is the same as the inductor at a given cutoff frequency.

The operating point for the VV52b was set by fixing the plate voltage at the recommended 450v. Then find a bias voltage and current that was just enough to make the tube sing but backed off enough from the specified maximum plate dissipation to extract as much life as possible from these expensive tubes.

Although you can find many theoretically sound bias points for this tube, it really sounds best with a higher plate voltage. The Vp voltage was the most dramatic knob on the prototype bench.

After trying a number of operating points, I found that the manufacturer's suggested operating point sounded best. If you allow B+ to fall much below 450v you start losing its distinctive high end and low end punch. However none of the four prototypes could get close to the plate current and power rating claimed by the manufacturer. All the tubes I tried have produced between 12 and 16 watts at around 135mA. Now at this operating point, the tube seems to be running effortlessly, even at full input voltage at 20Hz. The envelope temperature remains reasonable and those huge finned plates show no signs of stress. This seems to indicate that the tube could be pushed a lot harder.

I have so far refrained because I haven't felt the need to increase power, I love the sound as it is (so why fix it?) and, with the high cost of these tubes, I would just as soon have them run at a relaxed dissipation. When I get some extra time I will be trying some more aggressive operating points but for now I just want to enjoy the music!

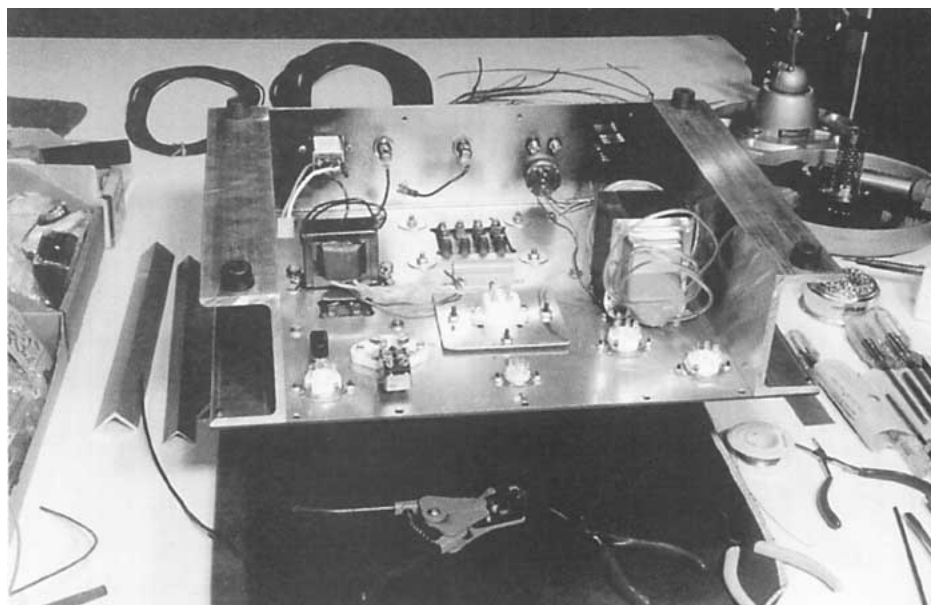
The bias point of the output stage dictates

a driver capable of swinging 200v. In addition, big power triodes like the VV52b and the 845, are quite capable of sourcing grid current so the driver can't be too wimpy.

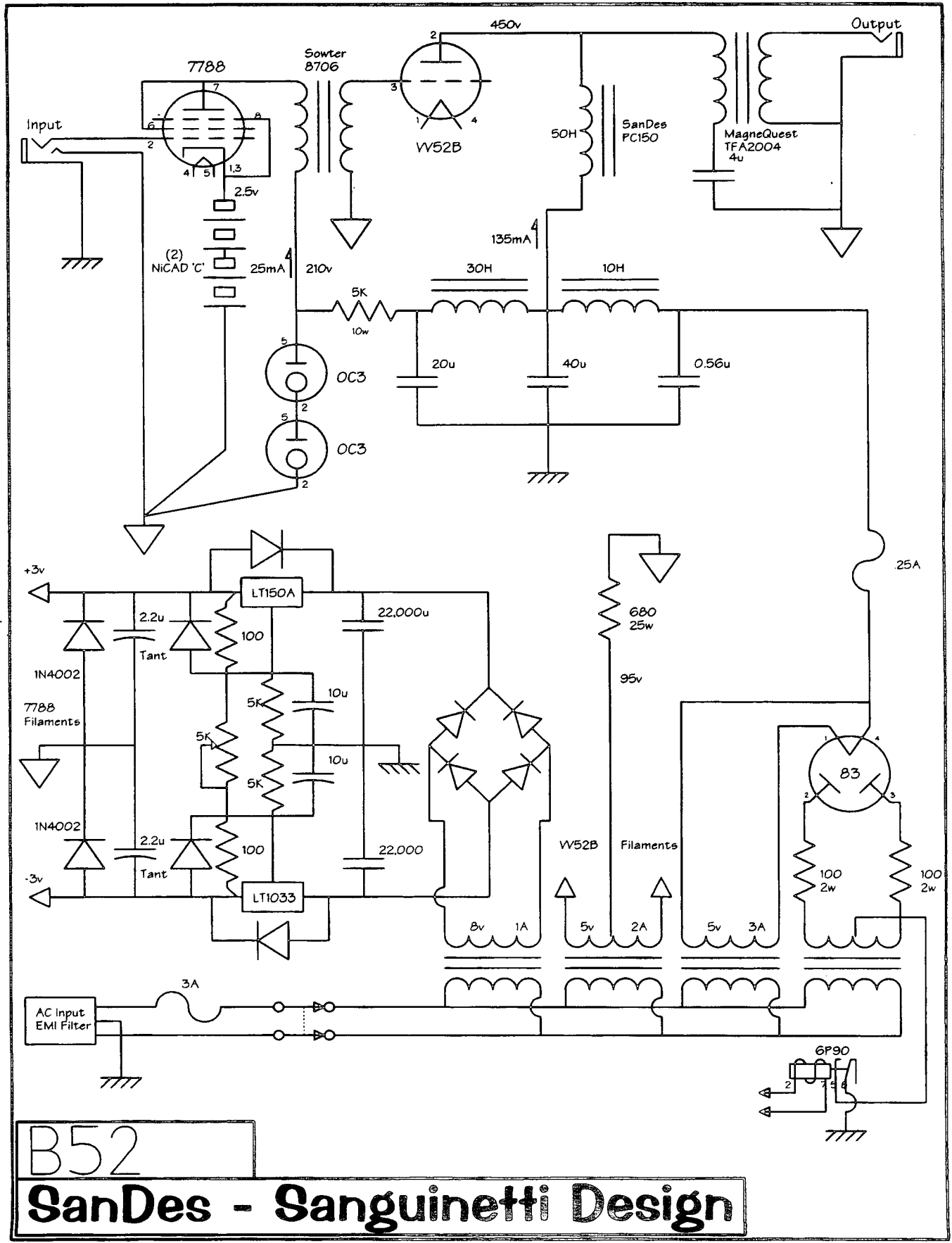
I immediately gravitated to a transformer coupled stage. I have been using interstage transformers a lot lately. They are really addictive, so beware! The simplified topology plays right into the goal of minimal device count since they perform the function of a choke load as well as AC coupling to the following stage. Transformers also really help the driver tube control the load, especially if employed in a step down configuration. The inductor load of the primary also allows the driver to swing up to and beyond the local B+ supply voltage.

I had some husky Sowter 8423's (5k primary@30 mA, 1:1+1 ratio) on hand from my PP6B4G project. They sounded great in that amp and in Mike Hathaway's SE 6A3 amp so they were the first thing I tried here.

I started with a cascaded 5965 driver, transformer coupled to the output tube. For those not familiar with this tube, it is a long life version of the 12AV7, intended for computer operation. Although this tube is widely overlooked, it is a good candidate for general-purpose voltage gain stages, with an Rp of 7K and a *mu* of 47. The 5965 was introduced in 1952 and built by GE,

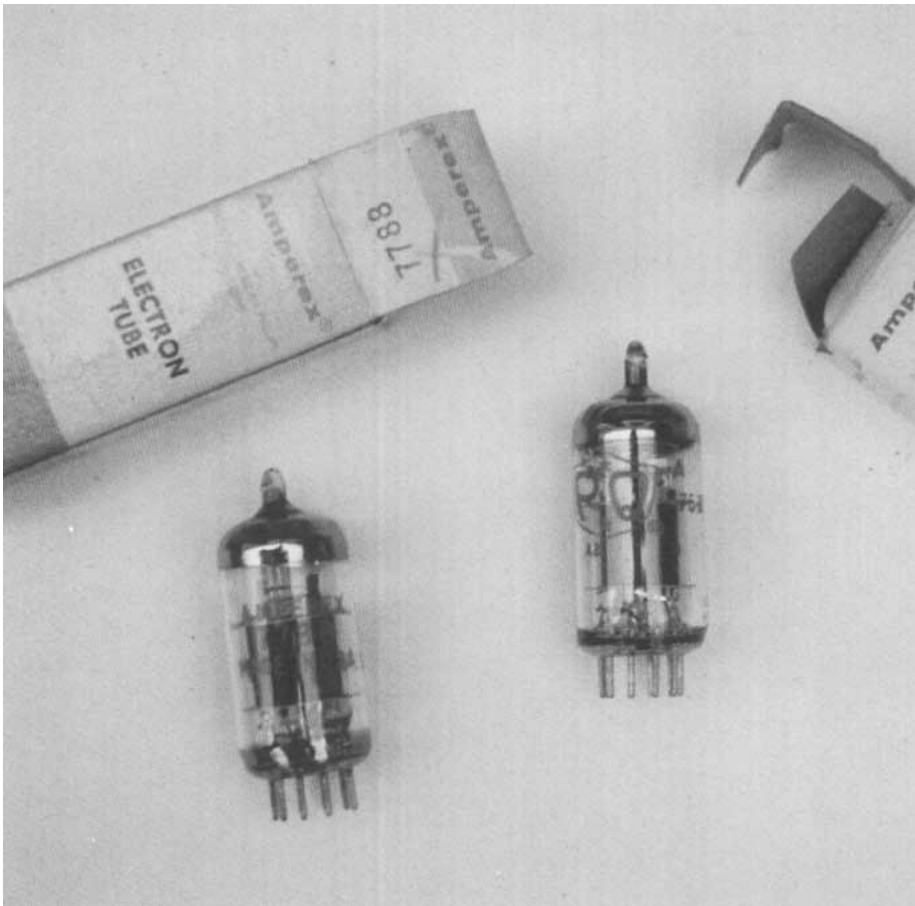


**View of a prototype under construction, showing the interior component placements. Notice the subchassis for the power tube socket, a Yamamoto in this case. The large Sowter interstage transformer is on the right and the filament transformer for the output tube is on the left. Not yet mounted in this example are the electrostatic shields separating the power supply components.**



B52

**SanDes - Sanguinetti Design**



RCA, Sylvania and Tung-Sol, and good NOS specimens are common and inexpensive.

The 5965 design, although good sounding, was barely adequate in terms of drive voltage for the VV52b. Looking for a bit more gain, I explored the use of single high gain tubes.

Last year I experimented with tubes like the WE417A/5842, WE437, 6J4WA/8532 as drivers for a PP6B4G amplifier. Of these I liked the 8532 best. It biases up a bit higher than the others, has a bit warmer sound (at least in this amp) and is by far the best value of the bunch. The 8532 was introduced in 1964 and built by RCA and Sylvania. Used as a single stage, these drivers would require a step up transformer for adequate gain.

Then Joe Lowe brought the 7788 pentode back to my attention. Many lives ago, an RF engineer had told me about this tube but I had dismissed it out of hand because it had too many electrodes. After all, isn't the pentagram the devil's logo? Dooh, take a look at your hands and feet. Five can't be all that bad?

Heck yes, the triode-wired 7788 is the ulti-

mate small signal voltage amplifier. When combined with the Sowter 5K interstage transformer hooked up with the secondaries in series (1:2 ratio), this gain stage can swing 450v before showing any symptoms of stress! At 200v it lopes along at 0.163%THD. Ee-yow!

OK, so the instruments are impressed, but

how does it sound? Well it is a little silly to talk about the sound of the driver apart from the output stage, so let's just say that I stopped looking at alternatives when I heard this one. The 7788/E810F was introduced in 1961 and was built by Amperex and GE, though rumor has it the GE's were built by Amperex.

The initial measurements were taken with a  $V_p$  of 134v @ 35mA into an instrumentation load of about 300K. It was down 3dB at 5Hz with a gain of 112 (with the transformer strapped for 1:2). For the final configuration in the amp I opted for a higher bias point to increase the input headroom. The tube seems to like this just as much. The higher bias also lowers the DC current through the interstage, although the big Sowter worked just fine at 35mA. The new  $V_p$  is 190v and it now draws 28mA.

Based on my experiments on the PP6B4G amp, I went with the battery cathode biasing scheme. You place a positively biased rechargeable battery in series with the cathode, replacing the cathode resistor. A bypass capacitor is not required since the battery provides a very low impedance AC ground.

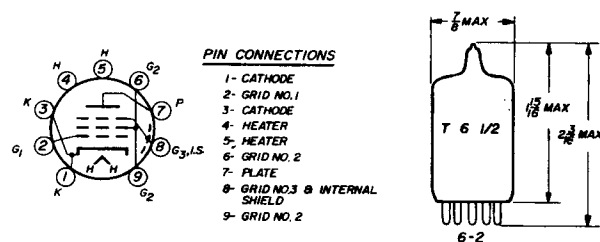
For this design I use two C-size NiCad batteries in series for about 2.8v. As it turns out, not all NiCads are created equal for this application. I started out using a couple of Radio Shack batteries. When I first powered up the design, on the protoboard, it was very unstable. It would go berserk as I moved the probes around. I eventually noticed that all I had to do was move my hand close to the batteries and the stage would take off. I wasn't trying to build a

## AMPEREX TUBE TYPE 7788

### TENTATIVE DATA

**The Amperex 7788 is a dual frame grid, long life, shock and vibration resistant pentode, especially designed for use in broad-band amplifying circuits such as radio and television relay systems, coaxial telephone lines, radar equipment and oscilloscopes.**

**The 7788, an Amperex "Premium Quality, 10,000 Hour" tube, features extremely high transconductance and an excellent figure of merit. The low noise equivalent resistance is typically only 100 ohms pentode connected, and 60 ohms triode connected.**



thermin, so I tried a pair of yellow Eveready's. Now the stage is rock-solid and another lesson was learned.

The battery, power supply and tube are all wired in series. So the battery is sinking current, a configuration that constantly charges the battery. Before, I had space heaters that played music. Now I have one that is also a battery charger!

I have been told to hold a constant charge current below 1/20th of the Ah rating of the battery. Since C NiCads are rated between 1800mAh and 2400mAh this load is well inside their margin of safety. It is important, however, to keep the batteries away from heat sources as this will lower their life span faster than anything else.

Although the amp sounded great, I was noticing a little overshoot and ringing at the secondary of the interstage transformer when driving with a square wave. I discussed this with Brian Sowter, talking about what kind of optimizations we could make.

The plate impedance had been measured at 1.3K so I could afford to lower the primary impedance of the transformer. This would in turn lower the inductance but there was room to play because the low frequency rolloff was so low. You can estimate the rolloff by  $f_3 = (R_p + R_{dc}) / 2\pi L$ . I ended up opting for a primary impedance of 2K.

This customized version of the 8423 can be obtained from Sowter as model number 8706. The amp still sounds great, but the instruments are a little happier with the square wave response! Got to throw those hard working instruments a bone once and a while...

I generally view complexity as a bad thing. Every component adds its own noise and parasitics, all parameters that shape sound. The input stage certainly has a very low device count, with only a tube, a couple of batteries and a transformer. Oh, I use a ferrite bead on the grid, so to be fair, I should count that also. The bead is used instead of a series grid-stopper resistor.

The power supply is choke input, although it does use a small capacitor just before the first choke. This helps with ripple filtering and can be small enough so that the effects of the choke swamp those of the capacitor.

In other words, the supply still acts as a choke input supply. I thank Gordon Rankin for this simple trick. I like to refer to the pre-filter capacitor as a tuning cap because

it tunes the power supply characteristics between those of a capacitive input filter and a choke input filter. A choke input filter generally results in better voltage regulation whereas a capacitive input filter yields better ripple filtration and at the same time provides higher output voltage.

Viewed purely from a topological point of view, the amp uses a CLC filter. But from a qualitative perspective, it is still an LC filter.

The size of the tuning capacitor must ultimately be determined empirically. The output voltage is very sensitive to the cap value. I generally start off with .5mF and work up to no greater than 2mF. We are trading off reduced hum and higher output voltage against better regulation and better sonics. Naturally, I try to keep the capacitance as small as practical in order to maximize the choke input characteristics.

Unless I need solid state rectifiers, or the voltage or current load is too great, I inevitably fall back on the venerable 83 mercury vapor rectifier. It is worth the small added complexity of the B+ delay circuit, required to hold off the plate voltage until the filament has liquefied the mercury. The rectifier and tuning cap are followed by a large, low DCR filter choke.

The LC filter is completed by modern manufacture GE motor start oil caps.

After tapping off for the output stage there is a second LC filter followed by the driver stage plate supply regulator. This is a shunt regulator consisting of two stacked 0C3 VR tubes and a series current limiter.

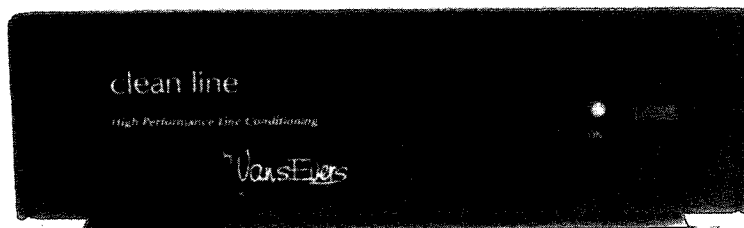
Although I feel that power supply voltage regulation is fundamentally good, the complexity of most regulation schemes betrays their benefit. The 0C3s do a fine job for a minimalist regulator and add priceless esthetic appeal. After all these years, I still giggle every time I see them hit excitation voltage.

To ensure good regulation, the current limiting resistor is sized so that current through the VR tube is below the maximum allowed for the device. In the case of the 0C3, this is 40mA. For best regulation, limit it to about 80% of maximum. We also need to make certain that at all times the plate sees a voltage higher than the minimum excitation voltage. The 0C3 needs a minimum of 133v, or 266v for the series pair and at least 5mA.

The output voltage is the voltage drop across the tube, which is 103v or 206v for the pair. For this Class A stage, the load current is pretty stable and within the load

## Professional-quality powerline conditioning

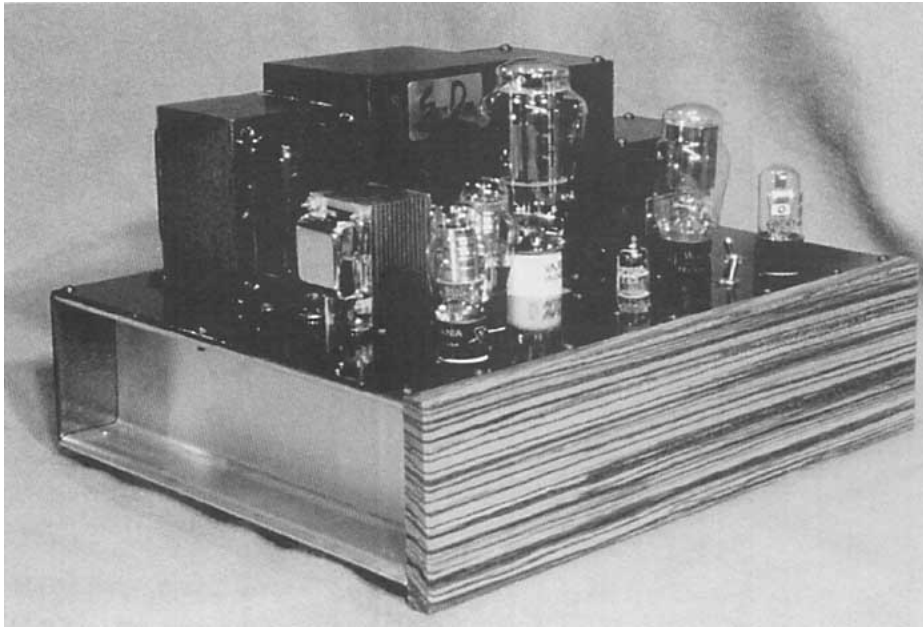
by: **VansEvers**



Clean Line Model 83 shown above  
Other powerline solutions from \$12.95

**1250 East Hillsborough Ave, Tampa, FL 33604**

**813-239-0700 813-239-0805 fax**



rating of the VR tube so I just used that for the tube current. The series resistance is calculated as  $R = (V_{in} - V_{excitation}) / I$ . The excitation voltage for the OC3 is 133v, as mentioned above.

So how does it sound? The VV52b is a crystal clear, detail king, without the high frequency sizzle one associates with an "audiophile" sound. The bass is authoritative and punchy. Being a bass player, this is very important to me. I was originally going to use a PP845 design for the bass and biamp but after listening to this amp I have decided to just use it full range. I will save the biamp rig for when I get bored and have to add something to the system—you know how that goes!

The cost of the Kron VV52b and the corresponding plate choke, combined with the limited availability of the 7788 has prompted me to offer some alternative suggestions. These will still produce a great sounding amp, even a bit more romantic.

As an alternative to the VV52b I suggest the 845. It can be run at the same plate voltage at a more moderate current than the VV52b, although I did prefer the 845 sound at a higher plate voltage. In my prototypes, I raised the plate voltage by simply moving one of the 20uF caps from the first filter stage to the front of the choke. This replaces the small pre-choke cap and converts the supply to capacitor input, raising the output voltage.

When I did this, the series resistor for the OC3's needed to be increased to allow for the higher B+ voltage. If you want even

more volts, you can convert to a full wave bridge. I would choose solid state diodes, followed by a damper diode, or four dampers if you don't object to the added resources.

Alternatively you could choose 816 or 866A MV rectifiers. Of course for the 845 you will need to substitute a 10v filament transformer for the 5v one used for the VV52b.

The 845 version doesn't have quite as much punch in the bass and the highs are not quite as glistening, but it makes up for it with a lush midrange. In fact it is a hard choice between the amps because they are good at different things. One bonus of the

845 is that the lower current requirements allow substitution of a MagneQuest B.A.C. 50H, 80mA choke, saving both money and weight.

As an alternative to the rare and subsequently expensive 7788, I suggest using the cascade 5964, 5965/7062/E180CC or 7119/E182CC and using the stock Sowter 8423 (5K) interstage. Some of these will require adjusting the B+ voltage, for instance replacing the OC3 stack for a single OD3. Some also have enough gain, in cascade, to allow wiring the interstage secondaries in parallel (1:1 ratio).

