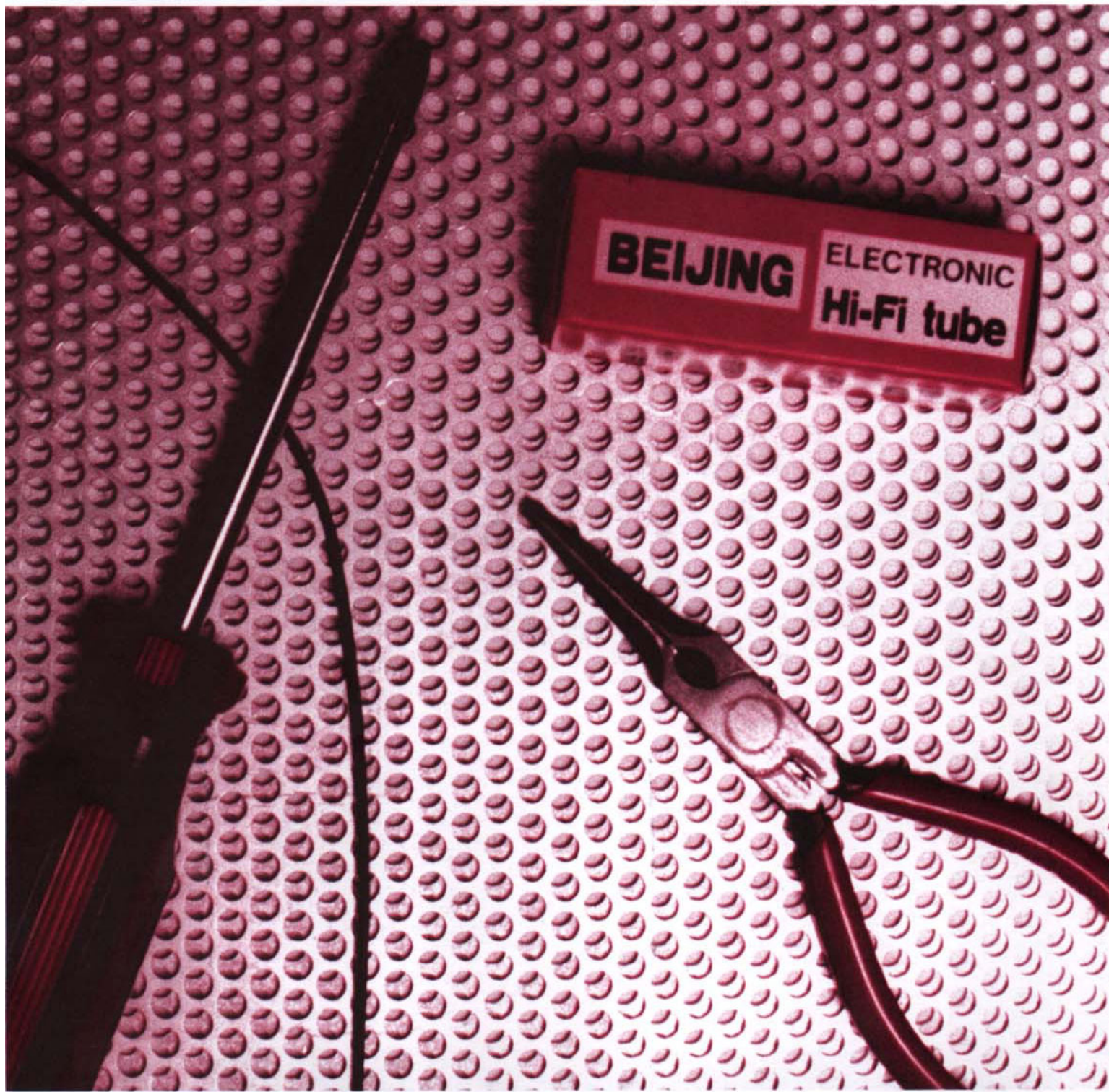


SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY

SUMMER 1994

FIVE DOLLARS



Audio Kit Revival!

Vol. 2:#2 Issue 6

Sound Practices

SOUND PRACTICES (Pending) is published quarterly by Sound Practices at 9405-C Grouse Meadow Lane, Austin TX 78758. Application to mail at Second Class rates pending at Austin, TX.

Please address all correspondence to SOUND PRACTICES Box 180562, Austin, TX 78718. Voice/FAX 512-339-6229. e-mail: SP@tpoint.com. Due to critical time/resource pressures, we must discourage calls for general advice or technical assistance.

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Subscriptions for Vol. 2 are available at the rate of \$20 yearly in the US, \$24 in Canada, \$30 UK/Europe Airmail, \$35 Elsewhere Airmail. Regardless of the month in which you subscribe, you will receive all four issues published in the current volume.

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POSTMASTER: Send address corrections to Sound Practices, POB 180562, Austin, TX 78718-0562.

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History Lessons

There is a lot of confusion regarding the cultural significance of vacuum tube audio in general and single-ended audio in particular. All of a sudden, we are confronted with a harvest of new stuff which apparently has a lot to do with very, very old stuff. Some mainstream journalists were quick to dismiss the whole phenomenon as a "retro" movement, a term of pointed disdain in high-tech circles signifying an unnatural preoccupation with an imagined past. "Now is better" is the cry of the old guard rallying in defense against this blast from the past.

Well, now is better. But "now" is composed of our collective and individual past experiences and it offers a diverse set of possibilities for the future. The rise of single-ended amplifiers is a NOW thing. You can build one of these so-called "retro" amplifiers with parts manufactured last week and designed after the Intel 486 chip was well on its way to obsolescence. Recent changes in World sociopolitical structures provided the side benefit of new manufacture and even new design vacuum tubes for audio. Yes, now is better — especially if you're into certain kinds of "retro" tube gear!

Although there is a romantic reflective aspect to the current reconsideration of foregone audio technologies, those involved in this movement are excited about future prospects and see themselves as working to make NOW better until we get to the future. Sure we have come a long way since the first 300B rolled off the line back in 1935, but this is not to say that a 300B can't take you today to a place you have never been before, somewhere you might discover that you really want to be. As new concepts blend with old, new directions emerge. Why shouldn't history offer lessons in audio as it does in politics?

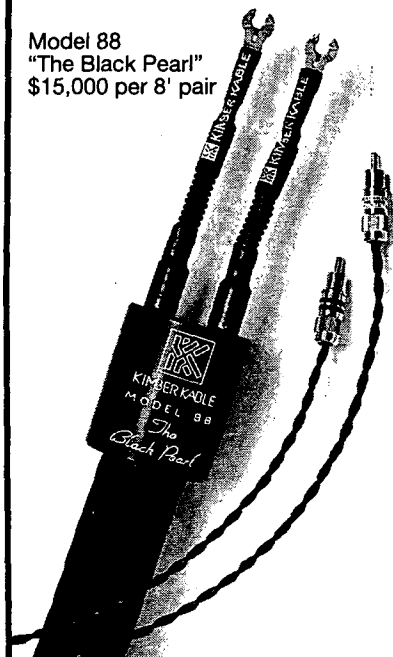
Technological progress rarely traces a straight line. If it had in audio, our systems would be so good by now that further development would be strictly academic. As it stands we have a long way to go. More often than not, a step forward in one area of performance is repaid by a step backwards in other domains of evaluation. Transistors rode to dominance on economic advantages but it took at least 25 years before they even came close to the vacuum tube as a reproducer of music. A dramatic advance in, say, efficiency, size reduction, or cost per unit may temporarily blind us to shortcomings but over time our initial over-enthusiasm is moderated by experience. Such is the engine of progress that it drives us between one incomplete solution and another.

Since the values of the modern audiophile radically depart from those of the market-driven engineering perspective which officially defines progress, maybe it's time to reassess technologies passed by in big industry's quest for economy, efficiency, and miniaturization according to our own uneconomic aesthetic ideals. Many possibilities appear on the horizon when we break out of the tiny slice of time that is 1994 and take as our playing field the entire range of technologies which came to pass during our century of electrical sound reproduction. Let us make our own choices with our own special goals in mind.

Like postmodernism, the new wave in audio draws on and juxtaposes wildly disparate influences, from points scattered across space and time. But in contrast to the jaded cynical superficial attitude of the postmoderns, the core of new audio is heartfelt excitement about possibilities and a joy of participation in the giant experiment. In this sense we have a rebirth of modernism in the classical sense with a 1994 thing going on. Fellow adventurers, modernism might even be better the second time around!

Single-ended audio is not vintage audio. However, one of the crucial lessons that many of us have learned from living with the best classic components of the first electric century is that there are more possible musical sounds than the latest Recommended Components list offers. Some widely neglected devices can really play music. We surely haven't heard the best yet, but maybe we will get there during the next audio century by keeping an open mind today.

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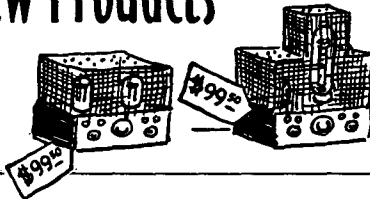
At the Summer 1994 Consumer Electronics Show our brochure was honored with a major award. We are very proud and pleased, and would like to send you one. But we would point out that our cables are even better, and our cables have been receiving "note worthy" accolades for 15 years. Yes, the humor in the last ad was deliberate. It was our way of making you smile—that is if you don't have Kimber Kable in your system... yet!



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Las Vegas, NV 89108
702-646-7990 voice
702-646-7752 fax

VAIC Valve Italia

Vaic Valve is offering a line of new design, European manufacture power triodes created with the discerning audiophile in mind.

The Vaic Valve VV30B will be of particular interest to the readers of this magazine. This triode can be substituted directly for the 300B, but it is not a mere copy of that classic tube. The VV30B has a redesigned mechanical structure, gold plated grid, and graphitized plate. It also uses a ribbon filament in parallel instead of the round extruded filament used in the original WE 300B and currently manufactured versions. The working lifespan of the VV30B was tested at over 10,000 hours by an independent Swiss testing laboratory.



The mu of the VV30B is higher than that of the 300B, therefore less input drive is required. According to the manufacturer, the same operating voltages which produce 7 Watts out with a 300B produce 12 Watts out with the VV30B. Several other output triodes are in the works, including higher power versions.

Vaic Valve Italia
via Machiavelli 12/a
36061 Bassano del Grappa, Italy
00 39 424 523328 tel
00 39 424 524395 fax

SP on Line!

Information highway cruising readers: get on line with the Sound Practices Internet mailing list, an electronic forum created to promote experimentation for a better sounding 21st century. This is an automated mailing list where every piece of mail posted to the list goes out to everybody on the list. Get in contact with people all over the world who understand your special interests. Trade parts. Get feedback on your latest theories. Find a roommate. Whatever.

To sign up, simply send a message to sound-request@tpoint.com with the following text in the body of the message: *subscribe sound first-name lastname* on one line. Post messages for distribution to sound@tpoint.com.

Svetlana Electron Devices

This venture is a joint stock company formed between a privatized manufacturing facility in St. Petersburg and an American consortium. The Russian manufacturing facility, probably the largest vacuum tube plant in the world, has established a reputation for quality in the broadcast and industrial markets.

Svetlana is very aware of the growing demand for high quality audio tubes and they are approaching this market from three sides: exact plug compatible versions of Western tubes like the 6550, 5U4-G, and EL-34, excellent quality Russian designs like the 6P4SS, and totally new design thoriated tungsten class A triodes specifically created for audio. Russian 300Bs and 6B4-Gs are currently in development.

Interested manufacturers and OEM suppliers can contact George Badger, VP and Director of Marketing, for more information.

Svetlana Electron Devices
3000 Alpine Road
Portola Valley, CA 94028
415-233-0429 voice
415-233-0439 fax

Kit Frenzy!!

following the third path to top sound

by joe roberts

Back in the Dark Ages when the first issue of *Sound Practices* hit the streets, single ended triode amplifiers were the exclusive province of the intrepid DIYer. If you wanted it, you had to build it.

Yeah it was fun back in the old days (last year), but it was a bit lonely. If you were interested in triodes and single-ended stuff back then you were likely to have enormous phone bills because the only two people who understood what you were talking about lived in Montana and Florida.

Two years ago, you could still find N.I.B. Western Electric 300Bs for \$75 and only exporters were buying them since only a few crazed builders and Western Electric collectors had amps to plug them into. Over the past year, single-ended audio moved from being an exclusively DIY pursuit to a legitimate conceptual suburb of high-end audio. Mention that you have a triode amp down at the audiophile society meeting these days and you are more likely to get a request for an audition than the traditional blank stare.