Not shown on the schematic are two negative temperature coefficient (NTC) thermistors, known as inrush current limiters, placed in the primary of each filament transformer. These are resistors that start out at some higher resistance and then decrease in resistance as they heat up. They act as a soft start for the tube filaments. Your expensive tubes will appreciate the gesture. For the 7788 you can use the Keystone CL-130 (Digikey #KC013L) which starts at 50 ohms and settles out at .75 ohms. It is rated at 1.6A. For the VV52B I used the Keystone CL-190 (Digikey #KC019L) which is rated at 25 ohms going to .4 ohms at 2.4A.

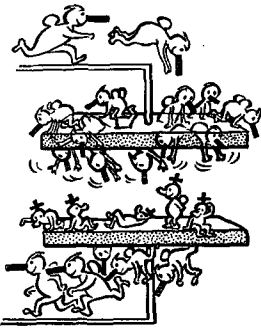
The chassis design was intended to occupy the space of a conventional audio component and fit between the rails of an EIA relay rack. Some experimenters have noted microphonics problems with the VV52B. Although I have not experienced this with my prototypes, I chose to mount the socket on a subchassis suspended from the main



chassis with rubber standoffs.

The chassis is comprised of a single plate of 1/8th inch aluminum with a bent section that forms the top and back panel. The sides are 4x2 inch aluminum U channel extrusions and the front is machined out of rough-cut selected Zebra wood. The finish on the top and back panels and the transformers is black Hammerite. This completes goal number 3! A fine-looking piece if I do say so myself.

Contact the author at  
grego@europa.com



**UNITED STATES POSTAL SERVICE** Statement of Ownership, Management, and Circulation (Required by 39 USC 3685)

1. Publication Title: **SOUND PRACTICES** Issue Date: **10 OCT 97**

2. Issue Frequency: **QUARTERLY** Number of Issues Published Annually: **4** Annual Subscription Price: **\$30**

3. Complete Mailing Address of Current Office of Publication (Not necessarily street and ZIP): **1306 FERNWOOD RD, AUSTIN, TX 78722** Complete Mailing Address of Headquarters or General Business Office of Publisher (Not street): **372-467-013**

4. Complete Mailing Address of Publisher: **SAME**

5. Complete Mailing Address of Owner: **JOE ROBERTS, 1306 FERNWOOD RD, AUSTIN, TX 78722**

6. Complete Mailing Address of Known Bondholder, Mortgagee, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box: **SAME**

7. Tax Status: **JOE ROBERTS, 1306 FERNWOOD RD AUSTIN 78722**

8. Publication Title: **SOUND PRACTICES** Issue Date: **155 JUL 97 - SUMMER 1997**

10. Total Number of Copies (Net press run)	11. Total Number of Copies (Net press run)	12. Total Number of Copies (Net press run)
6250	6500	6500
3047	3014	3014
1373	1165	1165
4420	4179	4179
60	120	120
209	246	246
269	366	366
4689	4545	4545
1633	1955	1955
137		
6439	6500	6500
94290	9197	9197

13. Signature and Title of Editor, Publisher, Business Manager, or Owner: **YOUNG HAN EDITION** Date: **10 OCT 97**

14. Signature and Title of Publisher: **YOUNG HAN EDITION** Date: **10 OCT 97**

15. Signature and Title of Editor: **YOUNG HAN EDITION** Date: **10 OCT 97**

16. Signature and Title of Business Manager: **YOUNG HAN EDITION** Date: **10 OCT 97**

17. Signature and Title of Owner: **YOUNG HAN EDITION** Date: **10 OCT 97**

18. Signature and Title of Bondholder, Mortgagee, and Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

19. Signature and Title of Known Bondholder, Mortgagee, and Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

20. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

21. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

22. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

23. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

24. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

25. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

26. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

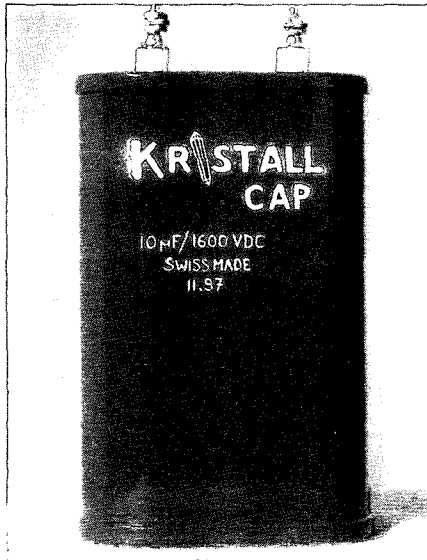
27. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

28. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

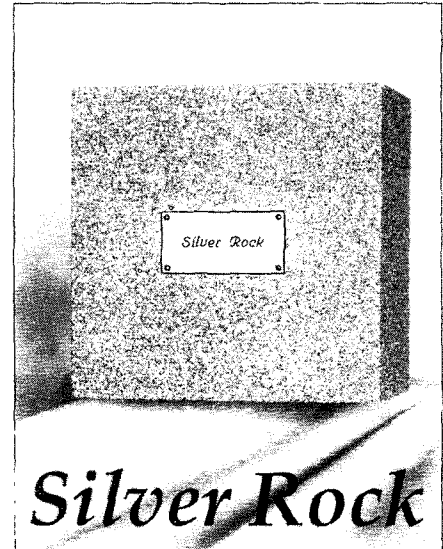
29. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

30. Signature and Title of Other Security Holder: **YOUNG HAN EDITION** Date: **10 OCT 97**

It is not enough to put oil into a capacitor to make it musical...



It is not enough to use silver wire for a good single-ended output transformer...



There is only one optimum solution for a given problem

Audio Consulting / 14B chemin des Vignes / 1292 Commugny / Switzerland  
Fax: +41 22 960 12 59 / e-mail: serge.schmidlin@span.ch

The best midrange horn available can now accommodate any driver!

# The edgarhorn 300 Hz Round Tractrix Horn

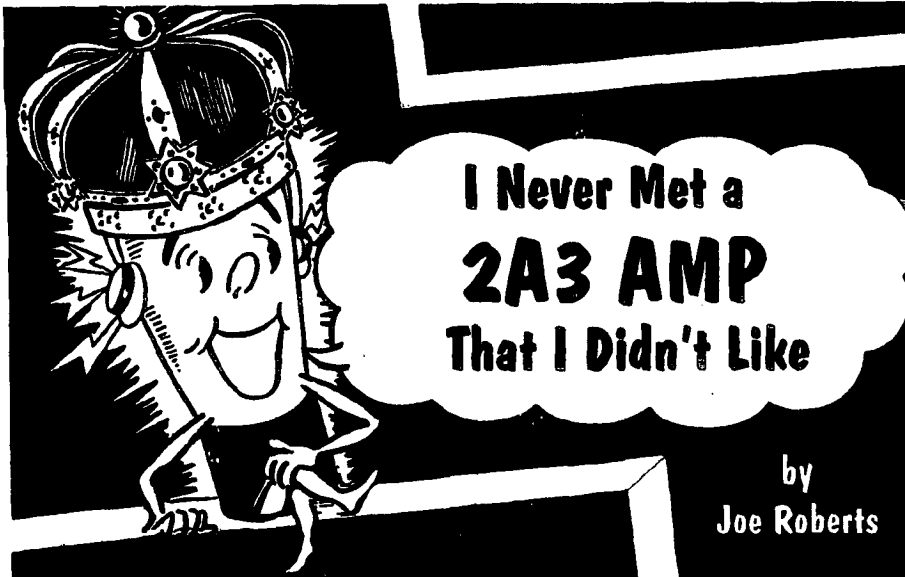
Hand-turned from Western Maple

2" dia throat (EV, JBL, TAD)	\$1200 pr
1.4" dia throat (Altec)	\$1200 pr.
1" dia throat (TAD, Altec)	\$1300 pr

## edgarhorn

2113 S. Vermont  
Torrance, CA 90502  
310-782-8076 voice  
310-371-8085 fax





# I Never Met a 2A3 AMP That I Didn't Like

by  
Joe Roberts

Nothing in audio is a sure deal but if I were forced to come up with a foolproof recommendation to stake my name on, I would have to go with the classic no-brainer: "It's hard to build a bad 2A3 amplifier."

There might be some bad ones somewhere but I have to say that every 2A3 amp I ever had the pleasure to hear was at least pretty good and some were downright amazing.

My introduction to triode amps came with restoring a few Brook 2A3 amps of the early 1950s, which I didn't get to hear until they were certified antiques in the early 1980s. Even in the late 1940s/early 1950s when they were current models, the Brook designs were a throwback to prewar technologies (see SP#2), valued by a few purists who knew that those newfangled pentodes were nothing but a sell out.

The Brook 10C wasn't even a pure Class A design or anything. It used a sliding bias adjustment scheme to switch the push pull 2A3s way into AB2 when the signal peaked. Yet, despite this elaborate and somewhat dubious conception, the 10C still sounded very very good. Real, real good, in fact.

In an attempt to come up with a simpler amp than the Brook 10C, I built the "Recording Amplifier" shown at right (minus the mic preamps). Glory, this was a mighty fine sounding amp and I'd build another one in a second. The "triode sound" is still really there with PP topologies and...*Man*, you can really get some low end out of a pair of these tubes. After all the 2A3s were chosen to run a record cutting head because of their good damping

behavior even sans feedback.

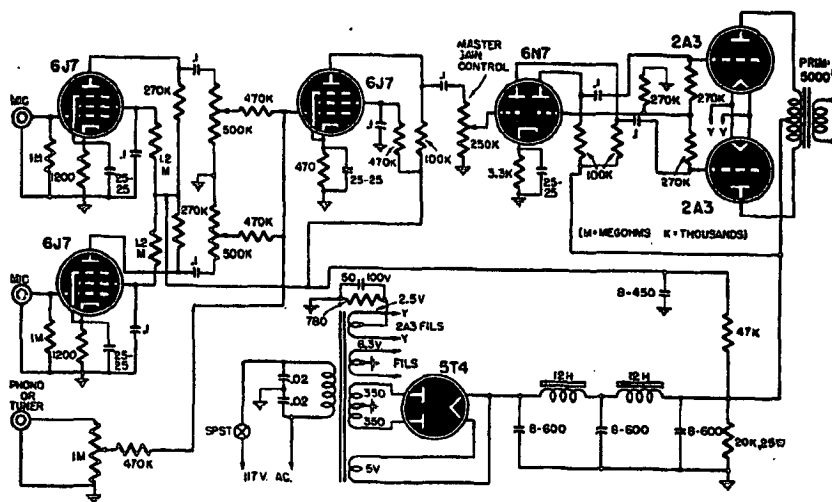
Yeah, somehow PP 2A3s fell through the cracks in this age of SE mania, but, on the other hand, maybe a single 2A3 amp is about as good as it gets. My first exposure to SE amplifiers was a shot in the dark. I

many of my vintage push-pull UTC LS-55 transformer.

When I turned this Frankenstein on I was floored. It sounded *way* better than it should have. It was a looser, more open, more organic sound than the PP 2A3, and although the bass wasn't as tight as the PP amp, it was very expressive. This experiment was obviously taking me somewhere I thought I might like to be.

Now, after years of study and experience, I might comment on how the 6J7/2A3 combo is reminiscent of the classic WECO Model 91 pentode driver/300B circuit and blabber on in an Ultra-Fi "dress-to-impress" patois about esoteric bullshit that doesn't matter anyway. Seems like everybody is a triode amp expert today, but back then I didn't know anything but what I was hearing. That's all I needed to know. The rest is history.

One of the things that I know now that I didn't back then was that Nobu Shishido, one of the "crazy Japanese guys" who revived the triode amp, wrote the first article about SE in the modern era in a



10 Watt Push-Pull Class AB1 "2A3 Recording Amplifier" from 1948

remember looking over a SE 2A3 circuit in the 1940 *Radiotron Designer's Handbook* (third edition), provided as an example for calculating the response of the circuit and thinking "Hmmm?"

With a few voltage adjustments, I figured I could scrape a single amp out of my "Recording Amplifier" by hooking the 6J7 straight into the grid of one 2A3. I didn't have any SE transformers back then. I just ran the DC through the pri-

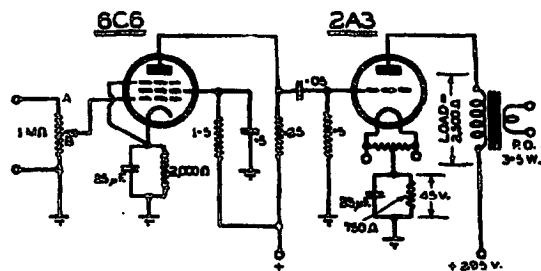


Figure 1

Radiotron example circuit

Japanese experimenter mag about a 2A3 "Loftin-White" he originally built from dumpster TVs while an MBA student in Oregon during the late 60s.. He didn't "go single-ended" to be hip. It was a cheap and easy way for a poor tinkerer to get some music playing in the dorm. Anyway, that amp ruined old Nobu for life.

The last SE 2A3 amp I built was inspired by JC Morrison's degenerate Loftin-White lash-up called the *Micro 3.5* from SP #6. The custom features of my implementation included a bank of *Western Electric* oil caps and a tasteful pink-and-white speckle over gray primer paint scheme. There were only a few lonely parts underneath that big, ugly "budbox" chassis, making it an air box beyond anything ever dreamed up by the mass marketeers.

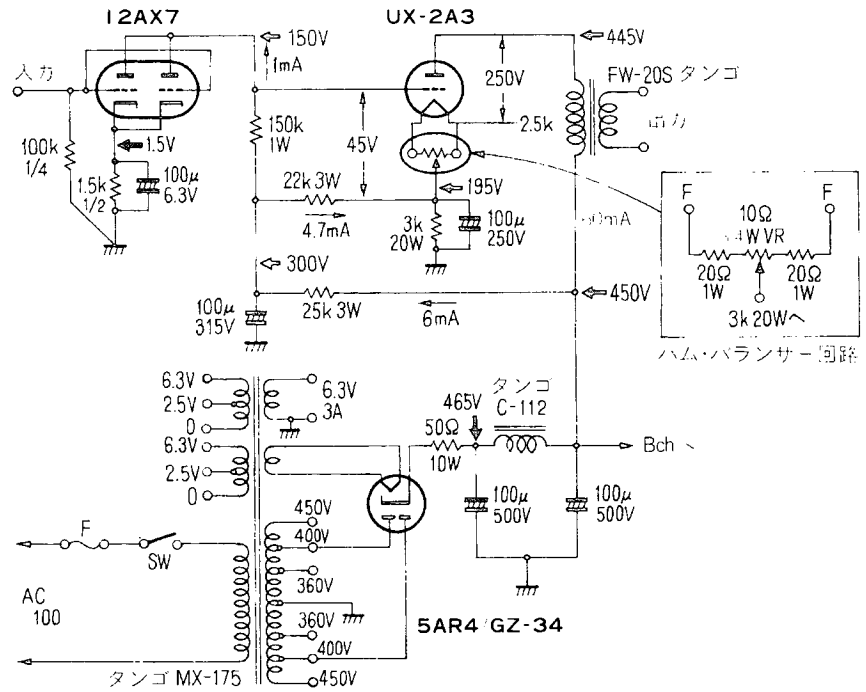
Also, I used indirectly-heated 6A5-Gs instead of directly-heated 2A3s, which sounded just like real DHT 2A3s to me but there was zero perceptible background noise even on a horn. It was a weirdo, one-off creation and no big looker, perhaps, but this amp kicked ass and took names, I swear!

I gave the 6A5 amp to a Korean friend of mine, who eventually lent it to a hi-fi magazine editor back home. The editor has since refused to return it, probably because it sounds better than almost anything you can buy! No surprise there. Look, it showed up in the pages of a Korean audio mag!!

Nobu Shishido probably loves the 2A3 as much as any man who ever walked the earth, but he has moved on in his own technical/aesthetic quest to exploring the grid circuits of transmitting tubes and the practical work of restoring old opera 78s. He downplays the 2A3 with a been there, done that attitude—"Sure the Loftin-White was a great amp but if it was *that* great why isn't everybody listening to Loftin-Whites?"

I'd be the last person to argue against audio diversity and the forward march of progress, but I do believe that everybody should be required by law to enjoy the pleasure of a good SE 2A3 amplifier for a while. There is great reference value in knowing how much you can get with so little.

Fortunately, in this day and age, you can buy super-quality parts to put together a 2A3 of your own, or buy USA-made 2A3 amps, your choice of finished or kit form. For the last 60 years, you had to *really* work to hear 2A3s, but now it's probably easier than it's ever been. That is a strange historical fact and the more I think about heavy historical facts like that, the more I want to stop thinking, spark up a 2A3 myself, and just listen, if you know what I mean.

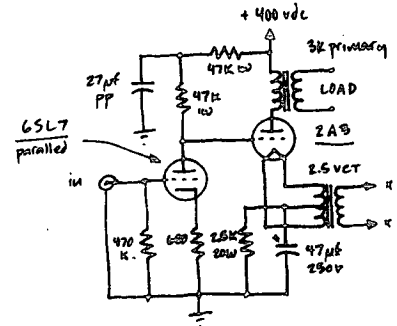


**Above: Nobu Shishido's famous 2A3 "Loftin-White"**

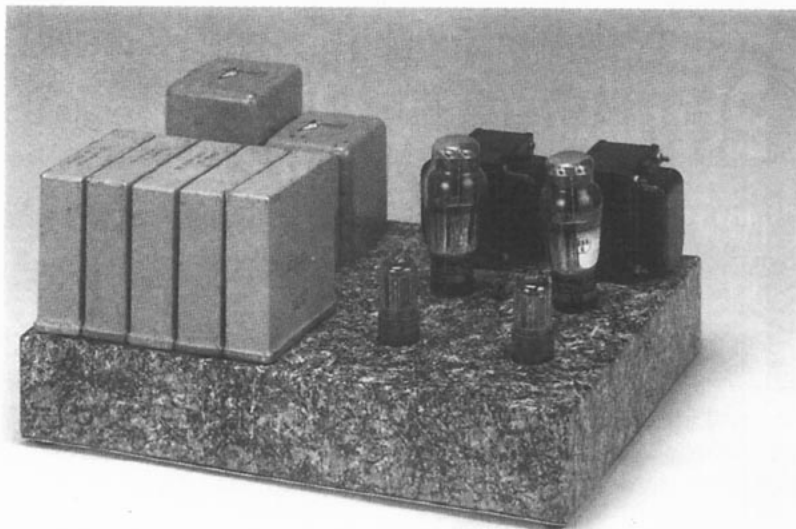
**Right: JC Morrison stripped down Micro 3.5 from SP #6**

**Below: My homebrew Micro 3.5 made the news in Korea!! Don't know what they said about it but I'm sure the words "kicks butt" are in there somewhere**

**MORRISON MICRO 3.5W TRIODE AMP**

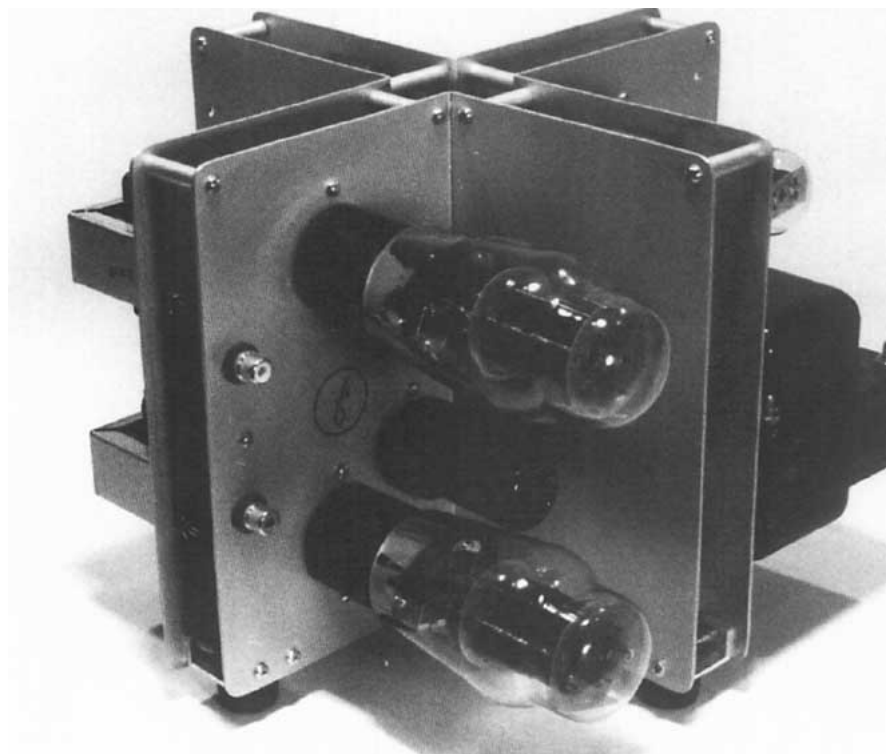


**플레인 지 스피커의 매력**



6A5G관 진공관을 사용한 이 앰프의 출력은 약 3.5W. 그 불꽃없는 모습과는 달리 음질만은 매우 매력적이다.

의 능  
기 위  
할 것  
프레  
구해  
상상  
도  
앰프  
나  
로 빈  
각한  
적  
는 격  
세  
였다.  
1  
부분  
이  
커의  
성  
있어  
서  
에이  
징  
커의  
섯



# Fi “X”

## direct coupled 2A3 SE

\$895 with Hammonds  
\$1175 with MQ iron

in the city. Don might remember this, since the “X” circuit adopts a staunchly minimal pose from the standpoint of parts count. This unit is a ruthlessly pruned-down version of Fi’s regular 2A3 direct coupled amp, itself already a lean, mean, low parts count machine. The “X” is the Sid Vicious of 2A3 amps. Time to get out the New York Dolls records.

Minimalists take note: the “X” is almost the least hardware you can use for the job— a pair of 6SF5 metal high mu triodes with the plates wired straight to the grids of the 2A3s, a couple resistors and a few electrolytic bypass and filter caps. If simplicity is a virtue, the “X” is a saint. There isn’t one extra screw in the whole assembly.

On the other hand, Garber does spring for a tube rectifier, which I was very glad to see, because I know it makes a big difference in the musical flow of an amp’s presentation. It’s reassuring that Fi didn’t skimp down to the 10 for \$1 silicon rectifier level of minimalism, but instead chose the inefficient, wasteful, purist high road. This amp wouldn’t be what it is without that tube rectifier— it’s as simple as that.

The “stock” trannys are \$75 a pair Hammonds, with MagneQuest DS025s available for an additional buck-fifty per channel. When quizzed, Don seemed non-committal on the value of the \$280 upgrade, saying the difference was “not as different as *some* people might like to think.”

I still don’t know what the heck that means, but I detected the distinct musky aroma of a reverse-cool parts choice statement in there somewhere. So, I told him, “Look, I useta live in New York myself, just hold the iron, cut the price, and I’ll install my own pair of Magnequest trannys.” Had some MQ TFA-204s I shook Mike LaFevre down for sitting idle on my workbench and

I could hardly believe my eyes with the “X” ad spread out in front of me. First of all, you have to ask “What is it?” The answer is that it’s a stereo 2A3 single amp. Who would have thought?

I don’t usually get sucked in by slick advertising campaigns, but the second I saw the ad for the Fi direct coupled 2A3 “X” amplifier, I immediately had to own one. As a homebuilder, I don’t often get the urge to whip out the Amex card for storebought gear but the “X” really hit my button hard.

Despite all the charms of the 2A3, “best tube” according to many confirmed triode nuts, there isn’t much perceived desire to own three watt amps yet. People just don’t realize what they can do, yet.

Fi’s Don Garber has always made 2A3 SEs and I think he always will. Among professional American amp makers, Don is alone in his unswerving dedication to the ancient 2A3, half-pioneer, half-keeper of the faith, and half-artisan—a man of many halves.

“Mr. 2A3” Garber is also in a class of his own as far as visual design goes. You would think you might have to go to Italy or something to get this kind of symbolic *objet d’art* approach to amp design, but Don just dreamed it up while riding home on the subway, “A freakin artist,” as they say in New York.

The “X” Amplifier is truly The Death of the

Box. The insides of this amp are mainly on the outside. Actually, it’s hard to say what is inside or outside. It reminds me of a revolving door.

Anyway, when my eye settled on that glossy b&w “X” promo snapshot, I instantly decided that I could never be cool again until I had the “X” playing in my system. And, aside from the unquenchable thrust to maintain a hipster self-image, always the best reason to buy audio gear, I had just rebuilt my bi-amp horn setup, using TAD 2001s and Altec 1505B multicell horns. I knew that a single 2A3 would be just the thing to run that overgrown fifteen cell tweeter.

If one could say this amp is art, and I would say so, it is industrial art. It is meant to be plugged into the wall and turned on and used. And treated with some due respect—the open nook and cranny construction and silky aluminum surfaces of the “X” invite the eye and hand, while the B+ terminals lie within reach, daring the uninitiated finger to probe the mysteries of its forbidden interior...

I later found out that Garber *usually* ships the “X” with a protective metal shield, but he shipped mine bare. Now I *know* he’s trying to off me, before it was all just talk.

Back in early-80s NYC, the “X” motif was tied in with the whole punk sparseness aesthetic that was so hard to avoid if you lived

they were already paid for and broken in, know what I mean?

That may be, but now I feel like I lost out on the cheapo/minimo posture of using the Hammonds and now I wish I had those cheap Hammonds for the urban coolness factor. I know the MagneQuests are probably technically better transformers, but so what?

Visual aesthetics aside, in terms of musical refreshment, I must say that the Fi "X" marks the spot. It's definitely worth the risk of painful electrocution to enjoy an amp with a rich soulful presentation that quickly puts me in the right mood like this amp does.

To generalize, the Fi amp has more of a celebratory musical posture than an analytical presentation, and this is what I am looking for to run my HF horn. It has a soft, seductive, whispery quality that makes me feel like it is singing right into my ear.

I must say that nothing in my experience compares with a good 2A3 in terms of getting just the right balance between *dramatic* and *natural*. A 300B can be more dramatic in some applications, and done well that can be mindblowing, but you always know you're getting a show. The 2A3 pose is perhaps a tad more restrained and a bit easier to believe most of the time.

That said, I wouldn't want to imply that the "X" is a *neutral* sounding amplifier at all. It delivers the full psych-o-delic special effect that triode amps can produce. The "X" creates a narrative drive beyond the usual realm of realistic reproduction, edging into a kind of intimate hyperrealism, but don't knock it until you've tried it. No matter how long I sit there trying to understand and deconstruct the 2A3 illusion, it doesn't go away.

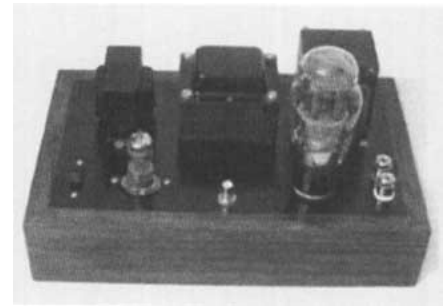
I expected top midrange out of a DC 2A3 and I got that with the "X" but the unexpected BASS performance on my Altec woofer definitely put some funk in my trunk, with grunt factor well beyond my expectations. I do get a bit more weight and control with my "big" 18W pp 6BQ5 Dyna ST-35 on the woofs, but in terms of punch and rhythm, the "X" was no slouch. A cute and effective rig up would be a pair of "X"s for a one-"X"-per-side bi-amp arrangement.

H'mmm, maybe I can work out some kind of involuntary payola arrangement with Don Garber, once he knows I know he usually ship the amps with a metal safety cover—either that or "Move over Jimmy Hoffa, Mr. 2A3 goin out to summer camp in the Meadowlands." They'll be saying, "Yeah I remember Garber, the guy made a helluva 2A3 before he went to Jersey!"

# ELECTRONIC TONALITIES

## AFTERGLOW

### 2A3 Direct Coupled Mono Kit Amps



No article called "I Never Met a 2A3 Amp I Didn't Like" would be complete without reference to a 2A3 amp I never met. So, before I even get close to finishing, here's one that I only read about: The \$849 *Afterglow* kit from Electronic Tonalities.

Like the Fi amplifier, the *Afterglow* is a direct coupled amp but, unlike the classical Fi "X" 2A3, the Electronic Tonalities design pursues a relatively high-tech approach to a simple two-tube circuit. North Texas amp guru John Camille and ex-Texas refugee to Washington State, John Tucker were involved in this project and those blokes are well known to prefer slick neo-technology over the "Pass the Radiotron, Dear" retro scheme a lot of tubeheads opt to pursue. If this were 1962, these guys would definitely be toting foot-long slide rules on their belts, I'll tell ya.

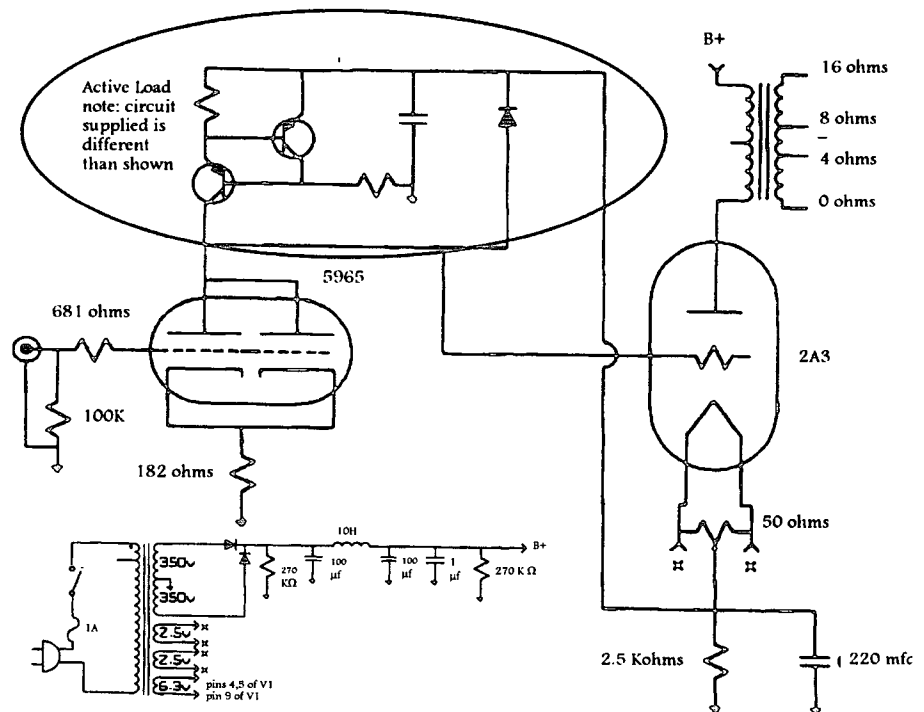
The driver is a paralleled 5965 running into a Camille C4S cascode constant current source contained on a little circuit board.

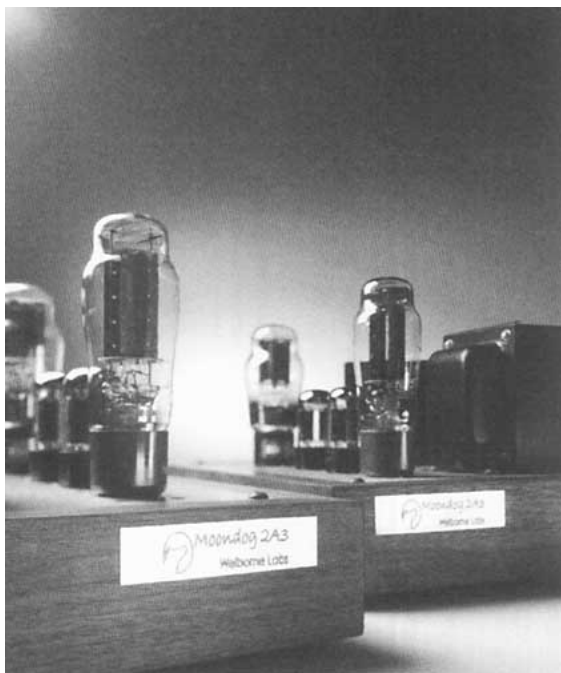
The advantage of this hookup is that the driver tube sees an *extremely high* load impedance (>5 meg $\Omega$ )! They sell the board separately if you want to mess with it.

Since I never heard the amp, obviously I don't have too much to say about the sound. ET's Dan Schmale says that the *Afterglow* is a very clean sounding piece: "A high level of sonic realism is achieved by the direct coupling of these stages"...blah, blah, blah. Know what, though? I believe him.

The *Afterglow* uses the little \$99 TFA-204 from MagneQuest, a good sounding cheap transformer that I used in a number of amps, including my Fi "X." It might not be the best or fanciest output in the whole wide world, but it's good enough for me.

According to the book, the *Afterglow* is good for 2.4 W at 5% distortion and the measured frequency response charts out at -1dB at 28 Hz and 19 kHz. But who cares?—nobody buys 2A3 amps from the spec sheet anyway.





# Welborne Labs MOON- DOG 2A3 monos

Kit Less Tubes \$1149

a throwback to a long-dormant 1930s all-triode amplifier paradigm, back from the ashes to play the music for the turn of the century.

Although I might have an intellectual reaction to a circuit, in one way or another, I don't really know how to think about the sound of a given circuit. A circuit is just an abstract picture until you build it out of real-world parts. And it is a particular combination of parts that gives each amp its actual sonic character. Often in my experiments with things like 2A3 single amps, I found that a coupling cap swap could impart more flavor than installing a whole new driver stage.

That being said, I still feel good about the *Moondog* schematic. You won't get burnt sticking with a classic framework like the two stage medium mu triode *Moondog* voltage amp stage and a 2A3. This approach has become a classic for many reasons, one of

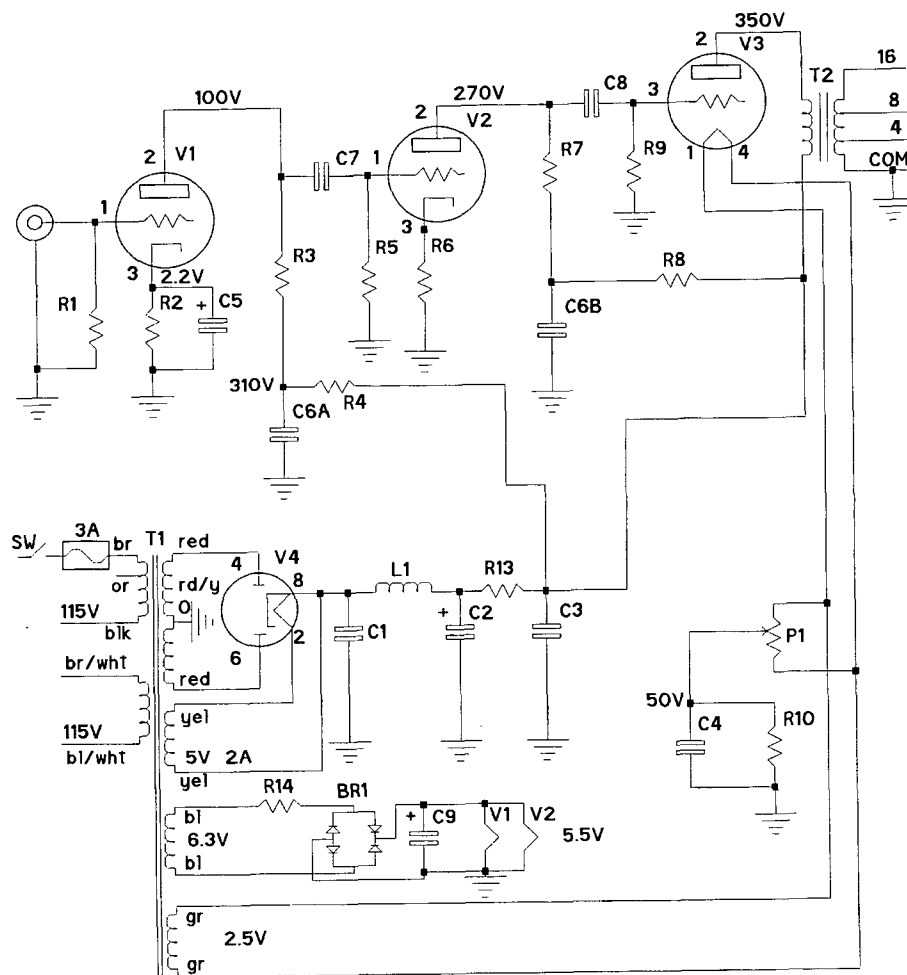
I really like the name of the *Moondog* 2A3 monoblocks from Welborne Labs, and not only because there is a certain timeless quality of regularity and dependability evoked by that lunar imagery. The cyclical theory of history implied by the endless gyrations of this ancestral audio tube, for those who like a little millennial poetic justice and tidal forces with their audio gear.

Beyond all that deep interplanetary symbolism, the name *Moondog* dares to speak the obvious truth—that anybody who has to have a 2A3 amp probably too far gone into audio lunacy to relate to normal society anymore.

And Ron Welborne is in a good position to know about that freaky triode crowd. Hey, Ron, do sales go up during the full moon or what? After all, *you* came up with the name, buddy!

Consistent with the access to ancient natural secrets and dedicated insanity implied by the *Moondog* title, these amps feature the kind of classic technology that is hard to argue against. GZ-37 tube rectifier with a pi-filter using a choke, a pair of 6SN7s and a 2A3. Output transformer is the MagneQuest DS025, my personal favorite Philadelphia-wound transformer.

This amp is a solid, traditional, and somewhat conservative design and, in those respects, it represents what is worth keeping from the retro concept. Except for the DC heater supply for the 6SN7s, the *Moondog* is



**Basic circuit layout of Moondog 2A3. A complete schematic, including part values is available in the kit manual (\$15 refundable with kit purchase)**

Moondog 2A3 Amplifier  
Welborne Labs  
Copyright 1998

them being that a simple circuit that sounds good is a tested recipe for satisfaction. Getting fancy isn't always the point.

The *Moondog* might borrow from bygone traditions, but this amp does not sound very antique at all. I believe that's because of those modern hi-tech components. In these simple, no-feedback amps, you can really hear the parts, every single one.

In the instruction manual, Mr. Welborne says that at first he tried the vintage carbon resistor and oil/paper cap scheme and they were impressed with the tonal results. Then, after swapping in some boutique bits from the Welborne parts catalog, such as Caddock foil resistors, a couple Mills wirewounds, ELNA Cerafine caps, Hovland MusiCaps, and whatnot, Ron felt that they had to go with the fancy stuff for modern audiophile performance aspects, like big soundstaging and sonic detail resolution.

Welborne, ever eager to please, is willing to customize the kit per the customer's individual audio fantasies, so if you're after something special, give the man a call. It's a kit, after all, so if you want to mellow it out with an oil cap or whatever, who's gonna stop you? Certainly not Ron Welborne. He'll even sell you the damn oil cap!

On the whole, the quality of the hardware and components that go into the *Moondog* kit are on the level to be expected from a specialist parts guy: Cardas connectors, OFC wire, name brand components out the wazoo. The *Moondog* package doesn't go over the top with swank and elaboration but there is no junk in sight.

The *Moondog* monos are packaged in the brass plate and walnut wood frame style seen before with the *Laurel* 300B amp. The look is natural and unadorned with a sort of rustic manly character. The amps look handcrafted rather than mass-produced, which is exactly what they are.

Like I said before, I think it's those new-fangled *Welborne Catalog* components, but the *Moondog* I heard, Ron's personal stock *Moondog*, tunes the antique 2A3 for the modern 1990s wide-bandwidth, high-resolution aesthetic. The 2A3 is capable of presenting an astonishingly natural, high-definition 3-D scenario and this amp showcases that impressive trait.

This is one of the important things triodes can do: that very detailed presentation with enough harmonic depth and color to get the emotional encoding of the tones across. In my opinion, the added color

imparted by the 2A3 is just what is needed to warm back to life that cold analytical concept of x-y-z axis positioning as a goal for hi-fi systems. Perhaps some "imaging" is necessary for realistic musical portrayal, but it is not in and of itself sufficient to get the illusion across. Imaging for me belongs to the intellectual side of recorded music listening, not the immediate physical communication part. Without that special expressive juice behind it, the image is just a skeleton—the dry, objective component of phonographic realism.

The way some SE triode amps get the audiophile transparency illusion right without sacrificing the vivid life and tonal complexity of music has been a hit with a lot of listeners, including me. Such amps can be shockers to hear.

A clear-voiced 2A3 is especially good at sneaking up on you every once in a while with realism that is scary. Like a bell sound out of nowhere that makes you jump out of your chair. Or how Miles' horn on *Live at the Blackhawk* cuts through the air like a flare. How could anyone not like this magical effect that I'm trying so uselessly to describe?

Since the *Moondog* is being offered in a package arrangement with Lowther Club of America, which I took to suggest a recommendation of the Lowther/*Moondog* combo, I had to try it with my PM6As in *Medallion* cabinets. Indeed, Welborne picked parts using his Lowther PM2As as one of his main reference speaks, so there ya go.

No shock then that the pairing really clicked, as expected. The *Moondog* supported the high-res well-lit effect of the paper cone Lowthers. The incisive midrange added realism where a more flabby mid would have steered the PM6As toward the boozy, lush flavor I got with a lot of my other SE triode amps on my Lowthers. There was something to be said for the tasteful restraint of the *Moondog* in this system configuration.

The *Moondog* also led me to rethink my theory that I really want some feedback on the Lowthers to add control the rear-loaded horn bass. Most no-FB SE amps I've tried on the Lowthers sounded gorgeous in many ways, but more often than not were underdamped in the bottom register.

However, to my amazement, the no-feedback *Moondog* played with excellent low end control, thanks only to the reasonably low damping factor provided by a naked

2A3. The tightness, definition, and punch were right there. Vibrations emanating from tightly-stretched membranes sounded like they were coming from tightly-stretched materials. Good job on the low end.

According to Welborne, most of the people who have been buying the *Moondog* kit own Altecs, Lowthers, or Klipschorns. The K-horn fans are particularly nirvana-stricken with the 2A3s, fitting since Paul Klipsch used Brook 2A3s back in the olden days.

Altec, Klipsch, etc....these are all obvious candidates, but I believe that the clear, crisp, and well-damped character of the *Moondog* would serve the amps well in the quest for matching speakers among the contemporary crop of audiophile boxes.

And if you find yourself in a situation where you think a bit more *whatever* is in order, remember that it's a kit. Feel free to screw around!

#### Comment

Obviously, I liked both 2A3 amplifiers that I heard quite a bit. Although I purchased the Fi "X" before ever hearing the Welborne *Moondog*, I was never stricken with buyer's remorse. Really, I would have felt the same way if I bought the *Moondogs*. Ahhh, 2A3 amps, I love 'em. These are the kind of amps I started building in order to enjoy. I'm really glad to see that you can go out and buy kits and amps like this now.

On sound alone, I could live with either amp, but with my Altec/TAD setup and system goal to build a funky blues/jazz oriented rig, the Fi amp is just the ticket for the job. Plus it fits on the mantle above my fireplace, an essential part of my babyproof scheme. Plus, plus, it is the coolest looking thing I ever saw and let's not underestimate *that*.

With compression drivers, I like a dash of romantic excess in the amp. These TAD 2001 drivers sure don't donate any romantic excess to the system. If I owned the *Moondogs*, I might try sticking in an oil coupling cap for compression driver use, although many would prefer the clean, low-distortion act of the stock amps. Tough to say. What I *think* I want isn't always what I *actually* want when it's playing there in front of me.

On the Lowthers, both amps again did a good job. The Fi 2A3 came across gutsy, rich, and punchy with a full, slightly puffy, and emotive bass. The *Moondog* shifted my attention upward in frequency to the ultra-clean midrange and sparkle effects but had

a low end that was surprisingly crisp and well-articulated for a NFB flea power amp on that rear-loaded bass horn.

Listening to these amps, it was hard to shift into an “amp shootout” review mode, because they both sounded so good in their own ways. I just wanted to sit back and listen to what the amps were doing.

#### **SPEAKERS**

Two of the big reasons 2A3 amps like the X and *Moondog* aren't more popular is that 1) Most people haven't heard anything like this and don't know how good it can be and 2) It does require a leap of faith to expect that there are speakers that 3W will drive. It is definitely difficult to believe, based on the usual preconceptions, that three watts will drive anything. All I can say is “ha, ha, ha.”

I used to think I needed fifty watts *at least*. Now I can bridge the power outputs of my five favorite amps, and the total wouldn't even hit fifty, probably closer to forty, watts.

Obviously, 2A3 and 45 amps are tailor-made for what I like to use 'em for— efficient multi-amplified horn systems. Indeed, with a horn, power ain't nothing but a number, and you can totally ignore the specs and select amplification on the basis of musical performance criteria alone.

One reality we can never get beyond is that there is always a moment of mystery when you hook up a new amp and speaker combination. The challenge is a bit more obvious when the amp is a three-watter, since engineering feats like high-power and feedback are intended precisely to reduce the mystery of the speaker drive equation, and single 2A3 amps do it without those technical advantages.

On the other hand, at least the 2A3s are great sounding amps, which can't be said for many “drive-anything” amps, because what you have to do to “drive anything” is not free in terms of sonic tradeoffs.

It's easy to overplay the case that three watts is more useful than one would think, for these are indeed very low powered amplifiers that we're talking about. However, except for stupid combinations like Apogees or Magnepans + single 2A3s, I think that the quality and quantity of music that single 2A3s would put out on many “normal” speakers is worthy of respect. Three watts will get some sound out of any speaker, not to say that it would be anything great to hear in many cases.