Sure the tired hi-end market was ready for something novel and fun beyond new digital formats and the SE explosion gave audio journalists something to discuss besides ABX testing. Nonetheless, the enthusiastic reception of SE triodes in the established press points also to the sonic merits of this technology. This stuff does all the Official Audiophile things well: Image, detail, back wall, yak, yak, yak. But a good triode amp also plays with a breath of soul that is rare in the usual run of commercial gear.

Fortunately, the prospect of listening to triodes is becoming more and more realistic as small to medium sized manufacturers arise to meet the burgeoning demand for store-bought products at various price levels. A niche industry catering to the special needs of adventurous DIYers rose up out of nowhere simultaneously. It's getting to the point where we hear about new tubes, transformers, amps, kits, etc., several

times a week! Things are really starting to get interesting. As good press on triode amps accumulates in the mainstream magazines, the market can only get better.

One particularly heartening development in the prevailing audio revolution is the resurgence of kits. Kits are a cool idea, once popular before they started building electronic gear with giant robots. Kits can help us recover the lost "hands-on" aspect of our hobby that many of us need in an era when you can't even tinker with your car without a 32-bit protocol analyzer. Everything in sight these days is a soulless "No User Repairable Parts Inside" black box appliance.

The kit is the great leveler. You can be a total novice at electronics and still jump right in. You'll be less of a novice at the other end. Most of what you learn is basic soldering and assembly technique, but you will also catch on to the idea that, on one level, any amp is simply a pile of parts. This can do a lot to demystify electronics. It's more like plumbing than audiophile journalism suggests. Every reviewer should build at least one kit in his or her life, I say.

Novices take heart: A service manager for former kit giant Heathkit wrote in *QST* magazine back in the 50s that sometimes knowledge and experience could even be a bit dangerous in kit building. While beginners tended to cling to every word of the instruction manual, old hands at building would often invent "shortcuts" and skip sections of the manual, typically leading to unforeseen disaster or at least lots of extra work.

If you are ready, willing, and able to follow directions, the probability of making some weird mistake you never even thought about is greatly lessened with a kit. Most problems can be traced to failure to follow instructions. And if you do screw up you can get somebody to help. If you can't get your scratch-built triode-wired single-ended cathode-coupled 6AR5 amp to work, light a candle and pray for divine inspiration.

In addition to providing a clear program of action and a complete collection of parts, kits usually offer a sound economic rationale as well. Often a kit sells as a turnkey package for less than you would spend to buy equivalent parts and materials yourself, especially when you factor in phone bills, time, and shipping charges. Sourcing non-standard power resistors and other obscure parts is the kitmaker's job, not yours. Rescues you from dozens of phone calls and \$30 minimum orders when all you need is two 880 ohm resistors.

Furthermore, no investment in specialized tools like chassis punches and rattail files is required for kit assembly. You can get by with a soldering iron, standard hand tools, and perhaps a basic digital meter. You won't have to do any metalwork on the kitchen counter, so you don't wind up with razor-sharp metal filings stuck in the carpet, just little blobs of solder and lost nuts and bolts. As far as I am concerned, learning how to solder and do routine electronics assembly isn't a big thing. The ability to do decent looking metal work, on the other hand, requires patience, skill, LOTS of practice, and a serious workshop. I don't have any of the above.

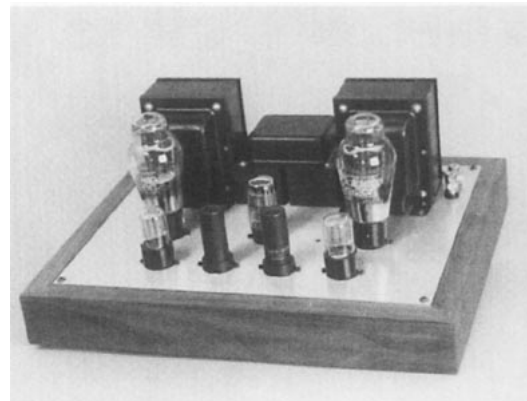
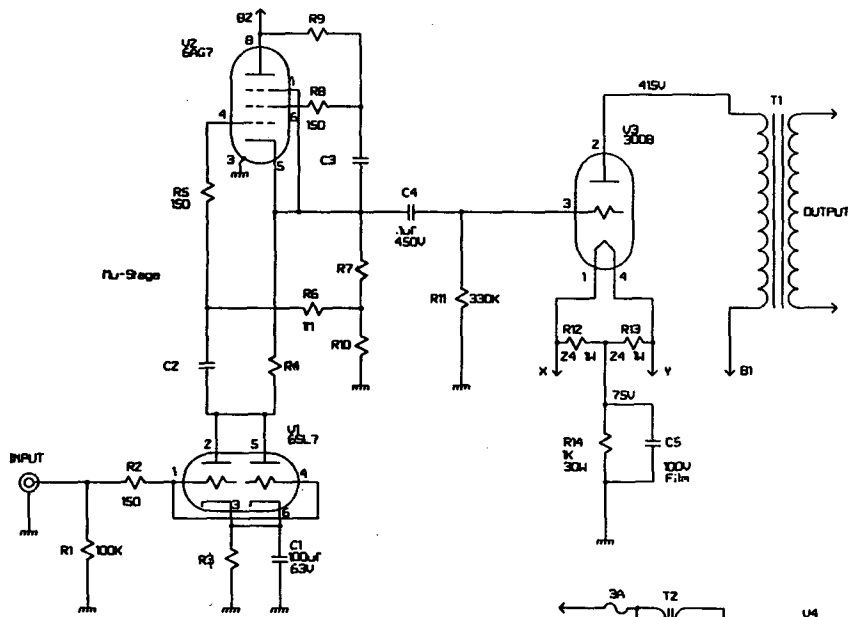
The question "How do I build an amp?" is like the question "How do I fix a car?" It's not that hard, if you know how. Unfortunately, learning how is a medium-to-long-term project and everybody wants to get building NOW, if not sooner. If this sounds familiar, whip out your credit card and call a kit dealer.

The psychic payoff of kit building is enormous. After a few nights of interesting and engaging work, you can be listening to an amplifier YOU built. Impress your next date: "Yeah, baby, I built that amplifier. Like that midrange?" Rediscover the rewards of actually doing something tangible in a push-button world.