As for specific speakers, well it either works or it doesn't. Only trying it will tell you if a 2A3 will play loud, play only at low-levels, or not at all on a given speaker. It would be nice if there were some specification that would tell us what we want to know, but there ain't no such thing, unfortunately

Speaker sensitivity helps but may not be important as highish ( $>8\Omega$ ) impedance and general voodoo synergism that applies to system matching. Simple or no crossover designs seem to work out a little better than lossy, complex networks, for obvious reasons, but anything is worth a shot because you never know.

Now that the speaker makers are hip to horns, isn't it time for the single-driver full range revival? Man, that's what we need! I still don't think I ever beat that pair of Altec 755A eight-inchers in 2 cu.ft. wall cabs that I had when I first started messing with low power. Lowthers are good but let's have something we can just stick into a plain old rectangular box and be done with it.

In various pockets of the globe, full-rangers like Diatones, Fostex, Supravox, Siemens, have their devotees, but the US scene never got hip to this classic low-intensity approach. True, single-cone drivers usually can't “do everything,” but, for this kind of thing, it's more important how well they do what they do, mainly the mids.

The way *not* to try a 2A3 on a “regular” speaker, exactly the way most audiophiles would probably do it, is to pull out an old copy of *The Sheffield Drum Record* or “1812” and immediately crank the program up until the amp clips. Sure, it will clip. What did you think?

The right way to try out a low power amp with a “regular speaker” is to go ahead and listen to music as you ordinarily would and see how it works out. What usually happens is that it sounds pretty good, but while you're listening, dreams of horns start dancing in your head. What can I say?

It's strange that amp choice decisions are so often tied in with the speakers already in the listening room, when what we're doing is looking for a new AMP, right? Let's face it, a more productive system-building logic and more satisfying recipe for personal happiness would be to go out and buy the damn 2A3 amp *first* and *then* look for speakers that will work with the new amp. The truth. You heard it here first, fellas!

## **IN MEMORIAM** **Koichi “Nobu” Shishido** **Master Tube Experimenter**



When I heard the sad news that Nobu Shishido died suddenly March 19th on the train home from an *MJ Magazine* party, I had his book open on my scanner, a fresh fax from him on my desk, and this 2A3 article in progress on my computer screen.

I wish that he could have read this article, not that he would learn anything new, but I thought he would get a kick out of seeing what he started many years ago, just like he always did. He was proud of his audio design work, but he seemed to especially relish his role as tube audio preacher.

Nobu was in chancy health for a number of years, but he spent his retirement working tirelessly to stretch the limits of tube audio design. Although best known in recent years for his Inverted Interstage Coupled transmitting tube designs, lately he seemed to consider his main work to be restoration of 78 recordings, even though he still loved tube amps like a little kid.

His last fax to me hinted at his experiments with the new Svetlana 572-3, joking that with the remarkable drive voltages required, “They must have been waiting for a genius like me to come along.” I'll never learn what kind of wicked new driver stage he created this time, but like all the other stuff he did, it was probably one of those things that is perfectly obvious—once Nobu showed us how to do it.

The heroic missionary work begun by Nobu Shishido to tell the world about single-ended directly-heated triodes will surely continue in the power of his ideas. As an ex-advertising man, he enjoyed seeing the world gradually come around to his way of thinking. As a designer and DIY journalist, he participated in building the audio world he wanted to live in. As a friend and teacher, he will be missed by all of us who knew him.

*Joe Roberts*

# OUTPUT TRANSFORMER-LESS OUTPUT CAPACITOR-LESS 6C33 Amplifier

by Fabio Camorani

*Less is MORE!!*

Output transformerless amplifiers have always excited admiration and also devotion in audiophiles. These amps have always been under "special observation" and seemingly always on the verge of revealing themselves as the best product of the field. However, in practice, they have never been considered totally convincing. What are the true limits of such amps?

Mirko Bersani and I tried to find an answer designing a very special OTL tube amp during 1993, a quasi-single ended OTL tube amp. In effect we went behind every previous OTL design. But we thought more and more could be done. And I did more during the following years, thinking about several limits in our original design. When two Italian audiophiles asked me to design custom versions for their systems a great evolution of the original design began.

Here I present those two versions, intermediate steps through the final (?) mono monsters which are the objects of my thesis.

#### INTRODUCING THE CIRCUIT

The origin of this OTL typology was fully described in *Costruire Hi-fi* during 1994/95 (#s 10-11-12-14). Here I write only a few things. First of all, in these two amps there is no feedback, neither global nor local. This is possible above all because they were designed for special and well-defined applications. In "general purpose" amps where the load is an unknown there may be some problems with no NFB OTL tube output stages.

Then, notice that they are two-stage designs, the simplest OTL tube amps I have ever seen. This is possible because they are not push-pull but, using an SRPP

as output stage, we may call them "quasi single-ended" OTL-OCL tube amplifiers.

In effect, the true limit of all push-pull designs is the phase splitter stage, always imperfect even if very sophisticated. And the SEPP is an asymmetrical push-pull stage. The only splitter stage with absolute sound performances is the transformer but I specified the use of no transformer at all (1).

Again, the SEPP stage needs feedback to balance the signals (gain and impedance). So, Mirko Bersani and I searched for a solution finding the SRPP as the natural choice for the job. Stephens used this typology (with 2A3) for the first time back in the 1950s to drive a special 500Ω speaker.

Later Philips used this circuit with EL86 (pentodes) with an output impedance around 1000 ohms (headphones). Other famous examples are the OTL amps developed for direct driving of electrostatic loudspeakers, like the one for Acoustat X (with pentodes).

However, my amps have a lower impedance output stage which is able to supply remarkable currents and to drive more conventional loudspeakers. Some time ago, the famous Japanese magazine *MJ* presented an amp with a SRPP output stage made with a 6080 coupled through a cap to an autotransformer (obtaining a few watts). Speaking with Ken Ishiwata-san at the Top Audio 1994, I learned that something similar to this design was published in Japan circa 20 years ago, then nothing more.

#### THE OUTPUT STAGE

Pentodes are not devices for audio, but they are very good for other applications. So we consider only pure triodes or triode-connected pentodes in this design.

The most useful pentodes are the ones originally used as sweep amplifiers in old television circuits. Such devices have high current capability and low internal impedance but they are not very linear and, since they were developed to dissipate impulsive power, they don't live a long time as output devices running in Class A. Maybe the new Svetlana EL509 is the ticket? It looks to be developed for linear circuits and it has a monster cathode.

Then...triodes. What triode? The most common and interesting tubes for our purpose are the ones from USA developed for series regulated power supplies, almost all with octal base, such as 5998, 6AS7G, 6080 (also WA, WB, WC), 6082, 6336 A/B and 6528, Sylvania 7241, or the deranging Sylvania 7026R. Or the 11A3 Mullard and the Soviet EC19P.

But the output stage reaches the highest level of performance only with the monster Russian triode known as 6C33C-B—although the correct Cyrillic name is 6S33S-V. (2).

#### THE INPUT STAGE

Even though the output stage is greatly responsible for the performance of the amplifier, the real cornerstone of the design is the input/driver stage. This is crucial and very critical. A stage can be designed only knowing what it has to drive. Some goals may be in discrepancy with other goals. The designer has to select the best choices based on listening tests (obvious?).

This input/driver stage must have some particular characteristics. Our choice of SRPP may not be obvious, so let us explain:

#### Low output impedance:

In general, a driver must have low output impedance for a better drive capability. The 6C33 has a very high input capacitance and near clipping is critical (its grid needs current).

#### Good slew rate:

The slew rate should be neither astronomical nor infinitesimal (research and published measurements show music slew rate rarely exceeds 1V/s, nor is ever more than 2V/s and is usually under 0.2V/s).

#### Linearity:

We must adjust the bias to have a low number of distortion harmonics (possibly only the second and the third ones for the whole voltage swing). One can try to have harmonic cancellation with one's particular loudspeakers. However, I do not think it's a very good idea.



Starting from these points, Mirko and I tried some circuits. And we saw that only SRPP reaches the goals. We tried the mu-follower as well. This circuit is the natural evolution of the SRPP and has been described elsewhere (*Glass Audio* #2-1993, #2-1991, TAA #3-1991 and elsewhere). It first appeared in '50s.

The mu follower circuit apparently has no technical defects to argue against it, but we tried it and do not like it so much. We used and continue to prefer SRPP drivers with a very high power supply voltage.

### THE POWER SUPPLY

OTL power amplifiers are, probably, the most sensitive ones to power supply quality because of the unfavorable relation between the power supply impedance and the internal impedance of the amp, among other reasons.

A dual "floating" power supply is typically used with excellent results. In this particular design the reference point for the load is between the filter caps: this point is floating so there is no dangerous DC voltage through the load. Only turning on the amp you have DC voltage in the output, that is during the charge-up of the filter caps.

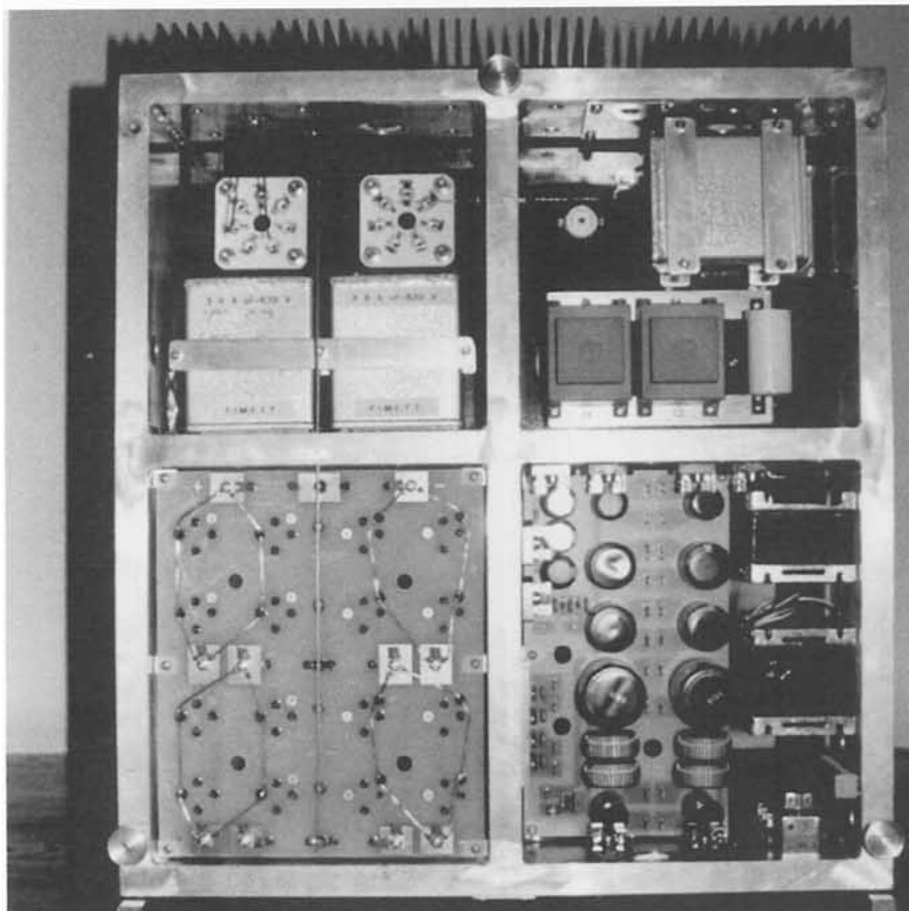
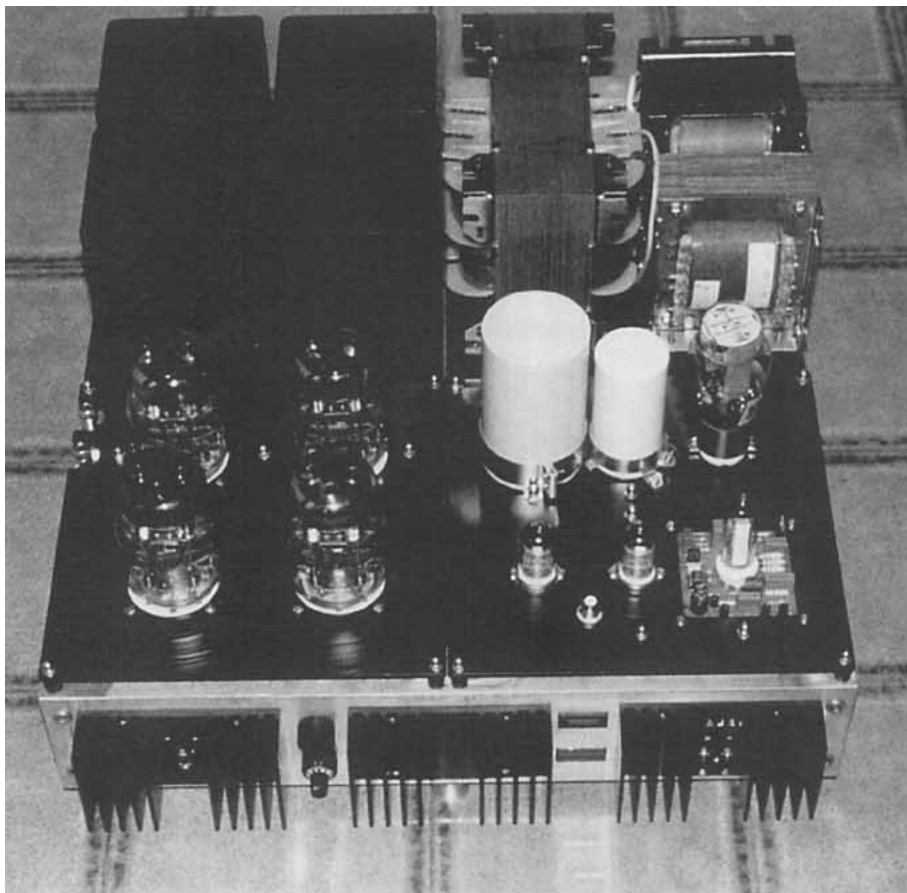
This system compensates for the natural aging of the tubes so you can use your amp for a bit more time between retubings. One would think that in so-called OCL amps there are no caps through the signal path, but this is not true. This is not a new subject, but a lot of manufacturers go on telling the opposite. The current needed by the upper tube (or bipolar transistor, or mosfet, or...) is supplied only by the caps in the positive rail and the current through the lower tube by the caps in the negative rail. So, the capacitors are in series to the signal, without a doubt. There is no commercial design without caps through the signal path!!!

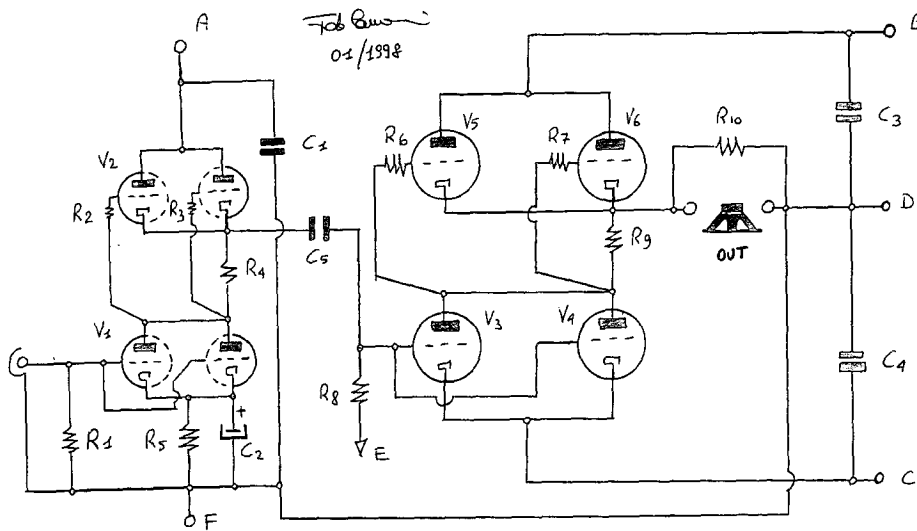
Again, a floating power supply has not only pros but also cons. The generators are in series each other, as well as the caps seen by the generators. In this case, the influence of filter caps is higher so the power supply has an even greater impact on the final sound.

### MORE ON SCHEMATICS AND COMPONENTS

Amp #1 has 4 output tubes per channel and was designed to drive a Quad ESL 63 electrostatic loudspeaker. The schematic is still very simple with a double SRPP as input/driver stage realized with two 5814A Sylvania, selected after some listening tests.

However, the power supply is very complex. The one of the output tubes has a double LC filter per rail, with choke input, and the diodes are soft recovery devices from IR. The





**Amp #1**

R1	220k	1W	Holco
R2-R3	220	1W	Allen Bradley
R4-R5	1k5	2W	Caddock MS220
R6-R7	220	1W	Allen Bradley
R8	47k	1W	Holco
R9	22	50W	Caddock MP850
R10	1k	2W	Caddock MS220
R11-12	150k	2W	carbon
R13-14	4k7	0.5W	carbon
R15	2k	1W	Holco
R16/R21	33k	2W	wire-wound

P1	10k	pot.	multiturn
----	-----	------	-----------

C1,C3,C4	12uF	600V	paper in oil
C2	100uF	35V	Black Gate
C5	.47uF	630V	AudioNote cop.
C6	5uF	600V	MKP
C7	50uF	800V	MKP
C8	140uF	630V	MKP
C9	10uF	450V	electrolytic
C10	68uF	400V	MKP
C11-12	220uF	200V	electrolytic
C13	22uF	160V	ROE electrolytic
C14/C29	1000uF	250V	Philips electro.
C30/C37	0.01uF	1kV	ceramic

L1-L2	10Hy	50mA	300 ohm
L3/L6	2Hy	1.5A	4 ohm

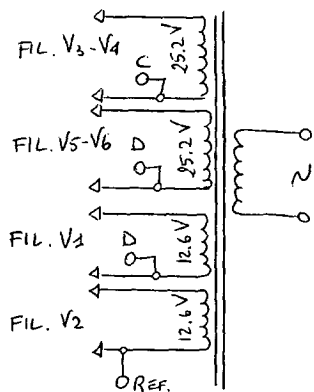
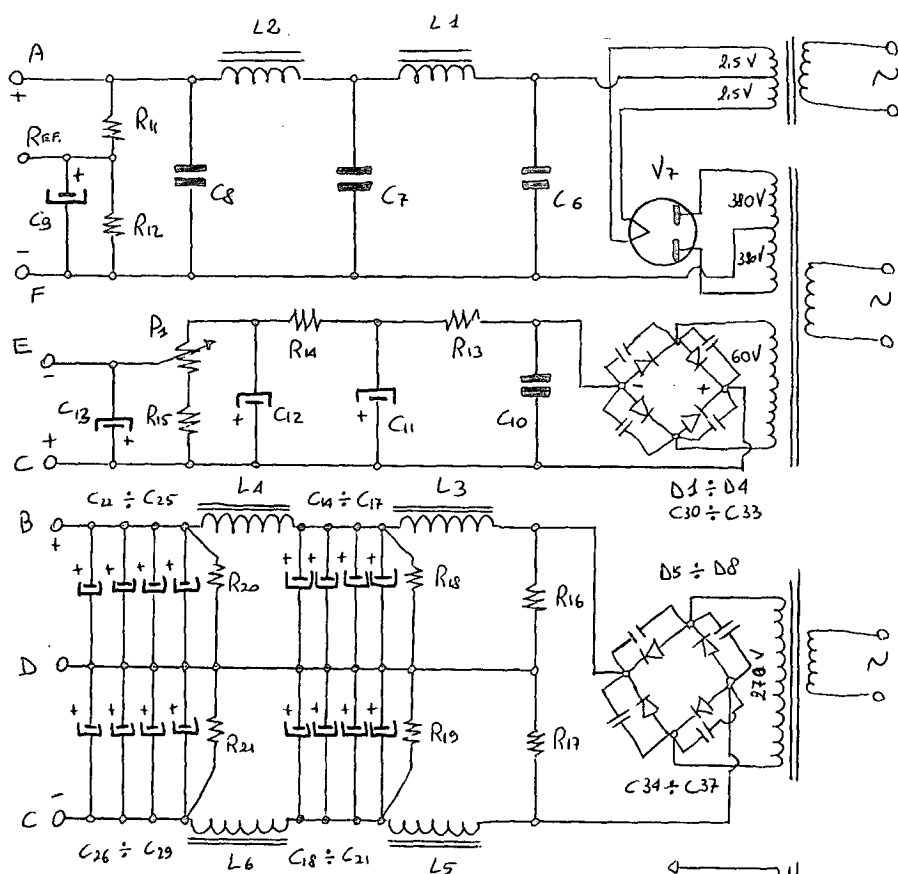
D1/D4	1A	1000V	UF4004
D5/D8	16A	1200V	IR-HFA16PB120

V1-V2	5814A	Sylvania
V3/V6	6C33C-B	Sovtek
V7	5R4GY	Fivre

more common double pi-filter is used in the power supply of the input stage.

The builder of this amp, Mr. Angelo Tondelli, performed a lot of listening tests choosing the best components for every stage. So you can see the amp uses Holco and Caddock resistors, Black Gate and Philips caps, Audio Note copper foil paper-in-oil cap as coupling capacitor. One can use an incredible and expensive ICAR device born for aerospace applications, the ICAR SP25, but it's not so easy to find (it's big too!).

Mirko Bersani and I made a special cap for the first version of the amp (published in CHF), a pure mica/pure copper capacitor using a structure arranged in layers. We still use them in some projects. Mr. Tondelli found AN oil/paper is better in his case. He was working on this project for two years. He claims that he has never heard better amps than these, including the usual high priced high-end ones.



Job Basso  
02/1998

Two views of Angelo Tondelli's four 6C33 tube per side OTL creation

AMP #1

He biased the amp so that he measures around 110-115V across the lower tubes and 90-95V across the upper tubes. This way the amp has circa 20W of max output power with a load of 8 ohms. Feel free to try different working points, adjusting them to your loudspeakers.

Mr. Tondelli used a 7812 three-terminal regulator (not in the schematic) to regulate the filament supplies for 5814As for problems with hum. He is planning to try 6SN7 double triodes, well known and much better than any 5814As or equivalent, especially if by Fivre or Sicté. He is planning to improve the performances by adding more Philips electrolytic caps in the output tubes' power supply.

Amp #2 has six power tubes per channel. The builder, Mr. Giuseppe Intorrella, wanted a bit more power to drive Sonus Faber and Magneplanar loudspeakers. I think a six-tube output stage is, in general, the best compromise with this particular OTL design, offering good interface to the load.

In this case, the driver is more critical because there are three grids to drive. We chose the 5687WB double triode and SP25 oil caps (he used Mallory PCB first). Mr. Intorrella chose to use only one CLC filter (pi-filter) in the power supply due to space problems. The components are again from Caddock, Black gate, Philips, IR etc..

Mr. Intorrella designed and built a circuit with microprocessor control for the full amp. With 6 tubes he can easily obtain 30W output, but he chose to run each tube at 40W plate dissipation, a very conservative level, for a measured output of 24W. It took almost two years to finish the pair of monoblocks.

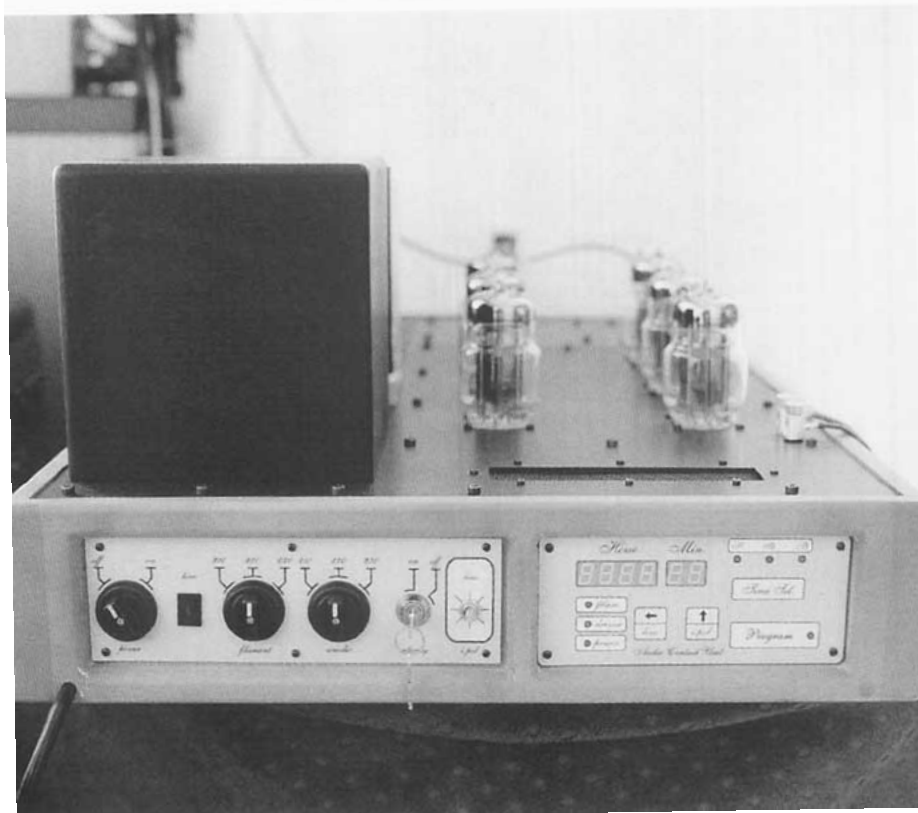
These amps have a very high power supply voltage for the input/driver stage, as mentioned. Both 5687WB and 5814A work very well at high voltages. I chose 450-500V (meaning 225-250V across each tube in the SRPP circuit).

Both amps use fixed bias for the output stage, very strange for an SRPP circuit. Because the upper tubes have a fixed resistor, you have to bias the lower tubes for almost equal voltages between anode and cathode of both upper and lower tubes, circa 400mA per tube. Notice the references for the filament supplies.

Regarding the life of the 6C33C-B power triodes, if used well below their limits (say 75-80% of max power dissipation), I think we can count on at least several thousand hours.

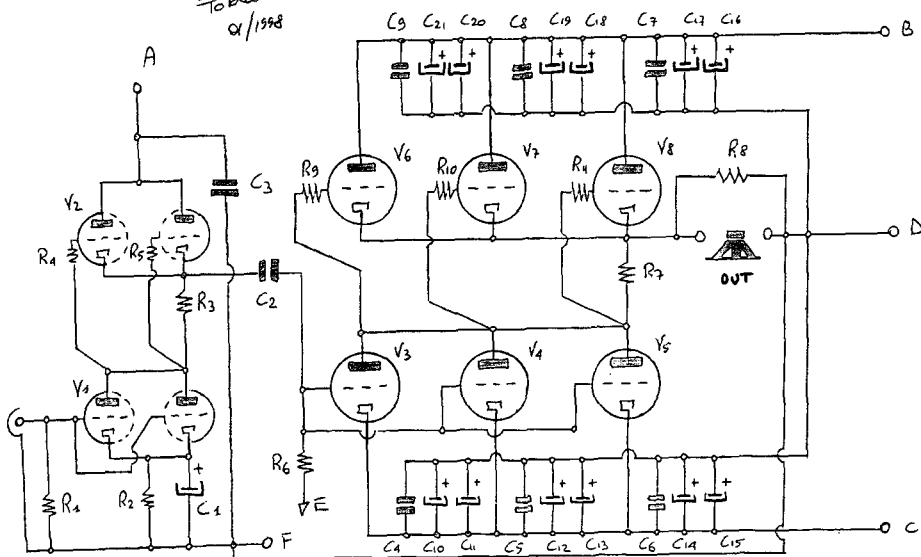
### CONCLUSIONS

In conclusion, I think these are very successful designs, reminiscent of the typical monodiode sound. Obviously, efficiency is not the goal of



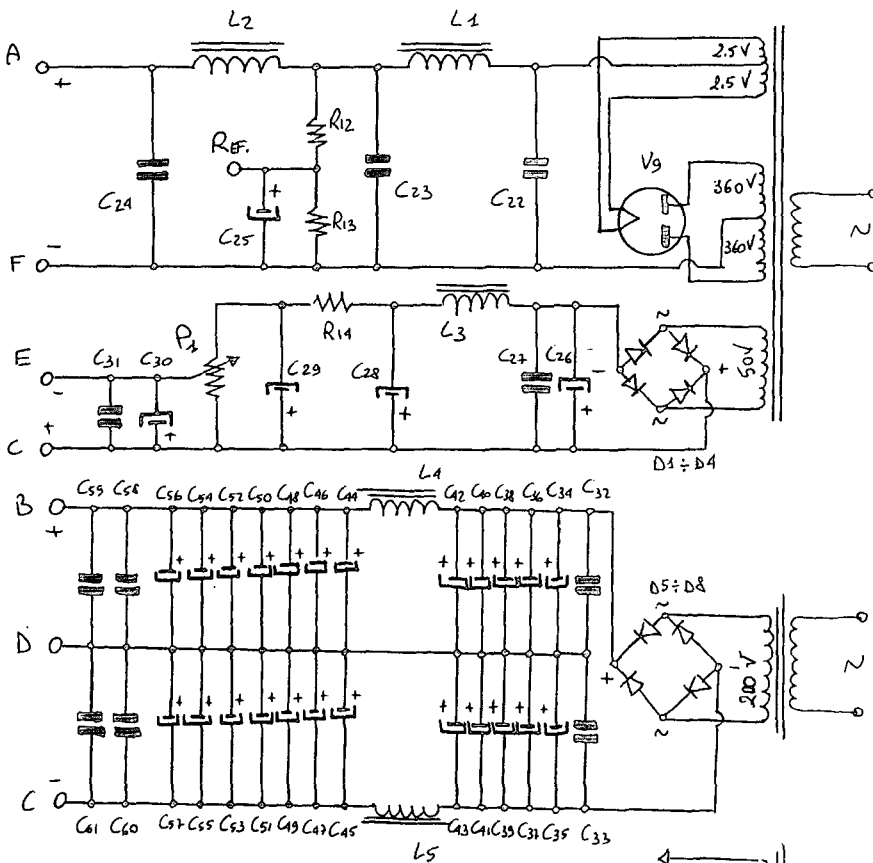
Giuseppe Intorrella's fabulous six-tube per side 6C33 OTL monos, two years in the making, feature the ultimate modern refinement of microprocessor control!

To Be Reviewed  
9/1998



**Amp #2**

R1	220k	0.5W	Holco
R2-R3	470	1W	Holco
R4-R5	1k	0.5W	Holco
R6	47k	1W	Holco
R7	15	50W	Caddock MP850
R8	1k	2W	Caddock MS220
R9/R11	1k	0.5W	Holco
R12-13	100k	1W	carbon
R14	8k2	1W	carbon
P1	15k	pot.	multiturn
C1	220uF	35V	Black Gate
C2	2uF	600V	ICAR SP25
C3/C9	12uF	600V	paper in oil
C10/C21	1000uF	250V	Philips electro.
C22	50uF	800V	MKP
C23-C24	140uF	630V	MKP
C25-C26	100uF	385V	ROE electrolytic
C27	0.22uF	250V	MKP
C28-C29	220uF	250V	electrolytic
C30	10uF	160V	ROE electrolytic
C31	0.1uF	250V	MKP
C32-C33	12uF	600V	paper in oil
L1-L2	10Hy	50mA	350 ohm
L3	20Hy	20mA	450 ohm
L4-L5	2Hy	2A	4 ohm
D1/D4	1A	1000V	IN4007
D5/D8	16A	1200V	IR-HFA16PB120
V1-V2	5687WB		Sylvania
V3/V8	6C33C-B		Sovtek
V9	5U4G		Sovtek



my OTL designs. Everything is used only for best results.

According with the purpose of this magazine, I presented schematics needing some "practices," some adjustments, leaving the experienced readers free to try. Even negative feedback, if they think...

I think the best possible use is with horns, with no doubts, perhaps 16 ohms devices for better power transfer. Obvious, maybe, but this is not true for every OTL. Most standard OTL designs really show their musical limits driving horns!

**Acknowledgments:**

I would like to thank Massimiliano Morini for help with the translation and editing.

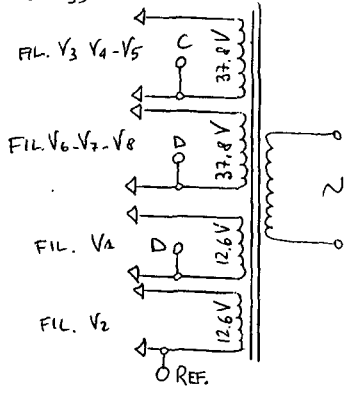
1— I do not think that the transformer is a sort of electronic devil. I even like fully transformer coupled tube amps, however I wanted (and want) to investigate the true limits of tube design without transformers.

2— For a complete report on 6C33C-B power triode, you can see the article published by the author in *Costruire Hi-Fi* n.25 December 1996.

**Costruire Hi-Fi Ordering Information**  
Italy's Leading DIY Journal

Europe \$62 Surface / \$75 Air  
Overseas \$95 Airmail  
Oceania \$105  
Back Issues \$9.50 each  
Special package deal: on back issues:  
Issues 1-20 \$120

Mozart Editrice,  
Voc La Castagna  
05024 Giove (Terni) ITALY



# Hello, "Darling"

## A 1626 Triode Single-Ended Stereo Amp

by Bob Danielak

**3/4 watts of CHEAP FUN!**

### Introduction

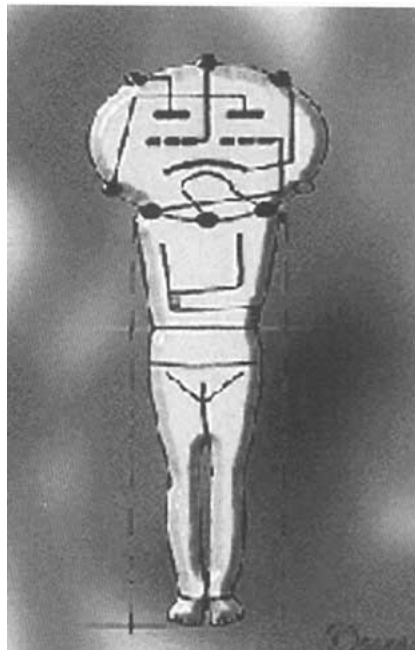
I've been doing tube amps for some time now (over 15 years if you count guitar amps). Over the past several years I've gravitated more and more toward designing/building "HI-FI" type equipment. At the risk of sounding like I'm jumping on the bandwagon, my main interest these days is in relatively low power Single Ended Triode amplifiers.

However, now that these types of amplifiers are practically "mainstream," I may sometimes purposely avoid otherwise great sounding tubes and circuits because others have already "been there - done that". The high price of most popular Directly Heated Triodes and quality output transformers is also an inducement to stay off the main road.

Luckily, if he keeps an open mind, with a little research, experimenting, and junk-box digging the avid DIY'er can end up with a very satisfying piece of equipment and still pay his mortgage.

### About the 1626

Okay. The 1626 is *not* a directly heated triode (DHT). It is an indirectly heated power triode originally used in low power RF amps. It is not the most linear of triodes, and its plate is only rated for about 250V/25mA. Another mild pain is that it requires a 12.6V filament supply (there's no 6.3V connection option). Amplification Factor is about 5. Plate resistance is around 2K.



On paper, the 1626 would not appear to be very promising for a Class A audio amp. What really attracted me to this tube, however, was its cute ST-12 shaped bottle. So I picked a few out of a pile of old tubes at some surplus joint for \$2.50 a pop. I was thinking about doing a funky line stage with them.

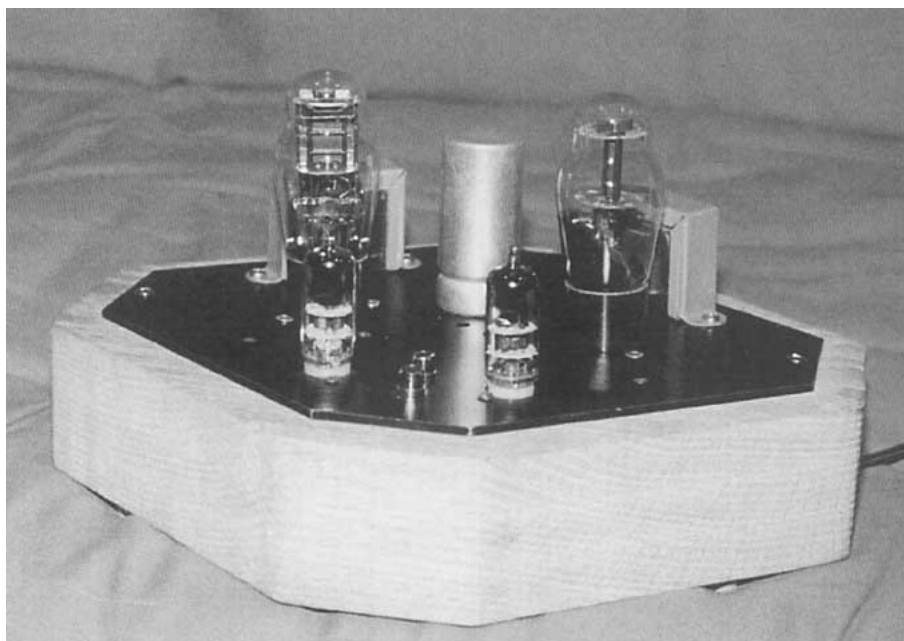
Of course they sat on a shelf for a while as I worked on several other projects. One of these projects just happened to be a SE 12V6 stereo amp using a 12SJ7 pentode

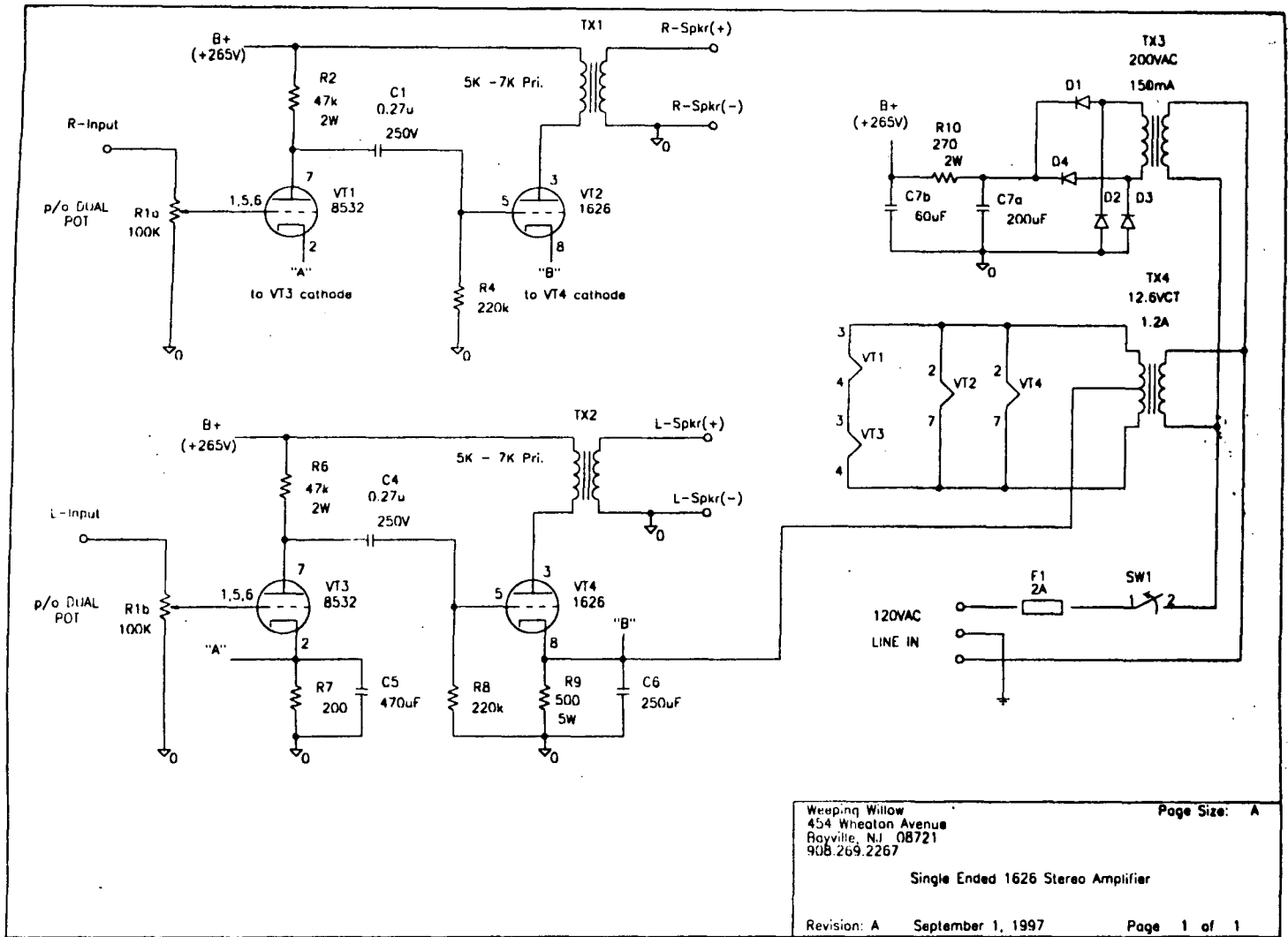
driver. Somehow, I figured out that the pinout of the 1626 is basically the same as the 12V6 minus the screen connection. So I just dusted off the 1626's and plugged them in.

I was pleasantly surprised with both the sound quality and with the apparent volume I achieved with only 3/4 watt of power. At this point I decided to devote some time to find a good driver for the 1626. Driving the 1626 is not as tricky as it is with other triodes such as the 2A3, 45, or 71A. Biased near its maximum ratings, we only need about 25 to 28V, peak grid voltage. The 1626's input capacitance is also rather low for a triode (around 30pF including Miller Effect). This means we don't need a super-high-current driver.

Any designer worth his salt ought to be able to bark out a dozen worthy candidates for this job. A gain of 20-30, drawing a couple of mA....easy, right?! The biggest problem was that there were too many choices!

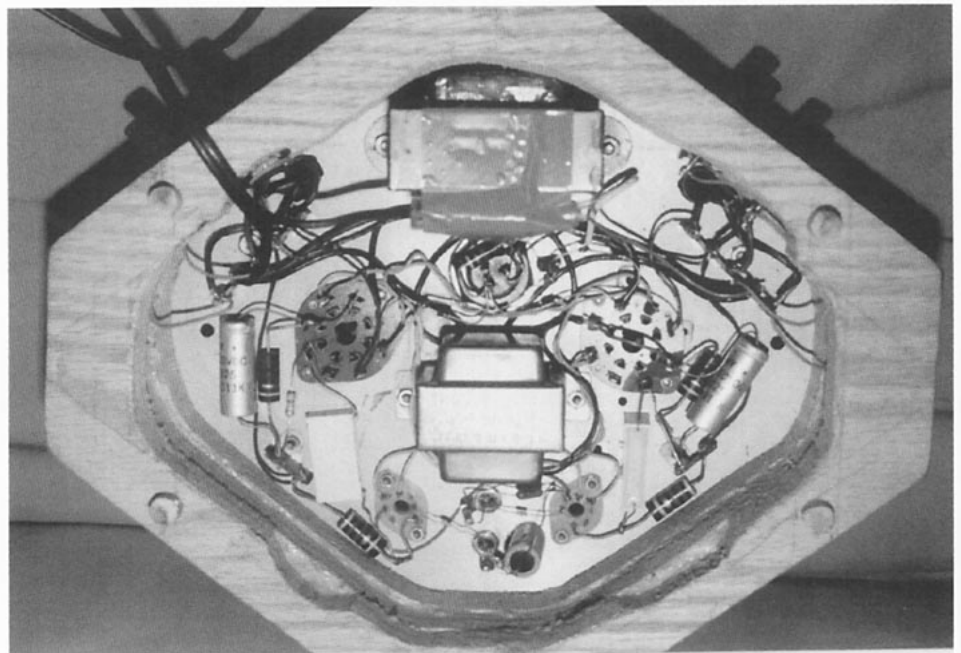
Before settling on any one driver I tried a whole slew of tubes/topologies. Just to name a few in descending order of preference: SRPP 12SL7, 12SJ7 pentode, SRPP 12SN7, simple plate loaded 12SL7, Parallel 12SL7, etc, etc.... I never got around to some of my favorite 9-pin triodes like the 12AY7 or 5965/12AV7. I have a feeling that the 5965 would be a good match for this application.





The driver that I eventually fell in love with is shown in Figure 1. It is a simple plate loaded gain stage using the 7-pin miniature high frequency triode, 8532, a ruggedized version of the commercial type 6J4. It has a mu of about 52 and a gm of about 11,000 uS. It biases up nicely for this application at its maximum plate voltage of 150V, drawing about 3-4mA with a bias of about -2V. This stage gives me a gain of about 32, resulting in an input sensitivity of less than 1V peak, with over 1V of signal headroom.

Higher plate current can be used, but this cuts into input headroom and output swing. Another novelty of the 8532 was its size. It seemed to fit nicely with the "miniature" theme. As you'll see in Photo 1, the finished amp looks like a 1/2 Scale version of a stereo 2A3 or 300B amp. Darling, isn't it?