The psychological rewards and economic advantages of kits are certainly considerable. However, the reason hobbyists build kits is to get the equipment at the other end of the process. Right now, there are some very interesting products on the kit market. Even though I'm a notorious trashpickin' cheapskate scratch builder myself, I was anxious to hear some of the current crop of SE kit amps because on paper they seemed to offer potential for high performance at a level of investment many hobbyists can tolerate.

Welborne Labs Laurel

At \$1600 and up, the Welborne Laurel stereo and mono amplifiers are the higher-priced entries in the US kit market. With the Welborne kits, you can get into a serious triode based



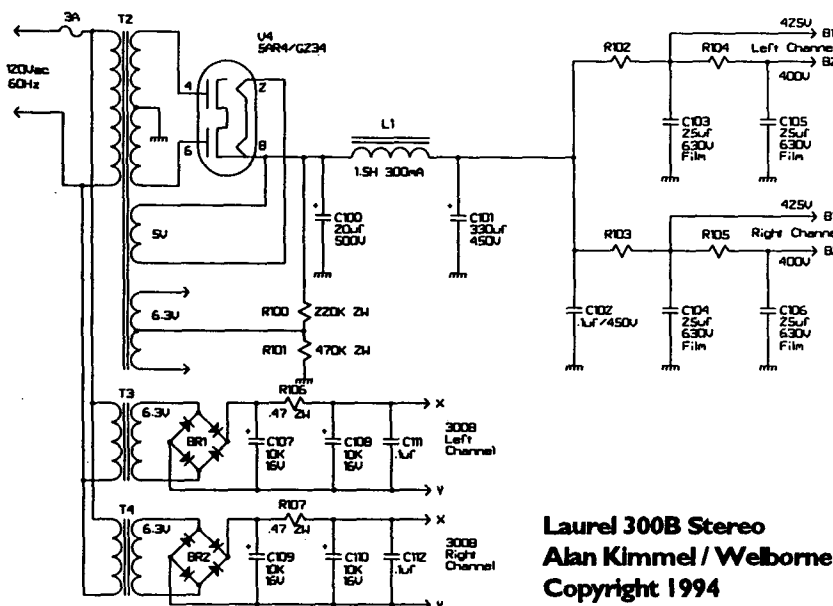
system for the cost of an Adcom-555 and a pair of Vandersteen 2C. You probably need to have gone through the 555/2C phase yourself to recognize how far ahead you would be with this 300B kit and a pair of efficient two ways.

Since Welborne's in the audiophile parts business, this amp is loaded with fancy designer parts. Outputs are Magnequest FS-030s on the stereo amp (\$1600), DS-025s or FS-030s on the monoblocks (\$1620 or \$1900/pr). A "stock" Laurel comes with Golden Dragon 300Bs, 6SL7s, and GZ-34, and a pair of new old stock 6AG7s. Kimber Kaps are used in the audio circuit and as bypasses for the SCR polypropylene filter caps.

Welborne is receptive to the idea of working with the buyer on parts selection, a refreshing alternative to a common high-end manufacturers' stance — "We auditioned every fuse holder on the market and this one is the most transparent" and so on. As a symbol of kit building freedom of choice, Welborne packs each unit with both Allen Bradley carbon composition resistors and fancy Roederstein metal films. "Have it your way," is the order of the day.

The Laurel I got my hands on was an assembled stereo unit. Quite nicely assembled at that. I almost hated to dive in with a soldering iron and really get into checking out the amp. Now, if it were a borrowed Audio Research, I wouldn't even want to open it because I might mess up the paint on the screws and lower the resale value by \$300. But this is after all a KIT amp. Kits don't have to stop being built. I saw it as a project waiting to happen.

I called Ron Welborne and asked, "Say, you wouldn't mind if I tried an experiment or two



Laurel 300B Stereo
Alan Kimmel / Welborne Labs
Copyright 1994

with the amp, would you?" Heck, Ron not only didn't mind, he encouraged my experiments. Got the same response from Dennis Had over at Cary about the SE-1. Both kit designers were actually eager for hot tweak tips to pass along to builders to try. I really appreciate that attitude.

Since I'm used to spray painted Bud chassis homebrew monstrosities, it was a bit of a shock to my listening room anti-decor to have the extremely handsome Laurel on my mantel. If I ever build an amp as nice looking as the Laurel, Joyce might finally stop moaning about the fact that I gave her Akai mini-system away five years ago. With its polished brass and walnut enclosure, the Laurel looks handcrafted rather than manufactured. It would be at home in a mahogany paneled den with green leather armchairs. Got that exclusive men's

club thing going on. The entire assembly fits on a compact 14 X 17 X 2" chassis. With all those burning Class A tubes on one and a half square feet of real estate, the Laurel would be nice to cozy up with during a snowy evening. (Right now its 105° in Texas, by the way).

All versions of the Welborne SE amps use a mu stage driver stage designed by Alan Kimmel. This circuit is a variation on the popular mu follower circuit optimized for use in power amps. A general idea of the circuit implementation is given above. The complete schematic and other relevant engineering data is available in Welborne Labs' latest design manual and catalog, a thick book of schematics and useful data worth every bit of the \$10 asking price. Further insight on the mu stage is also provided in Alan Kimmel's 1993:2 article on the topic in *Glass Audio*.

The assembly manual and layout are logical and should be easy to follow for the builder. Most of the parts are attached to a few epoxy terminal strips that run the length of the amplifier. Basically you mount the transformers, tube sockets, and terminal board in the amp, then install the parts in layers as instructed by pictorial diagrams. Once you get everything in there isn't too much leftover space, so forget about strapping a bank of oil filter caps rescued from an old radar console underneath.

Laurel Sound

Out of the box, with less than 50 hours burn-in time at Seth Goldwin's pad, the Laurel had a touch of zing, as I expected based on Seth's comments and my previous experience with freshly built gear.

The last few amps I built used Magnequest transformers and I found that they require up to two weeks of nearly constant play before they fully settle down. Poly filter caps also take a few days to mellow out. Same probably goes for everything in the amp. I don't remember such dramatic burn-in effects with store-bought gear. I suppose most manufacturers put some hours on a factory unit before it ships.