1626

# TRANSMITTING TRIODE

For oscillator applications requiring unusually stable characteristics

Heater <sup>o</sup>	Coated Unipotential Cathode	
Voltage	12.6	a-c or d-c volts
Current	0.25	amp.
Amplification Factor	5	
Direct Interelectrode Capacitances:		
Grid to Plate	4.4	$\mu$ uf
Grid to Cathode	3.2	$\mu$ uf
Plate to Cathode	3.4	$\mu$ uf
Maximum Overall Length		4-1/8"
Maximum Seated Height		3-9/16"
Maximum Diameter		1-9/16"
Bulb		ST-12
Base	Small Shell Octal 8-Pin, HICAROL <sup>h</sup>	

## MAXIMUM CCS RATINGS and TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service

### R-F POWER AMPLIFIER & OSCILLATOR - Class C Telegraphy

Key-down conditions per tube without modulation 0%

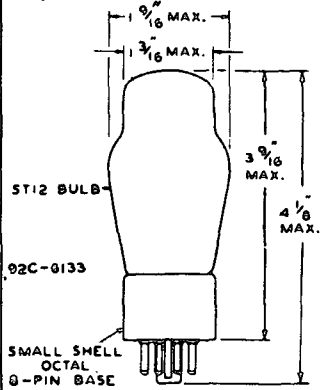
D-C Plate Voltage	250 max.	volts
D-C Grid Voltage	-150 max.	volts
D-C Plate Current	25 max.	ma.
D-C Grid Current	8 max.	ma.
Plate Input	6.25 max.	watts
Plate Dissipation	5 max.	watts
Typical Operation:		
D-C Plate Voltage	250	volts
D-C Grid Voltage <sup>a</sup>	{ -70	volts
	{ 14000	ohms
	{ 2300	ohms
Peak R-F Grid Voltage	105	volts
D-C Plate Current	25	ma.
D-C Grid Current <sup>aa</sup>	5	approx. ma.
Driving Power <sup>aa</sup>	0.5	approx. watts
Power Output	4	approx. watts

<sup>o</sup> In circuits where the cathode is not directly connected to the heater, the potential difference between heater and cathode should be kept as low as possible.

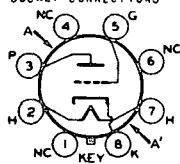
<sup>aa</sup> Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions. <sup>a</sup> Obtained from fixed supply (-70), by grid resistor (14000), or cathode resistor (230), or by combination methods. When the 1626 is used in the final amplifier or a preceding stage of a transmitter designed for break-in operation and oscillator keying, a small amount of fixed bias must be used to maintain the plate current at a low value. With plate volts of 250, a fixed bias of at least -35 volts must be used. <sup>h</sup> Subject to wide variations as explained on sheet: TRANS. TUBE RATINGS.

<sup>h</sup> Registered trademark.

Data on operating frequencies for the 1626 are given on the sheet TRANS. TUBE RATINGS vs. FREQUENCY.



### BOTTOM VIEW OF SOCKET CONNECTIONS



### AA' = PLANE OF ELECTRODES

- Pin 1 - No Connection
- Pin 2 - Heater
- Pin 3 - Plate
- Pin 4 - No Connection
- Pin 5 - Grid
- Pin 6 - No Connection
- Pin 7 - Heater
- Pin 8 - Cathode

TUBE MOUNTING POSITION  
VERTICAL OR HORIZONTAL

MARCH 15, 1941

RCA RADIODRON DIVISION  
RCA MANUFACTURING COMPANY, INC.

TENTATIVE DATA

## Cutting Corners

I guess you could call this amp a study in minimalism: a single 1626 driven by a single 8532 per channel all fed from a common B+ supply. Then, pushing the envelope even further, I called upon a trick sometimes used by commercial stereo manufacturers to reduce parts count and unit cost.

Rather than using separate cathode resistors and bypass caps for each channel, some designs shared the cathode resistor and bypass cap between Left and Right channels. Although I've only seen this done in the output stage, I extended this technique to include the input stage cathodes as well.

At best, this small degree of "mixing" might be similar to some of those fancy "matrix" enhanced stereo effects found in "room simulators" or early synthetic stereo surround sound systems. In fact, it might actually explain the extraordinarily wide image that this little amp presents.

However, for the range of frequencies that we are normally interested in, these effects should be negligible. I have tried both shared and separate cathode circuit elements in this amp. Couldn't really tell a difference....Perhaps another benefit of this approach is that you can now afford to use one good quality bypass cap (Cerafine, Black Gates, etc.) instead of two mediocre ones.

Fundamentally, this should work just fine. After all, the bypass cap is essentially an ac short. One short - Two shorts, what's the difference?!! Half the cathode resistance, double the capacitance and you're done...Of course, the bypass cap is not a perfect short. At low frequencies its impedance naturally begins to rise. And then there are the effects of ESR and ESL (which will cause an impedance rise at higher frequencies). At worst, this could cause some degree of mixing of left and right signals in each channel. So for a normal stereo input you might expect some crazy phase cancellation effects.

## Construction: Cutting More Corners

As you can see in the photos, shape I chose is rather unusual. The aluminum top plate began its life as an 8" x 10" rectangle. Then the corners were lopped off creating a sort of eight-sided diamond shape. Tubes, Output Transformers, and a can-style dual filter cap are mounted on deck while the small power transformer and separate 12.6 VCT filament transformer are mounted below.

The base was made by laminating three 8" x 10" x 3/4" oak boards and cutting out the middle. Oak was chosen for this approach because it is the only wood that has a decent looking end-grain. Previous attempts at a mitered vertical maple base proved very frustrating. The solid oak approach makes for a much sturdier base, and it fit in better with my home decor, anyway!

The view of the undercarriage shows how much room I had to work with. The worst thing about this layout is the proximity of the filament tranny to the input tubes. I do get a slight bit of hum, as a result. With my speakers (90dB/w/m, Design Acoustic PS-10's) hum is barely audible. Through a friend's (Dave Slagle) "Big-Fun" Lowthers, the hum was more noticeable, but it was soon forgotten about once the music started.

In later versions of the "Darling", I used an 8" x 12" footprint. Moving the filament tranny to the opposite end of the chassis practically eliminated the hum. Another trick that helps reduce heater-induced hum is connecting the filament winding center-tap to a positive potential. This is most conveniently provided by the output stage cathode.

## Wrap-up

To quote a friend, "this amp has no right to

sound as good as it does." The design is nothing special. No rocket science (my day job) employed. No fancy parts were used in the original. But perhaps it is the simplicity of the design that makes it sound the way it does. I'm guessing that I may have lucked into a "synergy" between the 8532 and 1626.

Individually, their characteristics are seemingly "less than optimal" (both create a lot of 2nd harmonic distortion). But together, at the chosen operating points, they seem to complement each other very well. I still haven't figured out why this amp should sound so good, but when I do, I'm going to bottle it!



## AUDI ALTERAM PARTEM

Quality handwound S.E. output transformers

Primaries from 1.8k to 10k

Exclusive wideband design

Silver windings available

Push-pull output transformers

2.5k, 5k, and 10k plate to plate

40 to 75 watt

single 8Ω output

10hz to 40khz

Interstage transformers S.E. and P-P

40 mA primaries

Full bandwidth 20 to 20khz

Custom power transformers/Chokes

Wound to your requirements

DC filament supply windings

HV and high-current chokes

Svetlana and VV output tubes

### ELECTRA-PRINT AUDIO CO.

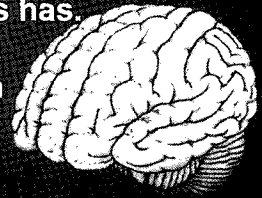
4117 ROXANNE DRIVE

LAS VEGAS, NV 89108

702-396-4909 / FAX 702-396-4910

e-mail [electaudio@aol.com](mailto:electaudio@aol.com)

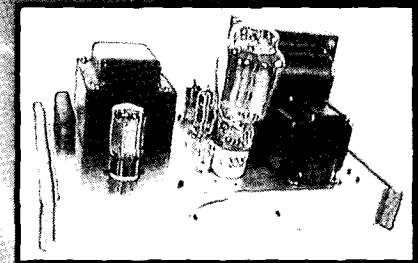
Not too many times does lightning hit an industry like single-ended triodes has. But there are still some reviewers and consumers who feel that SE just does not have the power for most speakers. Well here is some information for the right side of your brain that your left side has been saying all the time.



**listen to your left side of your brain**

We listen typically at 84dB's in our listening chair at say 6.5 feet (2M) centered on our speakers. The SPL at 1M away to make 84dB at the chair is only 89dB. So if we have a 89dB efficient speaker at one watt we would have a comfortable output. This leaves us with a ton of options considering most of the SE amps are 8W or better to deliver ample transient information.

If you would like to see the vast amplifier styles and offerings that we have stop by our WEBSITE for the latest information on the Napoleon, Cardinal, Duetto, KIR, Cornet and Junior. Pictured to the right is our new KIR 32W SE mono block amplifiers based on the VV52B with power to spare!



Customer and Dealer inquires welcome!



Stop by the WEBSITE to see our line level preamps, phono preamps and speakers

4539 Plainville Road Cincinnati, Ohio 45227 (513) 271-4186

eMail: [waudio@cinti.net](mailto:waudio@cinti.net) WEBSITE: [www.wavelengthaudio.com](http://www.wavelengthaudio.com)



# The 210 Split

Domesticating the Giant  
Altec 210 Bass Cabinet

by  
Michael Frye

*If you can domesticate the 210,  
you're pretty good at that kind of work*

The Altec VOT A5 and later A7 system using the 825 and 828 enclosures have been featured in a number of excellent articles in the pages of *Sound Practices*. A few of the modification suggestions to the enclosures have been straightforward and have enabled me to get much more from the upgraded boxes.

Changing woofers has also made some difference. The 803A with its thin straight wall cone and higher (40-50 Hz) resonance offered improvement in the lower mids while the 515 with its lower cone resonance and larger magnet seemed to improve the mid-bass output and snap somewhat.

I speculated that better bass extension, improved bass and midrange clarity, and

the elusive quality of articulation and detail might be more easily realized using a full bass horn design. It seemed to me that a longer bass horn with its lower horn cut off would be a choice worthy of exploration.

Fortunately, I had access to a large number of Altec's big 210 bass horn enclosures and more than enough Minneapolis cold weather shut-in time to experiment.

## ALTEC 210 HORN DESCRIPTION

The 210 bass cabinet is clearly built for the auditorium. Its physical dimensions measure 84 H x 34 W x 39.5 D. These dimensions are so unruly for home use that about the only door through which it can be maneuvered is a wide front door or a large patio door. Most interior doorways are 30 or 32 inches, so unless one has a very large foyer that serves as a listening room, this behemoth is not going to work.

However, the Altec 210 has the potential to produce better articulation and a deeper, smoother, more continuous response than its smaller sibling, the A5 bass enclosure. In part, this is due to the bass horn's nominally lower free air cut off frequency (70 Hz versus 180 Hz). This free air response is going to be quite a bit lower in a listening room because among other things coupling the enclosure to the floor in the right places within a room may give perhaps another octave (35 Hz) of range. I later found out that usable bass output in my room extends even lower.

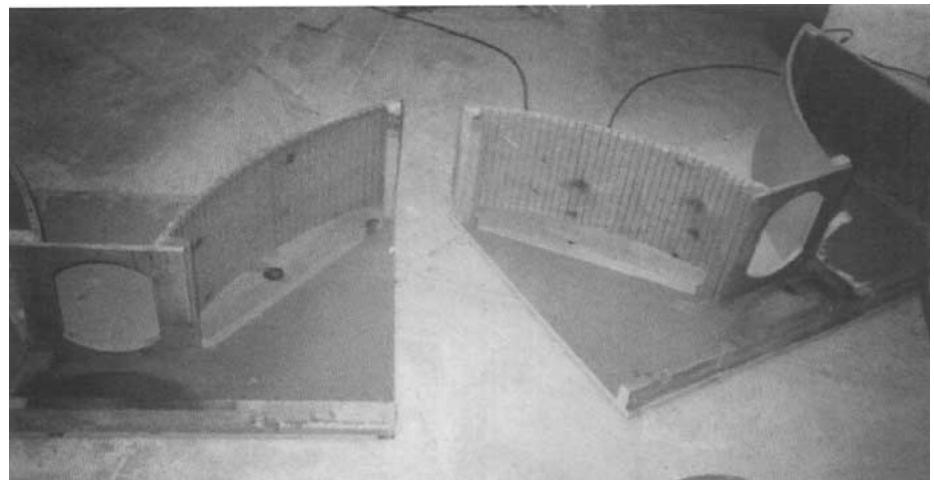
The stock cabinet takes two 15 inch woofers per side. Loaded with a pair of Altec 515 woofers, it should produce about 110 db/1 watt/1meter given Altec's 104 dB rating for a single 515 without horn loading. Like the 825/828 cabinet the 210 has an approximately 2 foot high port area



**Above—Even without “wings,” the 210 cabinet is a giant at 84” tall**

**Right—210 bass horn bisected on the workshop floor.**

In particular, bracing and damping suggestions improved the VOT system's definition in the lower mids and upper bass and make an otherwise excellent loudspeaker better. Any change to tame the stock crossover has to be an improvement and several suggestions (issues #2 and #11) are worthy of consideration.



beneath the bass horn. In contrast with the 825/828 horn, the non flared sides of the 210 horn are parallel. (The two non-flared sides of the very early 825 cabinets were parallel.) These sides in the 210 are 5 feet in length at the mouth of the horn. All in all, this is one impressive looking horn!

### DOMESTICATING THE 210

The kernel of the idea to tame this giant for use in a home listening room derived in part from the design of the JBL 4550 cabinet. The JBL is a dual woofer design along the lines of the 210, but it is a full horn load and is claimed to have usable response to 50 Hz in JBL's literature. Compared with the 210, the 4550's dimensions seem almost manageable at 60" H x 36" W x 32.5"D. Although the 4550 doesn't pass the doorway test either, it is physically smaller because it lacks the two foot port section found on the 210.

My solution for the 210 was to cut off the two foot port ala the JBL 4450 and, since the saw would already be out, cut the enclosure in a vertical line, right down the center.

In the process of creating an enclosure that met the doorway test, cutting the enclosure halved the number of woofers one would need for a stereo pair. After the cuts were made, new plywood was cut, glued, and screwed to create new bottoms and sides.

The result is visually quite stunning (at least to a horn aficionado). With its 17.75" x 39.5" footprint it occupies slightly less floor area than the standard A7/A5 and is just 18 inches taller. The surgery had reduced the footprint by half but also reduced the total volume to less than 37% of its original size, while maintaining the original horn geometry.

The clean, sweeping curves of the horn flares and the slim frontal aspect makes for a modern, elegant looking enclosure. Looking into that 5 foot vertical horn mouth made me want to load it up real fast and see what this beauty could do.

### LISTENING AND ADJUSTMENTS

After loading the modified cabinets with my favorite woofers and adding high frequency horns, drivers, and crossovers, it was clear that this rig had great potential. One of the first adjustments I made was to add a strut across the mouth of the bass horn. The

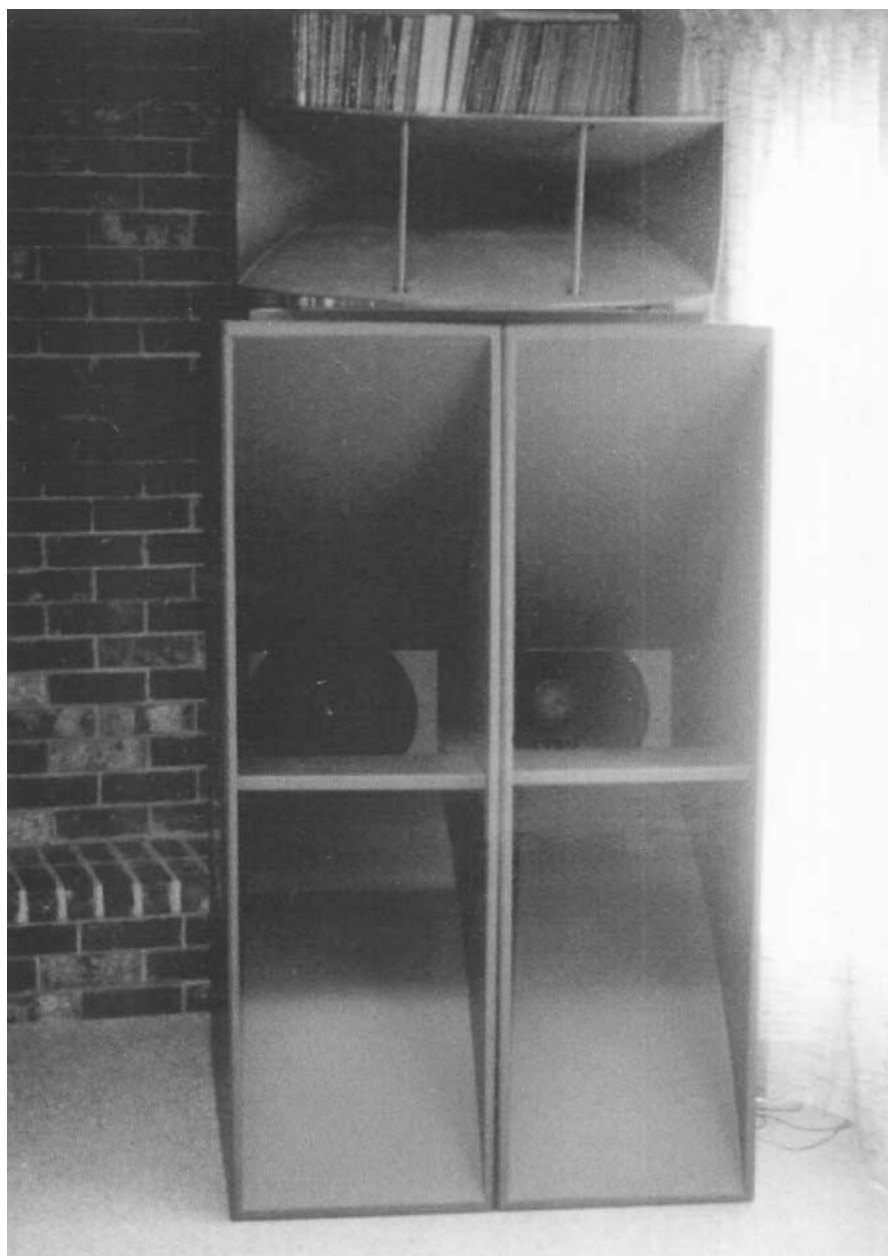
large, unsupported area of plywood on the 5 foot sides resonated and rattled at certain frequencies causing some bass muddiness.

Since the horn mouth was essentially unchanged from the original Altec design except for halving the distance from side to side, I wondered why Altec or JBL, for that matter, did not address the matter of cabinet resonance caused by these large unsupported panels. Earlier RCA bass bins from the 1940s had horizontal and vertical struts across the mouth to eliminate the resonances that naturally results from large unsupported panels. Two more struts added internally further cut cabinet resonances.

Originally, the split 210 cabinet was intended to be a fully horn loaded bass enclosure

just like JBL's 4550. While changing woofers, I left the center section of the three part back off. The effect of this "accidental" rear port was to increase the range of bass response. In addition, there seemed to be no sacrifice in the upper bass clarity with the reflex port in the rear of the cabinet as there was with a front reflex port. I found that I enjoyed the noticeably lower bottom end with the accidental port and decided to stick with a reflex port contrary to my original plan to have a full horn load.

I cut different-sized center board sections according to whether I would be using a Jensen, Altec, JBL, or EV woofer. The calculated effective interior volume of these modified bass horns was found to be 12



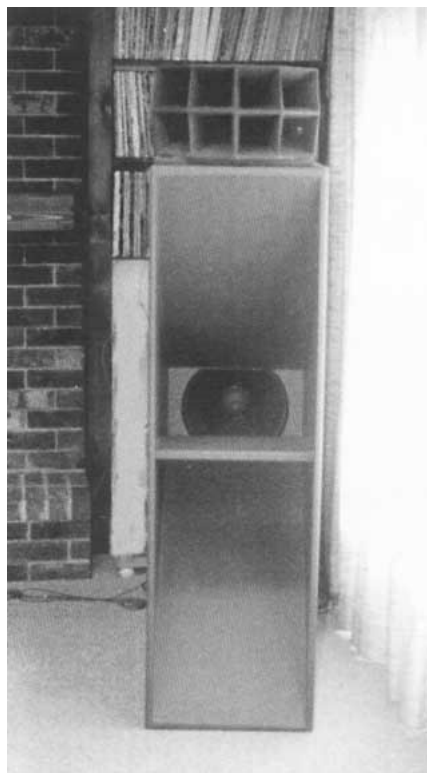
Right—"Double" modified 210 configuration with Altec 329A HF horn plus a 288 driver

cubic feet. At this volume, there is supposed to be no advantage in using a reflex port. However, after a good deal of experimentation, I found that a rear port of approximately 64 square inches seemed slightly preferable to a full horn loading in my listening room.

Now that the enclosure was about right, I tried two bass cabinets per side in both the upright position and then one stacked upon another in the horizontal position. Though not particularly practical for my narrow listening room, the horizontally placed double cabinets per side certainly sounded great. The two vertically placed cabinets per side with a nice 329A high frequency horn resting on top looked as cool as they sounded.

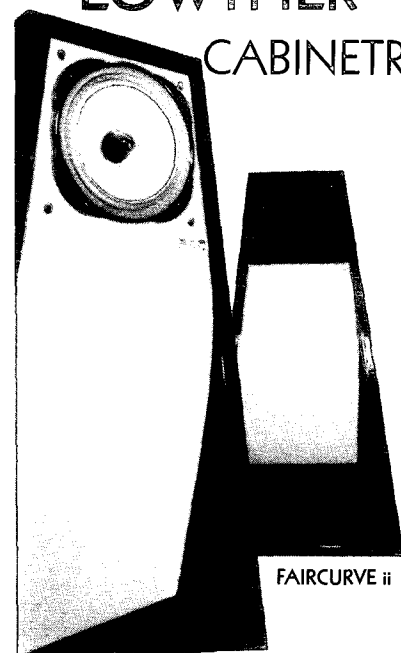
Cool as they looked to me, the females of the family opined that a single enclosure per side sounded every bit as good and had a nice, slim, minimalist look that was quite appealing. You judge for yourself from the photos.

SP readers wishing to share their experiences can write to me at 18435 5th Ave. N., Minneapolis, MN 55447. By the way, I might still have access to some 210 cabinets if anyone is interested...



Right—Single 15" modified 210 with early wood 808 horn/802 driver

## CUSTOM CRAFTED LOWTHER CABINETRY



**DC AUDIO**  
108 TRAIL ONE  
WURTSBORO, NY 12790  
(914) 888-2360

SINGLE ENDED PUSH PULL ACROSOUND PEERLESS COPPER WINDINGS SILVER WINDINGS HAND WOUND

SINGLE ENDED PUSH PULL ACROSOUND PEERLESS COPPER WINDINGS SILVER WINDINGS

**DELICIOUS!**  
**MMM, MMM, GOOD!**  
**TASTY!**  
**SCRUM-DIDDLY-UMPTOUS!**  
**PARALLEL**  
**FEEED**  
**TRANSFORMERS!**

Enjoy the natural wholesome goodness of pure nickel, expertly optimized in our parallel feed transformers.

Used in single ended applications, our parallel feeds have no air gap and carry no dc current, so they are small, light, cost efficient and oh-so tasty.

And the nickel core lets more music flow to your tastebuds, er, ears.

We handbuild them in solid brass channel frames for 300B, 2A3, and 45 tubes (and preamp outputs, too).

This recipe calls for loading the output tube with a yummy 40 or 50 henry choke. Which we happen to, ahhh, make. And sell.

Call 215-288-4816 for our take-out menu of unparalleled parallel feeds. They're gourmet delights at carry-out prices.

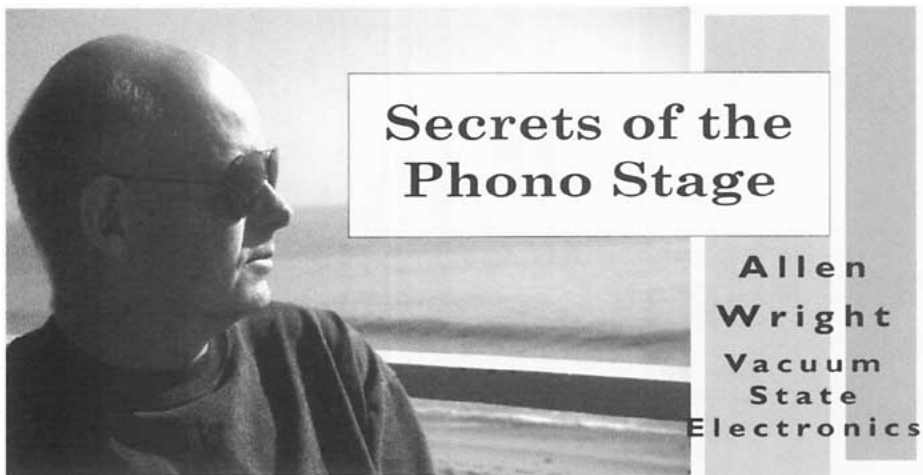
**MagneQuest**

HANDBUILT TO PERFORM WITHOUT EQUAL

MAGNEQUEST, 1404 E. BRISTOL ST PHIL., PA. 19124  
[HTTP://www.MagneQuest.com](http://www.MagneQuest.com)

SINGLE ENDED PUSH PULL ACROSOUND PEERLESS COPPER WINDINGS SILVER WINDINGS HAND WOUND

SINGLE ENDED PUSH PULL ACROSOUND PEERLESS COPPER WINDINGS



When it...finally...arrived...*SP #14* was a blast! Three *New York* power amps and an *Italian* phono stage with full details of how, when and why—which in a world overrun with micro poweramps masquerading as preamps takes big time courage—*Bravo Diego!*

I put my ass on the line with the heavily phono biased *TubePreamp Cookbook* so I get very interested in seeing what others come up with in this trickiest of audio areas. Any half decent tube poweramp can sound acceptably musical, and line amps in this age of digital cut more than boost—but phono preamps have to handle very dynamic yet incredibly low signal levels—hit them with a wild equalization curve and all the while (hopefully) maintaining a *very* tight gain/phase relationship between the channels—so as not to corrupt a stereo picture hard won from a diamond to vinyl *mechanical* interface!

Before Diego's opus, a few passive EQ phono stages/preamps appeared in the literature; some balanced, most s/e:

- the legendary *Loesch* in *SP#3*,
- *JC's Siren Song* in *SP#3 + #4*
- Joe Curcio's *Daniel* in *AA* circa '85
- Erno Borbely's hybrid in *GA 2/97*
- My balanced *RTP's* in the *TPCB*
- My s/e *FVP* in the *TPCB 2nd* edition.

Now my intention is not to offend in discussing these designs, but to help make these units *even* better. And I've included my latest s/e effort so you can see where I'm coming from.

#### **VITAL points in phono stages:**

**1 No loop feedback!** No contest—the sonic advantages of dumping all time dispersive NFB and going *realtime* doesn't have to be preached to too many *SP* readers!

**2 Use high gm tubes at high currents!** Arthur Loesch runs those freaky 417A UHF tubes as RIAA inputs, with 6922's to follow—a man with soul! And why use such tubes? Consider this from Prof. M. O. Hawksford (*HFN&RR 8/84*):

*"...just as the stylus is required to resolve distances compared to the wave length of green light, so the (phono) amplifier is required to resolve charge levels in the order of an electron"*

This is a MC cartridge hunting for the *extreme* low level ambience that makes great live recordings shift time and space so wonderfully—and a WE417A with its 25mA/V (or a 2SK147V with 40mA/V) will have *W-A-Y* more chance of perceiving and acting upon this lone little electron than a 12AX7 with one twentieth the gm. They're also much quieter, and at typically ten times the running current the associated impedances are much lower—which all helps the music roll on through.

**3 Accurate RIAA!** The three time constants in the original RIAA spec create four areas in the audio spectrum: under 50Hz, 50Hz to 500Hz, 500 to 2122Hz, and 2122Hz on up. Now normally a 1dB shift is not easy to hear, but such an error in one of these bands can make a whole system become light and bright (or dark and mysterious) because it moves at least two whole *octaves* of music bandwidth around!

Although not a cure-all, split time constant EQ is the way to go (unless you are a devotee of the KISS principle chasing *minimal* stage count) but the key advantage has not been emphasized by our authors: split EQ may or may not sound better—but it is *infinitely* easier to trim to exact RIAA conformance than any "all in one" topology. And trim it you *must* if you want to get real RIAA accuracy!

Your wiring capacitances will always be different to the designers unit, and unless you luck onto some 0.2% C's and R's of *exactly* the specified value, you won't be in the ballpark—even assuming the published values were right in the first place!

As detailed in the *TPCB*:

a) Acquire RIAA caps as close as possible to the spec'ed values. I use *WIMA* FKP2 polyprop and foil. Buy lots...

b) Match these caps channel to channel to better than 0.1%. N.B. Diego's *Audio Note* paper & oils may sound wonderful, but they don't come in the tolerances needed here—so you may need *quite a few* to find those *matched* pairs...

c) Input a square wave via a precise reverse RIAA network and then tweak the relevant resistors to get the best possible square wave out. I use 10 turn trimmers to start, and replace them with fixed R's once it's AOK.

Surprisingly, few designers suggest precise caps, and none say to match them *super tight* channel to channel. But Diego splits the network the way I found sounds best: with the 3180 + 318μS first and the 75 μS last...

**4 Add the missing Time Constant!** The 75μS networks in all these designs (except mine) fall at 6 dB/oct *forever*... OK, this may be the RIAA spec but if you think of the record cutting process—can they really boost at 6dB/Oct. from 2122Hz on up *forever*?

Back in the 70's we called some cutting equipment service departments and found they do roll off this boost with a chicane at around 50kHz (3.18μS)—so as to keep cutter head warranty claims to a minimum or whatever. And when this is done (in reverse) in a preamp, it flattens out that 75μS drop to hell and restores much of the air and naturalness that's on the master tape.

This is the purpose of R3 on the *FVP5* map, and it's pretty easy to try yourself:

a) Find the cap used for the 75μS roll off (i.e. 820 or 1000 pF in Diego's)

b) Calculate what R you will need to get 3.18μS in conjunction with this cap (= 3K87 or 3K18 in Diego's) using  $t = RC$ .

c) Fit it in *series* with the cap—and tweak for sonic satisfaction and *exact* upper octave channel to channel balance. N.B.: It's phase accuracy across all four bands that gives you that *real life* image the bottom feeders say don't exist!

**5 Starwire Everything!** I always *star wire* my modular stages to just one point each for B+ and gnd, and further *starwire* each of these modules to the power supply reference points—all with low impedance 3mm silver foil.

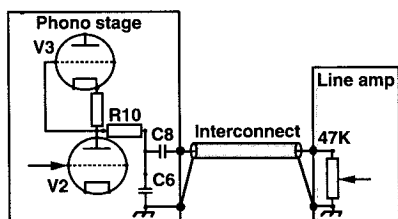
**6 No redundant stages!** This generally means high gain per stage. Most of the listed units need two stages in the phono for MM and three for MC—but the *FVP5* does MC with two and the *RTP3/5* does MC with just one!

And Joe & Diego, please...*NO* cathode followers, nowhere! I call them *Miss Piggy* as they sound just horrible, yet with some innovative thinking it's off to market for her...

For example; Diego's 75µS network is driven from the second tube, and followed by a CF. Yet he says this CF has to be very lightly loaded or it sounds *tired*, which is a very good description of the *Miss Piggy* sound. But if she can't perform, why use her at all? As the subsequent v/control is 50K, her only purpose is to isolate the 75µS network from the outside world—and that's a small job for a very big girl...

If the phono stage is in the same box as the line amp, this problem's minimal anyway and *Miss Piggy's* redundant.

But if they are separate, and if you're prepared to always use the same I/C between the boxes (perhaps a superb silver foil/teflon construction from the *SCCB*?) why not turn this bug into a benefit by using the high quality capacitance of the I/C as part of the 75µS?

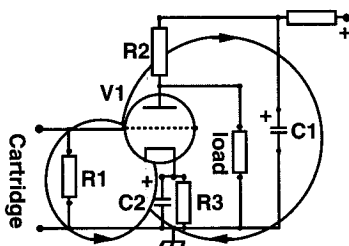


**The "Give Miss Piggy a Miss" mod**

*Miss P* is again redundant and should perhaps look to a career in the movies!

**7 Circuit before components!** Diego identifies the places where you need to spend money, and where it doesn't matter so much—but I say focus on these vital points and *first* get the circuit right to ensure you keep *all* the dynamics and information—*then* find the sonic flavor you like by playing with components to your heart's content.

**8 No Electrolytic Caps in the signal path!** No SP reader would ever e/cap one stage to the next, but do realize this also means no e/cap cathode bypasses and no e/cap B+ rail bypasses? I'm sure there are some real scientific terms for the "input" and "output loops"



**Input and Output Loops**

that exist in every stage, but these are good enough for a country boy to make his point with someone else's amp...so let's look at Diego's input stage:

Here the input loop contains C2, and the output loop contains C1 plus C2! Look, I know everybody uses these things—but does that make it right?

Every time I pull a cathode e/cap, things get cleaner, more dynamic and transparent, and when I also do the B+ rail correctly—magic occurs!

**9 Use Shunt Regs!** I agree that series regulators are a waste of time and do more harm than good, but a full house, fast and *current sourced* shunt reg will change your views on B+ bypassing and regulation—forever!

In my opinion the two most important articles ever to appear in SP rocketed right over most people's heads—but they contain vital info for all music lovers, so dig out SP#4 and #6 and read the John Camille articles. Their 211 amp is amazing but that's not the point—get into their shunt reg revelations. And if you don't get a growing feeling of excitement, then read them again and again until you do—and then study the *SuperReg* chapter in the *TPCB* for even more info.

We've been using shunt regs for 20 years and B & C's discoveries exactly parallel ours. The circuits are conceptually similar—so build up one of the designs (and one is enough even for stereo), pull all your B+ ecap bypasses, starwire the shunter into your box with *low z* wiring—and be prepared to be blessed. I'll spare you the superlatives!

**The FVP5**

Up until 1980 I was making *Audio Research* style preamps, but they soon became a dead end, with huge work needed to bring minor improvements.



**The plug & play SuperReg**

Luckily, lateral thinking mode kicked in and I tried what was essentially a *Tek/HP* 'scope gain block (balanced cascaded 6922's, no feedback) for phono and line stages. A complete shot in the dark, it was sonically wonderful and became our first (limited) production *Realtime Preamp (RTP)*.

This concept is still the best I know and has evolved into the current *RTP3/5's*. This eighteen year long development path is fully documented in the *TPCB*, with (now) all the schematics.

But no matter how perfect a design you come up with (*has he got an ego or what?*), there are always &^\$#@! minimalists hanging around waving their "*Bucky sez: Do more with less!*" placards and shouting their downbeat riff: "*KISS! KISS! KISS!*" But one day back in '85 or so, one of them actually put some \$\$ on the table and said:

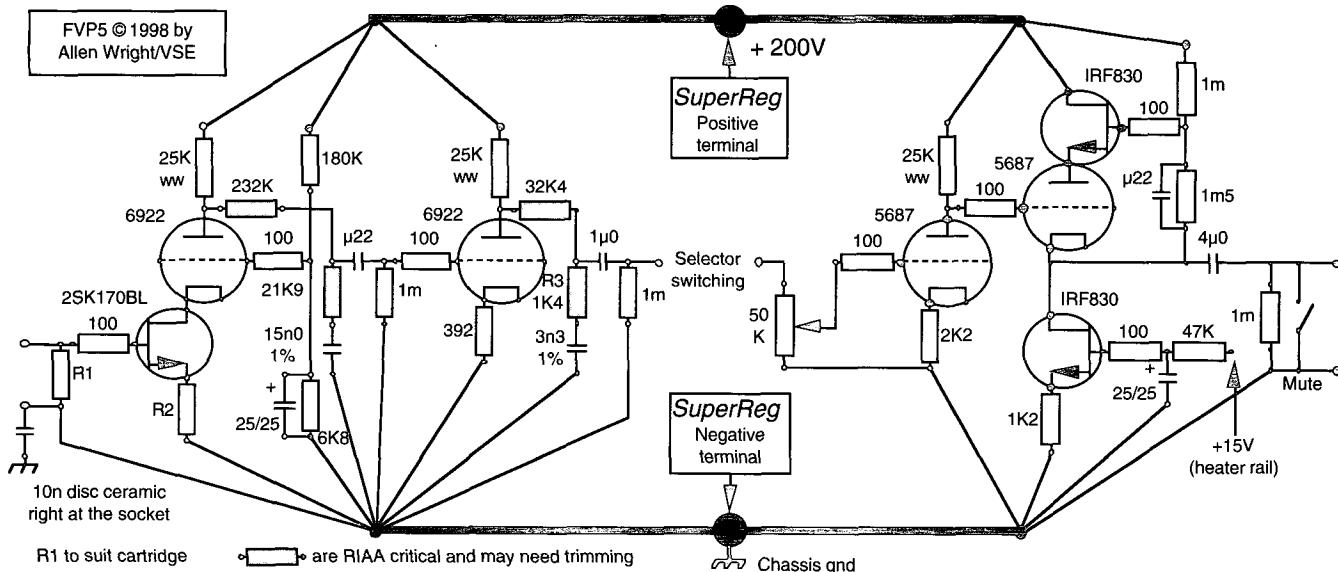
*"I want a single ended Realtime..."*

Cool idea, it sounded as dynamic as a *RTP*—just less refined and missing the super bass tonality. Forgotten for years, the concept was resurrected recently. Using the *SuperReg* and a few other tricks it finally became a serious device that—in hard wired form—was the first preamp I've ever heard that bettered my own—but on a PCB—*RTP3!*

Sure, there were a few false starts with SRPP line stages—not obviously ugly like poor *Miss Piggy* but they gross you out over time—and rest assured, a hard wired *RTP3/5* is another story...

**Phono Stage.** Enough back patting—I can already hear most of you muttering: "*Yukko—FETs*". But hear me out—I've built it all tube and this is simpler, cheaper and sounds even (slightly) better. The FET allows a *consistent* low noise figure that handles all but those *nanovolt* output MC's, and without the blurring (and horrific cost) that I find comes with step-up transformers. And used in this way (but only this way) as the bottom half of a cascade, this FET is *completely sonically invisible!*

Please, try it *before* you sneer, OK?



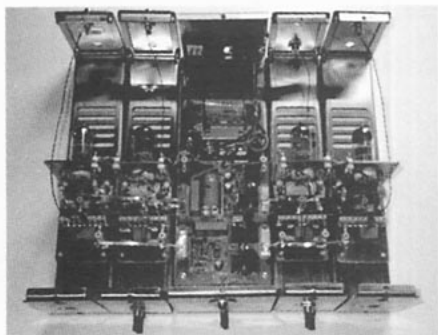
The 2SK147 is now out of production and almost impossible to get—but the readily available 2SK170 and '369 seem pin and chip identical. The only change is the TO92 package which limits dissipation to 400mW—but they're cheaper and the '170 is even quieter!

**Schematic Details—Phono:** A cascode 1st stage brings several advantages:

- 1- R2 can range from 150Ω down to 15Ω, which adjusts the phono gain from 40 to 60dB—with no side effects.
- 2- The high output Z means tube selection and/or aging doesn't affect the 1st part of the RIAA network—and with both the 3180 and 318μS points there you don't want too many changes...
- 3- It is inherently quiet, linear and very fast—which is why Tek & HP used it.

The stuff on the 1st grid ensures the FET operates at it's best point—it will work with the grid grounded (via the stopper!) but not at all gain settings.

This stage feeds through the RIAA into the second tube, a common cathode (CC) stage with (an unbypassed) cathode R—a topology



The prototype modular "kit" FVP5

that should *never* be called an *anode follower* because that's something *very* different: a tube "op-amp" with -1 gain from 100% NFB.

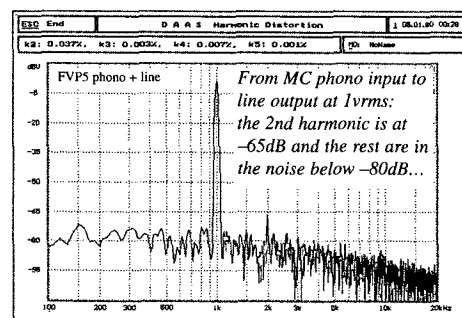
The cathode degeneration makes this stage more linear and again helps to keep things stable long term with differing tubes and the effects of aging.

It feeds into the 75μS network—where the trick 3.18μS time constant is formed by R3. Now if you can't figure anything like 75μS from these values—add in the 50K pot and the Rp of the tube as they're very much part of this network. The RIAA values given are those from the prototype "kit" FVP5 (as pictured) and should be close—but tweek you must if you want it to *really* focus...

**The Line Amp** runs a hi gm low μ triode for a stage gain of 15dB—the lowest I could get while still having lots of current to keep it fast and clean. And even then it's more than digital needs. A 12AU7 works fine and octalists could try a 6SN7. First tube is a CC amp and then a very special output stage we call the *Super Linear Cathode Follower*.

I guess with all my dissing of *Miss P* I'll have to explain the SLCF a little: It is the only cable driving stage we have found that's (almost) transparent—and came about after some serious study of *Valley & Wallman* back in '84.

They say a CF is helped by a current source in it's tail—sure, but it's not enough—so we added an *active bootstrap* to force the CF to also operate under constant *voltage* conditions, which is how they're supposed to like to work—and miracles of miracles—*Miss P* blossomed into *Jessica Rabbit* and I fell



deeply and seriously in love!

MOSFETs, which are fine in (but *only* in) "secondary" signal paths make this stage tighter than if it were all tube—and this SLCF topology sonically *kills* the SRPP, the μF and *everything* else we have tried that has any muscle...

Enough FVP5's have been built to ensure the bugs are flushed, so you can build it with every confidence of having a real stunner. And it is—because it's fast, detailed and ultra dynamic, yet it *really* honours the music...

I still prefer a hardwired RTP3/5 if only for its inherent ease of *absolute polarity* switching—but this FVP5 has been in my system for six months now and it still impresses me, and my visitors.

Whatever...let's not forget why we do all this fooling around—and as the way cool Steven R sez:

**Enjoy the music, dudes...**

# An InDHSET amplifier (In-Directly-Heated-Single-Ended-Triode)

by Vernon Taylor, Lyon, France

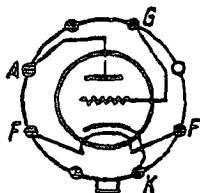
*One step closer...*

This little project may help or encourage those with just an overall knowledge of how valve amplifiers work (like me!), to design and build their very own design. So, those of you with real design skills, please excuse any mistakes that I have made—and in my defense I should add that my creation works very nicely.

I imagine my DIY audio resume is similar to many: first modifying by upgrading components (Linn, Naim, Wharfedale), then trying to build something from an electronics mag that didn't work (Graham Nalty's *ETI* pre-amp. I was too ambitious and tried to star-ground everything), then building something else that did (*Elektor* valve pre-amp—this time I didn't try to make my own PCBs), and then successfully building things from circuit diagrams (Jean Hiraga's *8W Monstre*—no caps except the reservoirs). I think this sort of learn-as-you-go path is a necessary and fun way of getting where you want to go.

## TYPE R120

Indirectly-heated power triode



### Class A Single-ended Operation

Plate Voltage	-250V
Grid Bias	-35V
Plate Resistance	840Ω
Amplification Factor	5.4
Cathode Resistor	600Ω
Plate Load	2,500Ω
Power Output	2.5W
Max. Plate Current	90 mA

### Output stage

So back to my new amp. It actually started as a lash-up of a direct-coupled 2A3 that appeared in *Sound Practices*. It didn't work (the 6A3 plate started to glow brightly); and despite the simplicity of the circuit diagram, I couldn't figure out why. I'll have to read up on Loftin-White and build something more traditional.

The importance of this first step is that I had actually started an SE project and so I had to finish. I decided to put the 6A3s aside and opened Jean Hiraga's "Initiation aux Amplis a Tubes" (1) for inspiration. I remembered reading something about an R120, and that it was an easy triode to build around as it's an indirectly heated triode.

That word 'indirectly' put me off a bit, but Hiraga says that the R120 has a much clearer sound than the 2A3 and that despite being indirectly heated, it keeps the DHT qualities of its more popular relatives. I should also mention that I found the tube at only 100FF (\$16) which helped considerably in the final selection! (Note: my source

apparently only had the two, and I've never seen them advertised or in catalogues elsewhere. There were only two companies that made them, Philips and Radiotechnique, so be warned.)

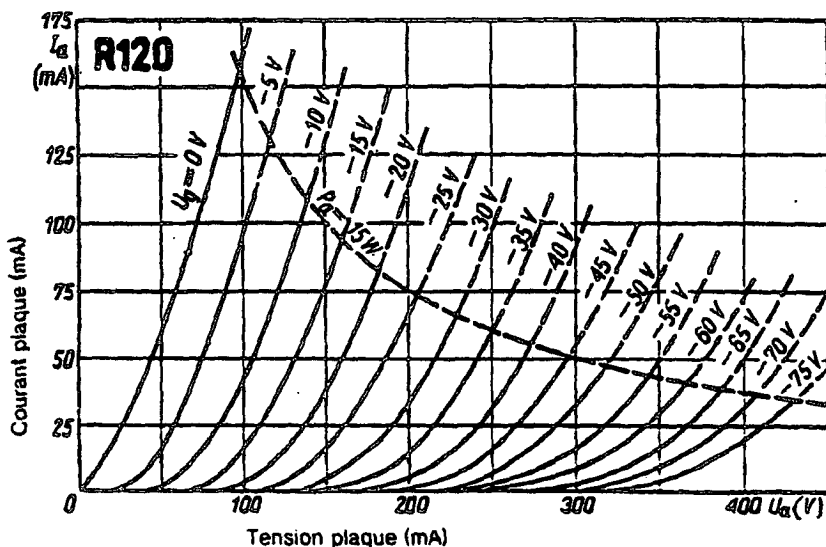
So the next major design choice was the output transformer. The R120 has characteristics that are very close to the 2A3/6A3 which means that the output transformer could be recycled for a future project using these tubes or even a 300B that I'm still hoping to find in an army surplus for a buck-apiece. I wanted a pair that I wouldn't be tempted to change in the future and that were cheap.