Like everything else in audio, the whole question of break-in is under dispute. Psychologists often attribute such effects to perceptual recalibration, where the perceived break-in is actually a by-product of the listener getting used to the particular sonic character of a given device. Although I agree that man has a high capacity for self-delusion, I believe that break in is real. Fooled me, anyway.

The Gauss 1502 compression driver tweeters I use for the top end in my Edgarnhorn/Onken system are a mixed blessing. With the right amp these tweeters really sing but with some otherwise respectable equipment they turn into audio-frequency death beams. Over the years, I have developed a liking for systems with mildly sharp speakers and slightly soft amps, or at least amps that have a musical rather than a clinical top end. Altec 755C or Lowther PM-6s in my 4" throat Edgar horns also give me a squeaky clean sound, but they are far more forgiving than the pro-sound tweets.

I usually bi-amp with a triode amp on the mids and tweeters. Accordingly, most of my Laurel listening was done with the amp on the mids and highs, 350 Hz up, but I also wired up the system with the Laurel playing full range. Until I get a chance to build a PP triode bass amp, I am using a Dynaco ST-35 I borrowed from a friend as a bass amp on the Onken/Altec 416. Even with a wimpy Dyna bass amp, the bi-amp

setup sounds better overall because I don't have to pad down the mid horn to match output levels. The bass was actually much more natural with the Laurel but I couldn't take the midrange quality losses with an attenuator in line, so I mainly listened bi-amp. Anyway, after a week of nonstop listening, I decided that the Laurel still had a pinch too much lower treble information for my system. A subtle thing and probably as much to do with my speakers as the amp. Anyway, I was looking for an excuse to start heavy tweaking.

My first experiment was to unbypass the poly filter caps. The 0.1 mF Kimber Kaps shunted across the filter might offer lower impedance at high frequencies but the SCR caps are okay by themselves. With a film bypass cap, they can get a bit too lively sounding — an advantage in some cases but not what I needed. After I yanked the bypass caps, the amp smoothed out enough that I was happy. Power supply components have major sonic effects in SE amps because the PS is *in series* with the audio stage in SE.

Continuing to experiment, I installed four Audio Note paper in oil caps for coupling. The AN caps, while a touch on the laid back side, are free of the melodramatic quality some people don't like in classic oil caps like Vitamin Qs. They offer a polite tonal balance and poise without squashing dynamics. A tiny bit soft on the leading edge but the overall effect is very natural and involving. They provide just enough bite for a convincing illusion of reality. A friend once suggested that a good system is one you can fall asleep listening to, but not one that puts you to sleep. The AN caps will give you a comfortable sound that is still exciting and very engaging.

Another capacitor I have been interested in lately is the Hovland MusiCap, a polypropylene and foil type. I have always been partial to a nice oil/paper cap for power amp interstage coupling, but after a week of living with Wavelength Audio's superb MusiCapped Cardinal amplifiers, I began to reconsider my position. I tried an SRPP driver stage in a 300B amp with Magnequest FS-030s, but it didn't sound like *this*. The Cardinals gave a lot of overused review-speak terms new meaning for me. Want transparency, detail, and accuracy that doesn't singe your mustache? Here it is. I figured the Hovland caps played a part in the Cardinal sound so I wanted to try 'em in the Laurel.

Indeed, the Hovland MusiCaps were a killer in the Laurel, even though it sounded very different from the Cardinal. If you want see-thru, high-definition, detail *and* listenability, try the MusiCaps. Where the Audio Note caps had a

bit of smoky after-hours jazz club flavor, the MusiCaps had that sunny afternoon chamber music on the patio sound. Know what I'm sayin'? Oh, well.

Basically, I had the Laurel for three weeks and during that time I had three different sets of caps in the amplifier. All I can say is, you folks who find cable swapping and resonance tweaks engaging should look in to cap swapping as a new hobby. In these simple no-feedback amplifiers, each "passive" component has a truly radical effect on the sound. Sure, you can hear parts changes in push-pull feedback amps too, but here it is a different order of magnitude. I had a real blast experimenting. The range of possible sounds you can craft by swapping low cost parts is mind bending. The Laurel can assume many guises.

Throughout my experiments, the Laurel maintained a sense of tight control and focus. This amp is very fast and punchy. It had the snap for Buddy Guy and just the right amount of richness and color to give female vocals the appropriate emotional twist. The bass performance of the Laurel was highly controlled for a SE 300B. It would be a good choice to run appropriate speakers full range. If you think SE amps can only sound "old fashioned" or hopelessly tubey, you haven't heard the Laurel — or most other modern SE amps, for that matter.

Additionally, the Laurel has the vivid 3-D presentation that instantly lets you know you are listening to an SE triode. This is one of the main things you are paying for when you invest in triode amps. With a good SE amp, the music just floats in the air — a pleasant, almost psychedelic illusion that never wears away.

Don't mistake this little essay for a serious review. I mainly used the Laurel as a midrange amp with a non-standard speaker system. If anything was matched to +/-1 dB, I'd be very surprised. I just wanted to "check it out" in my natural listening and tweaking mode to see if it would give me the level of musical impact I expect from a 300B SE. It sure does. It is a really nice amp.

After playing with the Laurel and the Cary SE-1, I am even more excited about kits. Both products were like "fun in a box" and each gave up some real good music for the money (and high perceived value overall) in their respective price classes. A kit can give you most of the fun stuff of scratch building without any of the dog work and tedium. Since I grew up in a silicon universe, I missed out on tube amp kits the first time around. I'm sure glad they're back!

SINGLE ENDED ME



BUILDING THE ALMOST AFFORDABLE SE AMP KITS

BY SETH GOLDWIN

*From high-end zombie to amp
building he-man in just 32 hours*

When I needed new tubes for my one-time *Stereophile* Class A rated amplifier earlier this year, I went down to Stereo Exchange. They had just installed the new Fosgate speaker system in their THX room, so I popped in for a listen. Playing the reprehensible pseudo-jazz of David Grusin off some Lucas Film demo disc, the system enveloped you in a 360 degree panorama of listless, cardboard thin sterility, with a kidney punch of BIG BASS thrown in once every little while. A salesman told me this was what the recording sounded like, because this was an accurate system, and that if I didn't like it then I didn't like the recording 'cause that's what I was hearing.