I considered Magnequest, Audio Note, Sowter, SJS, and a few others, but finally plumped for Partridge because of its legendary reputation, classic status, good reviews in *L'Audiophile* and *Sound Practices*, and of course the price. I got 'em for 89 Pounds apiece plus VAT (\$130) when the Pound was just under 8FF, which I consider very reasonable for the quality and double-C-core construction.

The reference is TK 7441. This is exactly the same transformer as the highly sought after TK 4519 and cased TH4663/2 (TK is a reference for transformers delivered nude, and TH for those delivered cased). TK 4519 is a reference reserved for Lectron/La Maison de L'Audiophile. Partridge has a catalogue and now sell to the public in small quantities, e.g. two.

### Power supply

The power stage was completed by a power supply from my junk box, using a double-C mains transformer and a nice cased Partridge



6H choke that I had found for a fiver (\$9). I had no 5V secondary which meant rectifying with some fast-switching silicon. I used a full-wave configuration and adjusted  $C_x$  to get my 300V. Making it smaller will reduce your B+ and vice-versa.

In fact, here's a little tip if you're more concerned with using the power transformer you've got, rather than the merits of rectifying with valves versus silicon or the smoothing and regulation advantages of choke-input versus Pi-filter. The final B+ can be adjusted from 0.45Vrms to 0.9Vrms using full-wave regulation and adjusting  $C_x$ , and from 0.7Vrms to 1.4Vrms using a bridge. Include also the voltage drops across valve rectifiers and the choke, and you can see that a very wide range of B+s can be squeezed out of your transformer. Note however, that for correct choke-input functioning, the minimum current drawn by the circuit should be:

$$\frac{2 * \text{sq.root of } 2 * V_{\text{rms}}}{6 * \pi \text{ squared} * fL}$$

$V_{\text{rms}}$  is the full secondary voltage before rectification

$f$  is the mains frequency (Hz)

$L$  is the choke value (H)

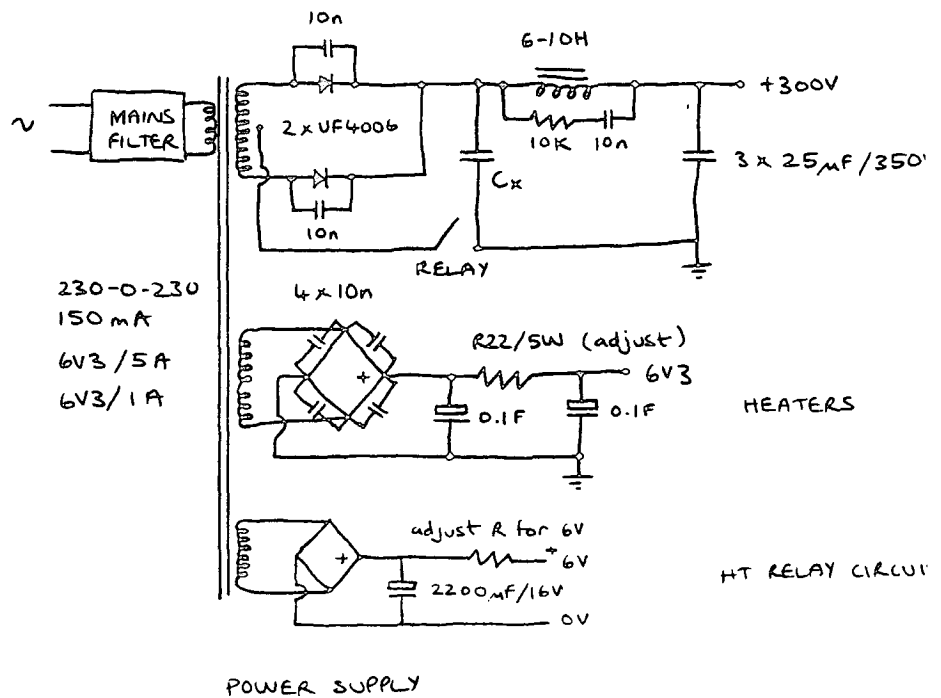
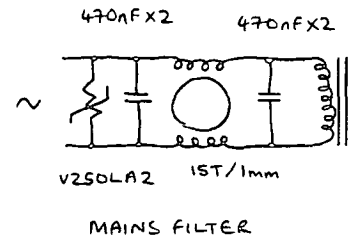
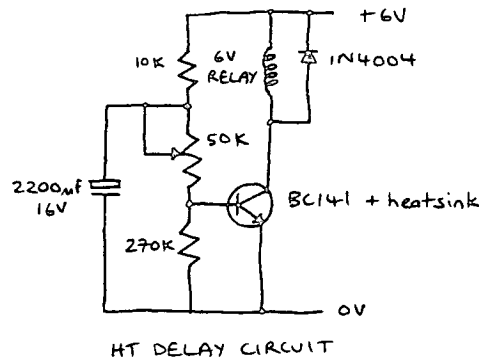
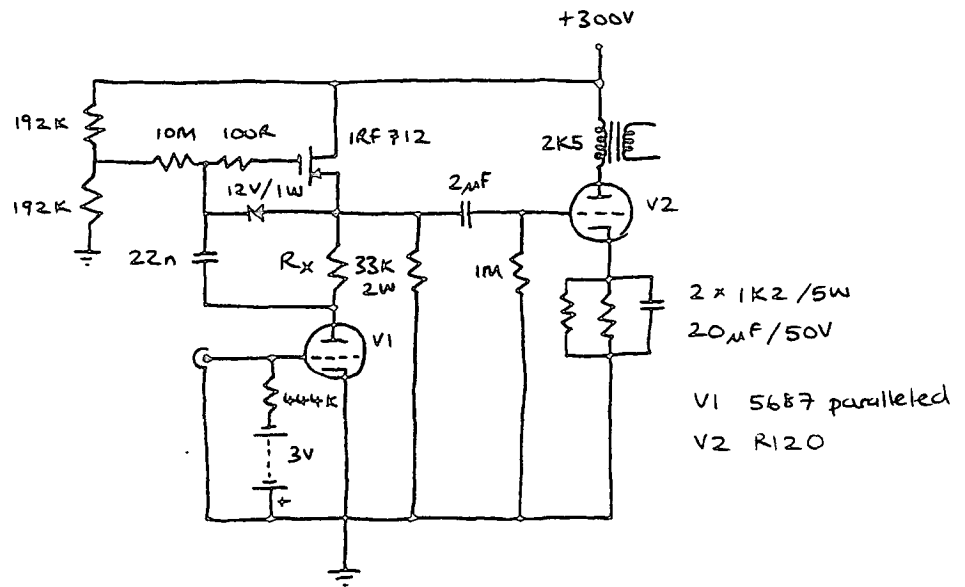
Your B+ will rise to 1.4Vrms if the current is too low. The above equation is for bridge rectification. Divide by 2 for full-wave.

I fitted a mains filter and a snubber network across the choke to reduce spikes. (2)

The heater supply is DC, smoothed by some nice big caps and a resistor to complete the Pi filter and drop the voltage to 6.3V. I added a little delay circuit to let the valves warm-up before applying the HT.

#### Driver stage

So all that was left was the driver stage. After the glowing experience mentioned, I decided to go for something simpler with a coupling cap (Infinicap had sent me a couple of free samples). I had found Alan Kimmel's Mu-stage (3) interesting, so that was the reason for its selection, along with the fact that it needs a 300V B+, which is conveniently more or less what the power stage needs—actually 250V on the R120 plate, and -35V on the grid, so 285V in all plus the voltage drop across the output transformer primary. Practically perfect, huh?





The driver valve choice was between those in my junk box: ECC8X, 6SL7, 6SN7 and 5687. I didn't fancy using the first—not enough street cred', I wanted to keep the 6SL7/6SN7 for a pre-amp project, so that left the 5687. Audio Note uses it to drive their 300Bs, and I read something good about it elsewhere, so why not I asked myself.

I chose Rx as per Alan Kimmel's article, and put in a battery bias because I liked the idea on a gut level, and also because it cut out the usual cathode bias resistor and electrolytic bypass.

#### Construction

I made a chassis out of MDF for the top plate and pine planks for the sides—particularly because it's non-magnetic, but more because wood is easier to cut than metal. It also looks nicer too. The valve sockets were mounted on a copper sheet to act as a ground plane. I mounted half the components on RS tag board and the other half made the connections from the tag-board to the chassis-mounted components.

Single strand silver insulated with teflon tube was used for signal connections, and silver-plated polypropylene insulated multi-strand for the power wiring. Resistors were military surplus, all caps are

polypropylene excepting the filament reservoirs, and the diodes fast-switching types. Absolute values are not critical. A lot of the values were chosen because that's what I had—so use what you've got. Rx in my case is 6k3, and Cx is 25uF.

It may also be worthwhile playing around with the bias and value of Rx. Kimmel recommends that no more than 10% of your B+ should appear across Rx so as not to limit too much the maximum output voltage swing. However, I have a lot more than that and things are fine, but the R120 doesn't need much driving. When I get around to it, I'll change Rx to 2k, which should satisfy Kimmel's condition.

Use a 2A3/6A3/6B4G if you can't find a couple of R120s. Remember though that these are DHTs and will need the bias resistor and decoupling cap in the heater circuit. They need around -45V meaning a resistor value of around 750Ω for self-bias. If you need more front-end amplification, use an ECC83 or 6SL7. This will increase the driver gain from around 20 to 70.

#### So what?

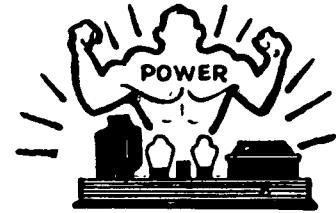
So, that's it. It worked first time, except that there was no bass. As I had built a stereo unit, I had wired up the two channels identically, forgetting about the speak-

er terminals. Changing the wires round on one of them revealed that the bass was not bad—in fact, rather good. It was better still on the 3k5 tap of the output transformer compared to the 2k3, but I reckon this will depend some on the speaker connected. An ohm or two difference in the speaker impedance is equivalent to the difference between the 2k3 and 3k5 taps.

The amp seems to have taken longer to settle down than I remember for transistor designs, but I'm very pleased with the results and feel that I'm one step closer to where I want to go.

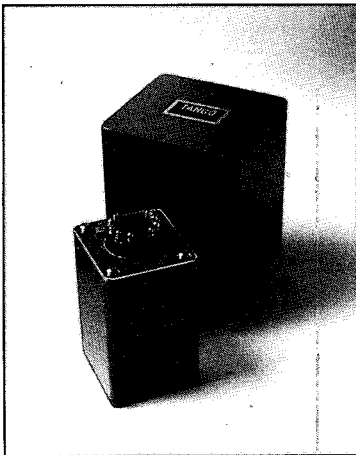
#### References

1. Hiraga, Jean, *Initiation aux Amplis a Tubes*, Eyrolles
2. Jones, Morgan (1995), *Valve Amplifiers*, Newnes
3. Kimmel, Alan (1993), *The Mu Stage*, Glass Audio 2/93



# APRILSOUND

*The finest imported materials for the discerning audio constructor*



<b>Audio Transformers</b>	<b>Universal OPT's</b>	<b>Phono Supplies</b>	<b>Custom Amps &amp; Preamps</b>	<b>Audiophile Books</b>
<ul style="list-style-type: none"> <li>• Tango OPT's, IT's, and Plate Chokes</li> <li>• Nature Sound Permalloy Transformers and PS Chokes</li> </ul>	<ul style="list-style-type: none"> <li>• Tango U-808, XE-20S</li> <li>• Nature Sound NS-70-S</li> </ul>	<ul style="list-style-type: none"> <li>• Denon DL103</li> <li>• Tamura TKS-27 step-up transformer</li> <li>• Berger-Morrison phono stage</li> </ul>	<ul style="list-style-type: none"> <li>• High Current, Zero Negative Feedback designs</li> </ul>	<ul style="list-style-type: none"> <li>• Asano I &amp; II</li> <li>• Shishido</li> <li>• World Tube Manual</li> <li>• and more...</li> </ul>

*The world's finest transformers... here now!*

Special offer: Free pair of tested good 45s with output transformer purchase!!

Steve Berger voice/fax 212.242.9515 e-mail: [aprilssound@earthlink.net](mailto:aprilssound@earthlink.net)  
223 West 21st Street New York, NY 10011 USA

# Casual Reactions

by Herb Reichert, Audio Note NYC



## The Matrix of Culture

Anyone familiar with my *Casual Reactions* column will have noticed that I like to speculate about the relevance of leading edge audio engineering and that I am constantly seeking to place this research in a larger cultural context. I can't help it, because it is impossible to study the basics of electronics without realizing how primary the physical laws that govern electronic circuits are. Changing energy from one level or state to another is fundamental to all science and a principal technology in human culture since the dawn of man.

In a very short time, less than 10,000 years, humankind has dematerialized its own culture. The objects we now manufacture tell us less about our present cultural state, than the data we store on discs and reels. Who we are, where we think we come from, and what we aspire to be are buried in some form of stored data, somewhere.

The archaeologist of the future will not be brushing off stone tablets. He will be resoldering traces and listening for archaic signals through headphones. The anthropologist will be studying microfilm. Signal and data recovery will become the primary tools of the historian, anthropologist, and archaeologist.

The archaeologist of the 30th century will need to decipher forgotten languages buried in electromagnetic code. His lab and study will be filled with discs and reels and scopes and meters. Screens and loudspeakers will surround him. He will transduce and decode. Part of his task will be to restore and reinvent ancient playback machines.

Our attention is turning away from the sensational interplay of natural forces and man's role within these forces. Instead we simply accept our role as "caretakers" of the planet. Our new "job" is to collect information about our collective selves and our environment. Great collaborative efforts now organize this information so that it may be used to solve problems concerning

our longer term survival. Our culture itself is now rapidly becoming information and theories of information. We have come to see problem solving as a process of data retrieval, sorting, and analysis.

Surprisingly, if we look broadly enough, we notice that the majority of this alluring information is stored on discs and reels, played back over and over and sent amplified through antennae to pulsate through space.

We create data, we store it, we transduce it, we study it and we give it power, transmitting it, globally and out into the stars. Alien anthropologists must see humans as doing only two things; moving heavy objects from place to place and transmitting data.

The contemporary human enterprise is evolving into a global ideas/technology generated matrix of coded electromagnetic waveforms. These vast interlocking waveforms are now, quite literally, the first living, vibrating, archaeological remnants. Like cultural DNA, this pulsating, encoded, electromagnetic plasma is becoming our species fingerprint. It is the ever-evolving, spherically-expanding, musical score of our civilization.

Remember, these are storage media we are discussing. The stone tablet and book were first but now, since the development of magnetic science, we have a rapidly evolving succession of cylinders, discs, reels and cassettes, each storing more information than the previous incarnation.

The big break with the past appeared when we began to store sounds where we can't hear them and sights where we can't see them.

## History is Superimposed upon History

We speak, we tell stories, we sing songs, we do business, we conduct experiments and everything that we do is recorded and then transmitted via periodic electromagnetic energy into the vastness of the galaxies. Interestingly, this larger matrix predates civilization and is, itself, an electromagnetic

record of the history of the universe.

Imagine vast layers of electromagnetic grid fields, pulsating, morphing and folding one upon another. Imagine these grids generating harmonics of themselves, picking up and dissipating energy, being pushed one way or another by electromagnetic, solar and celestial "winds." Imagine our own thoughts, movements and worldly interactions as organized disturbances in this electromagnetic medium. Imagine our narrow bandwidth human activity morphing harmonically into the wideband electromagnetic spectrum. Imagine the effects of playing music or acting drama, recording it and playing it back...over and over. Every solar eruption is super-imposed with *Citizen Kane* and Eric Dolphy. A symphony of ideas and dreams and aspirations is being written in electromagnetic code in our own remote corner of the ether.

The musical waveforms, the CDs and LPs we so innocently play with as hobbies in our living rooms, can easily be seen as very tiny "micro-models" for the whole picture. For the moment, the symphony, the raga or the song appear to be tangible glimpses of the big picture we are all seeking. The "where do we come from?", "who are we?" and "where are we going?" questions are most likely already answered—they are out there "coded." Recovering stored musical information to be played back, over and over again, is nothing less than a sacred enterprise.

## Audio Engineering

Lowly and often disparaged, audio engineering is potentially the most profound of the science disciplines. It can be seen as a distillation of all branches of science. Its primary purpose is to create machines that allow humanity to share in the examination of our most important scientific, religious, and philosophical data.

This is a grand enterprise. It is the beginning of man's first multi-disciplinary odyssey into real self-knowledge. The study of information storage and recovery, especially *analogue* storage and especially *musical* information, may be the core study that ultimately unites the now separate fields of science, art, and philosophy.

Audio engineering must be considered not as a subtext to hard science or the bastard child of electronic engineering. It must not be allowed to become a trivial branch of the entertainment industry. We must not too quickly forget that it is the armature of twentieth century scientific and cultural growth.

Audio engineering is the mother of all waveform and electromagnetic study. It is not only a core technology for cinema, radio, television, communications, computers and data processing, it is also related in substance to scientific studies in fields as far reaching as propulsion, atmosphere science, leading edge particle physics, quantum mechanics, and astronomy.

#### Transmission and content

I believe that it is reasonable to assume that all of nature's secrets, the answers to all our better questions, are already encoded and stored! More than likely, these concepts are stored in the larger and smaller interlocking electromagnetic energy matrixes that envelope us. Perhaps, quite literally, the answers are "blowing in the wind"—or broadcast from our radio?

Accepting this, it is obvious that nothing could be more shallow than discussing audio engineering in terms of detail, soundstage depth or bass slam. We must stop focusing our attention on the clarity of the transmission and begin to recognize and examine the patterns of the content.

Our audio equipment can be considered at least *adequate* if it directs our attention towards the content of these messages. When the music is playing we must be allowed to inquire about more than just *the sound*.

Unfortunately, almost none of our best audio equipment accomplishes even this simple feat. If audio equipment did indeed direct our attention towards the larger message, we would certainly not be wasting so much time discussing soundstage and bass definition. We would be considerably more busy decoding and analyzing the structure of what is on these discs and reels.

Typically, the 'hard science' school of audio design looks only at linear and steady-state data, hoping to recover a clean stream of amplitude and frequency modulations.

What tends to be forgotten is that the larger audience for *musically-encoded* data is receiving a confusing, severely edited and highly simplified version of the original musical event. It is almost as if another layer of "black ice" encoding has been added. The information has not only been magnified (amplified, with all the inevitable distortions that entails) but has gone through yet further, unnecessary stages of encoding.

Unfortunately, one cannot encode (or decode) information if they do not read

and understand the language of the original. Presently, the communities of art, science, philosophy and religion could not be more ignorant of each other and this ignorance has contributed mightily to our inability to recognize the significant patterns in the data we experience.

In fact, each of these disciplines has developed a lexicon so singular as to be barely intelligible to the others. The lack of a shared lexicon or even a pan-disciplinary approach to study is surely the biggest roadblock to any understanding of the bigger ideas being entertained today.

Let us presume, just for the moment, that we can recover and play back some crystals of musical code in nearly their virgin, but slightly amplified form. (I not only believe that this is possible, but I believe that some of the no-feedback single-ended triode technology emerging today has been quite successful at this.) Would the music and art loving public at large truly be able to process this information? Would some basic "where do we come from?" questions get answered? I believe so!

Here is how it happens. At first you will hear some lone shouts and momentary exclamations, "I've got it!" But no one will really take notice. In fact, many of you have already experienced this. The process has begun.

The solitary voices of those few who have experienced this new 'virgin data' have, by now, joined into small choruses. Worldwide there are little pockets of people emerging from their listening rooms and studios - instead of their minds reflecting on right and wrong or their lips speaking of profit and loss, we see the drunk-tough, glazed over eyes effect of a new innocence. The data was right there all along, we just couldn't distinguish it.

The technology is in place. The data is already stored. We can now begin the new anthropology. Starting perhaps with Thomas Edison and "Mary Had a Little Lamb," we can start examining the code, looking for the primal melody. We can begin to look at our culture broadly, not through a magnifying glass but through a pair of loudspeakers.



## GO AHEAD

Ask top engineers and music lovers worldwide what capacitors they choose for their ultimate designs.

### H O V L A N D MUSICAP®

"After auditioning a wide variety of caps, I find these film-and-foil capacitors to be the most musical performers—and by a large margin. The MusiCap specializes in textural liquidity (lack of grain) and delicacy of treble nuances."

Dick Olsner, Reviewer and Designer; from November 1996 Samadhi Acoustics white paper

## COMPARE NOW

The most naturally revealing capacitor. Film and foil polypropylene construction—optimized for fine speakers and vacuum tube electronics. Precision made in USA. Values from .01 to 10µF.

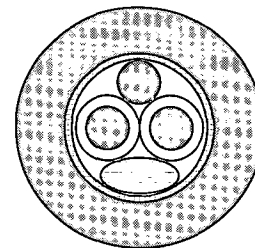
To listen to MusiCaps for yourself, contact:

- Welborne Labs 303-470-6585
- Madisound Speaker Components 608-831-3433
- The Parts Connection 800-769-0747
- Michael Percy Audio Products 415-669-7181
- Handmade Electronics 610-432-5732
- American Audio Import, Netherlands 31-78-6510567
- Anchor Cross Co., Tokyo, Japan 81-3-3203-5606
- Bina Putra Datamas, Indonesia 62-21-8209126
- Octave Electronics, West Malaysia 603-793-793-9
- SJS Electroacoustics, England 44-1706-823025
- Tang Hill International Ltd., Taiwan 886-2-5813605
- Thai Audio Center, Thailand 66-2-226-0773
- OEMs contact Hovland Company at:  
ph 209-966-4377 • fax 209-966-4632

## SILVER SONIC™ Audio Cables

*Making the High End  
Affordable!*

"With tube amps and hybrids, the Silver Sonic competed with the best."  
*Bound for Sound*



- T-14 Speaker Cable, \$4.00 per foot
- BL-1 Interconnect, \$99/1 meter pair
- D-110 AES/EBU Digital, \$89/1 meter
- D-75 Digital cable, \$75/1 meter
- Hook up wire and Connectors

D.H. LABS  
612 N. Orange Ave., Suite A-2  
Jupiter, FL 33458  
(561) 745-6406 (phone/fax)