And they didn't have my tubes. Another salesman suggested I try Fi at 30 Watts St.¹ I'd never heard of it, but loved the address, so off I went. Funky little street, funky little store with almost nothing in it. Some clearly homebrew 3-ways, a couple of serious looking tube amps and a turntable. Chatted with the all-time nice-guy owner, Don Garber, who sat me down and fired up the hidden CD player. Hoh, seeee-IT, man, here was MUSIC! I'd never heard a presentation like that, NEVER. Not one single thing was escaping the notice of that little amp: smooth, easy, relaxed, but filled with crystalline detail. It was a major moment for me, that

¹ — Fi is now operating on a mail-order/by appointment basis out of a Brooklyn workshop. Don can still be reached at 212-966-0831.

first introduction to the single ended triode amplifier. And by the time I left the store I had but one thought: I ain't gonna' work on Maggie's farm no more. To hell with hi-fi, I want that single ended SUPER-FI!

I took home Fi's utterly fabulous, and close to affordable (\$1,475) 2A3 amp all primed for ultimo sonic bliss. Not so fast, fella'. Not enough oomph to drive any of my stick-in-the-mud backwards-into-the-future low efficiency speakers. A truly fantastic sound, but only at volumes lower than I regularly listen. And I can't afford to even think about the \$4K 300B monoblocks.

I also picked up my first copy of this magazine during that visit. Read it and started grokking a fundamental fact: you don't have to buy at the store, you can build at home. Hmhmhm. I've been into audio since I was a kid, but my only building experience was to permanently and irrevocably destroy a Heathkit solid state amp kit when I was 15. I know, like, zip about electronics. I asked for advice. Old hands said, "Oh, just go build something: look at the schematic, figure out what the parts are, figure out where the parts go, then solder 'em together. It's easy, man, I built my last amp during my coffee break at the Sup 'n' Sip." So I started looking at schematics. I figure, hell, I went to college; look at the geniuses at the TV repair shop—how hard can it be to read a schematic?

Umm, pretty hard. After a while I was able to see that a squiggly line was a resistor and a curly-Q was a transformer and a little triangle was probably a diode, but SO WHAT? How do you keep 'em from rattling

around inside their little coffin? What do you use to string 'em together? Where do you get a tube socket? How do you get all those nice, neat holes in the chassis for things to stick through? And, for that matter, where do you get a chassis?

ENTER KITS

So I started looking at kits. The two cheapest kits around are the Audio Electronics Supply SE-1 and the Audio Note Kit One. In their basic forms, with Chinese tubes, the SE-1 is \$800, the Audio Note is \$1,150. Unable to hear ANY of them, I bought the Audio Electronics Supply SE-1 because it was cheapest, and it's available. That was about the extent of my research. Since I am unable to look at schematics and figure out what the resulting sound might be, throwing my money into the air and seeing where it landed was about all I could do. Oh, I also asked around, and one guy said no, and another guy said yes. Cleared things right up. After I bought the kit, I was asked to write up my experiences as a first time builder and kit amp shopper for this mag. Using my clout as a big time reviewer, I wangled an Audio Note to build and audition the next higher-priced option in the kit marketplace.

AUDIO ELECTRONIC SUPPLY SE-1

I called AES on Tuesday and received the package on Wednesday! Bravo! A company that understands the audiojunkie's need to have it right NOW! The kit was very nicely packed, each class of parts wrapped in its own custom plastic bag. Parts quality is a little hard for me to judge, as I don't have the experience. The resistors are plenty cool looking, though—black Dale milspec jobbies. These LOOK a little tougher, that tad bit MEANER, than the Holcos and Radio Shack junk I've handled before.

The SE-1 is a straightforward 100% class A, single ended design. It's assumed that you will use it with 300B tubes, but it can easily be rewired to use 2A3s or any other tube of that ilk that you may have lying around. There is no global feedback. The input tubes are 6SL7s in an SRPP configuration. The output transformers have been sourced to AES from somebody or other, and are said to be specifically designed for use in the SE-1. Output and power transformers are 200% duty cycle.

I ordered my kit with the oil-filled coupling cap option (an extra sixty bucks), so along with the Nichicon Muse electrolytics, for the filtering and the Kimber Kap kuties that



Audio Electronic Supply SE-1

do the bypassing, I got two metal case tubular caps with the highly-valued—highly priced at any rate²—Vitamin Q logo. AES hawks this option with the unbelievable cornball line that high frequencies "will come through as if *liquid syrup were filling the sound stage*"! [ed.- Aw, you're just grumpy cause you fell for that country breakfast yourself, City Boy. What do you want? Wine metaphors?]

The SE-1 manual is decently brief, yet thorough. It is 100%, absolutely required to sit down and go through the entire manual before starting in. This is not negotiable. You don't have to understand everything (I hardly understood anything), but you need to have some feel for what the construction process is all about BEFORE you start constructing. Without a big picture of the job, you're some idiot automaton, goose stepping through a fascist character building exercise, and you'll miss out on part of the educational experience.

I am INTO building things. I love the feeling of walking through a series of predefined steps, slowly working up from foundation to finished item. I don't know about you, but I gain knowledge of a thing by *handling* that

2- ed. - Vitamin Qs were *never* cheap. The major end user for these high class parts was always Uncle Sam. Thirty bucks for a low production (these days) high voltage industrial/mil grade cap built in a tinned brass tube with a glass to metal hermetic seal ain't too bad. Check the pricing on Vit Qs in the latest Newark Electronics catalog. Makes that fancy tweak stuff look cheap in comparison.

thing. No matter how many books I had read on the subject by the time I was 15, nothing gave me an approximation of the real feel of a woman's breast until I finally got my hand inside Becky's bra. Now I'm not saying building a kit is gonna' bring back THAT kind of intense satisfaction, but it is way more fun than going down to the local hi-fi salon to get snowed by the salesgeeks. Successfully building your own gear is the kind of thing that makes you proud to be a MAN, if you know what I mean. And you learn.

Remember where we're trying to get to: read the schematic, lay out the job, build the unit. For me, the point of a kit is to learn how a pro does things. It's an exercise in building sense memory, like those wacko machines that you strap yourself into so you can learn Arnold Palmer's golf swing. So, the point isn't just doing the thing, but learning WHY the thing is done that way.

Two double sheet sized drawings are inserted into the back of the manual. One is the schematic, which made no sense to me until I had built the thing. Now I can sort of follow it. The other insert contains a labeled legend to the holes on the top of the chassis, and another legend to the hardware bits underneath. This is conveniently keyed to the upside down chassis, and was pretty easy to follow. It did take me a little while to catch onto the connection between letter/number references in the manual, this chart, and the chassis itself, but once I got oriented it was pretty easy to navigate. This insert should be taped to the wall above your work bench

because you will be referring to it constantly through the rest of the process.

The construction process proceeds in a pretty logical and reasonable sequence. First you stuff the chassis with all the bits of hardware. Most of the things that go on the top of the chassis have little things attached on the bottom as well. This is clearly explained and the details of mounting each piece of hardware are detailed via explicit drawings. The next step is building some wire subassemblies which get used later.

And then you start wiring. There's a fair amount of wire and it goes all over the place. The manual suggests running all the wires, resistors, caps and other stuff first, and only after everything is placed doing any soldering. This makes sense because most of the connections are made through terminal strips, some of the lugs of which end up holding a lot of wire ends. It doesn't take much soldering experience to learn that it's a LOT easier to deal with a nice virgin joint than to solder something into a lug that's already been soldered. However, I'm not sure I completely agree with this suggested procedure, and I'll come back to the reason in a moment.

The wire supplied is mostly 20 ga. solid core, with a few lengths of 22 ga. twisted pair, and a few other specialty types for specific applications. At the end of the day I had reasonable amounts of each type and color left over, so at 30 cents a foot they didn't cheap out here. The Edison Price binding posts and other hardware is of fine quality. Where they did cheap out, however, is on the crummy plastic front panel switches. When I wired the on/off switches backwards, and had to desolder and rewire, the heat caused the contacts on BOTH switches to melt right out! The picture on the front of the manual shows nice metal toggle switches. What happened?³

The wires and parts placement proceeds by class: that is, first the twisted pairs, then the black ground wires, then the yellow wires, red wires, capacitors, resistors and finally the transformer wires. By the time you are done, what looked like all the room in the world is CROWDED, especially around the 8 pin input tube sockets in the lower left and right. There are a bunch of fiddly bits in

3- ed. - Most switches have "plastic" around the contacts. They call it "insulation." Meltdown can be prevented by using a clip-on heatsink.

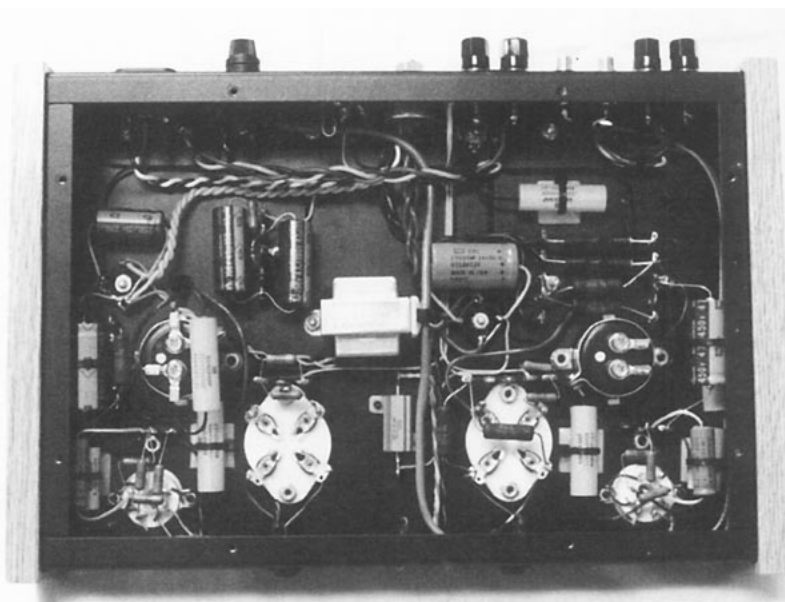
here, and figuring out how to route the teensy-tiny jumper from pin 2 to pin 4 and place the resistors that pretty much have to stack up on each other and keep all leads from shorting and keep all the little pieces from falling out of the tabs they're in every time you breathe is a major pain in the butt, dude.

There are two real dangers here, both of which I experienced firsthand. The first is that with all the layering of connections it's pretty easy for one to fall out. So you finish some step and look back over the thing and see a little yellow wire just hanging out, going nowhere. Which means you jostled the amp and it fell out and you have to CAREFULLY go back over the whole thing to get it back in the right place, then make sure you didn't knock something else out while you were fixing the first thing, and so on. Also, there's no master key to what all the wires at any one connection point are supposed to be so you have to thumb back through ALL the connection drawings each time you suspect something slipped, which is another pain.

Which brings us to the second danger. After a couple of slipped connections you start catching on and making your wire leads longer so that you can wrap them around the lugs or tabs you are connecting to.⁴ I don't really like doing this because it then becomes a major headache to desolder the connection and loosen the part or wire if you want to change or fix something, but at least they don't fall out. BUT, if you've got little wire pieces hanging out and space is tight and you're paranoid about unconnected wires and you happen to fasten one of those component tails across a tube socket from positive to negative and think everything's jake 'cause the extra connection is hidden under two layers of resistors where you can't see it and you plug the thing in, and get SMOKE and a BURNING SMELL, well then you did just what I did. I yanked the power, but, oh man, that one chilled me to the bone!

It took quite a while to work through the circuit and find my mistake. By that time it was 10:30 at night, and of course I had blown the fuse and had no replacements, so it wasn't 'till the next day that I found out that in fact everything was just fine except for a char mark on a resistor.

⁴ ed.- It is good procedure to always make a good mechanical connection at the joint *before* applying solder, as you learned the hard way.



AES SE-1 Underside View

Which brings me back to my major complaint about the build procedure that I mentioned above. Remember I'm a novice, and I'm assuming the kit designer is a pro, but it seems to me that if I were doing my own amp from scratch I would want to build up each of the connections and then solder it down, proceeding around the edges of the chassis then into the middle where there's more room. I'd have fewer connections slipping out, less chance of goofball mistakes like the one I made, and also less chance of charring unrelated wires with the soldering iron as I dug through layer after layer of wire to get at the joint to be soldered.

My only other quibble is that there should be some mention about how to identify capacitor polarities, especially because there IS a warning that "an explosion will take place if not installed properly." That kind of got my attention. A slightly frantic call to AES got me the answer. On the electrolytics, there is a stripe on the side with an arrow pointing to negative. Also, the negative side is shiny, positive is dark. On the Vitamin Qs, if you hold it so you can read the writing on it, the positive side is to the left of the writing. The Kimber and other Sprague caps are so clearly marked even I could figure them out unaided. By the way, only electrolytic caps pose the danger of explosion when reversed.

Ah, one last thing. The phono plug you shove in to set the bias shorts across the circuit so when it's in there's NO MUSIC.

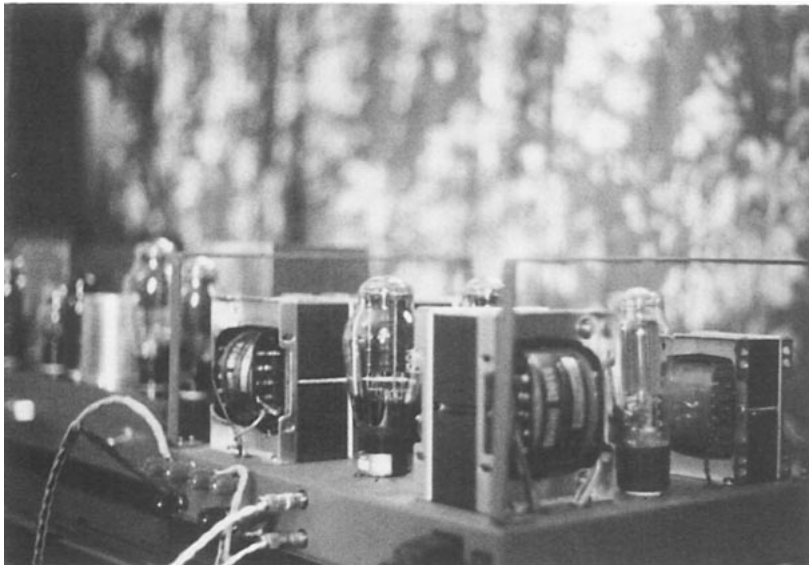
That flummoxed me for awhile, and gave me a sinking feeling when I first hooked up the completed amp to the rest of the system because I had forgotten to take out the plug. Oh, and also it would be nice if there was a photo of the completed amp's guts in the manual. Not required, but it would have been helpful.

Despite these complaints, the manual does its job, and I was able to put the whole thing together in about 16 hours over two days. The built unit is an attractive, compact little beast, measuring 13" wide by 9" deep and a little less than 8" to the top of the tubes. It ships with wooden side rails to screw onto the chassis, but I hate that kind of nonsense, fru-fru designer touch and just left mine off.

SE-1 SOUND

The highs are like liquid syrup, the midrange is smooth as butter, and the bass, while exhibiting a slight golden brown coloration, managed to be both as fluffy and as substantial as pancakes. But, for some reason, I never feel like listening after about 11:00 in the morning. Sorry, couldn't resist.

After finishing the amp and plugging it in, I *hated* it. The thing was so smooth it sounded compressed. I had heard that oil caps take a long time to break in, so I played the amp hard for a week, and then started serious listening again. I still hated it, except for one day after some insanely complicated stuff at my real job, I found it relaxing. I got one of my audionut buddies to come over



Audio Note Kit One 300B SE

filter (my intro to DIY, of which I am VERY proud) and let the powered SW2P take over the bass.

When I switched to the Hovland film caps, the Quads clearly sounded better than the NHTs. The SZs vastly improved, once again exhibiting great imaging and coherent, detailed sound from top to bottom. However, the Quads improved even more, again becoming the premier midrange speakers I know them to be. The Quad bass was still bloated, but with midrange-oriented material, I got a solid 3-D picture of the music.

Even with the film caps, though, the SE-1 seemed to lack a little of the life I've heard from other SE designs. The best way I can describe the overall sound of the SE-1 is to say it has a soft front, with a rich thick back. The back part is good. You get a real sense of the shape and sound of bodies of instruments, and voices, in all their complexity. But the front part isn't so good. Without transient snap the music is robbed of it's sense of excitement.

AUDIO NOTE KIT ONE

Like the AES, the AN is a 100% Class A, single ended design using 300B tubes with no negative feedback. It uses a single 6SN7GT double triode in the input stage which goes to a volume pot to allow for level tailoring. The output of this gain stage then feeds a 5687 twin triode driver configured in a series regulated push-pull circuit (SRPP). The signal finally winds up at the mighty 300Bs. The power supply uses a big

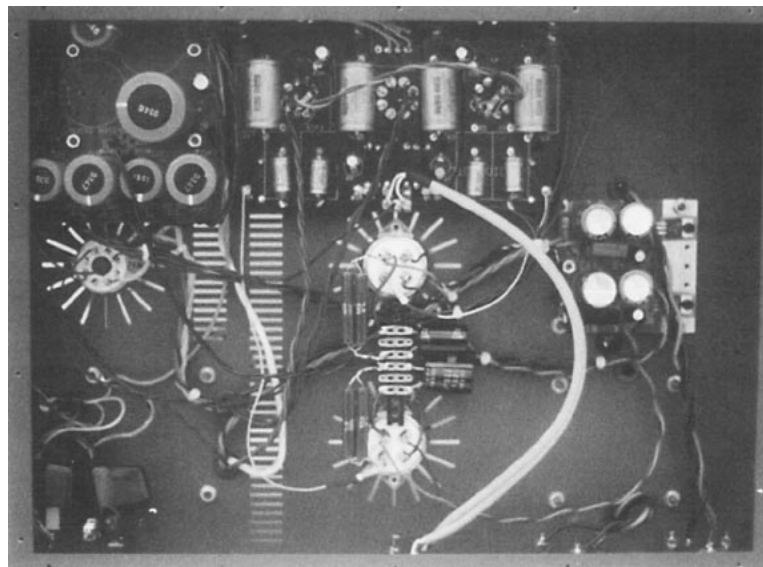
ol' 5U4G rectifier and a cap input filter with a heavy metal choke.

The finished product is not only BUTT UGLY, which I happen to like, but big too. Where the AES is a sensitive, caring guy who hopes your girlfriend likes him, the AN is just too macho to care. No attempt has been made to conceal that this is a piece of electronics. The transformers and choke look like a bunch of wire was stuffed into a brown paper bag and hidden in pieces of sorta' shiny, sorta' cheap metal. The chassis itself is painted in a very cool, lightly textured, industrial gray but it's still not gonna

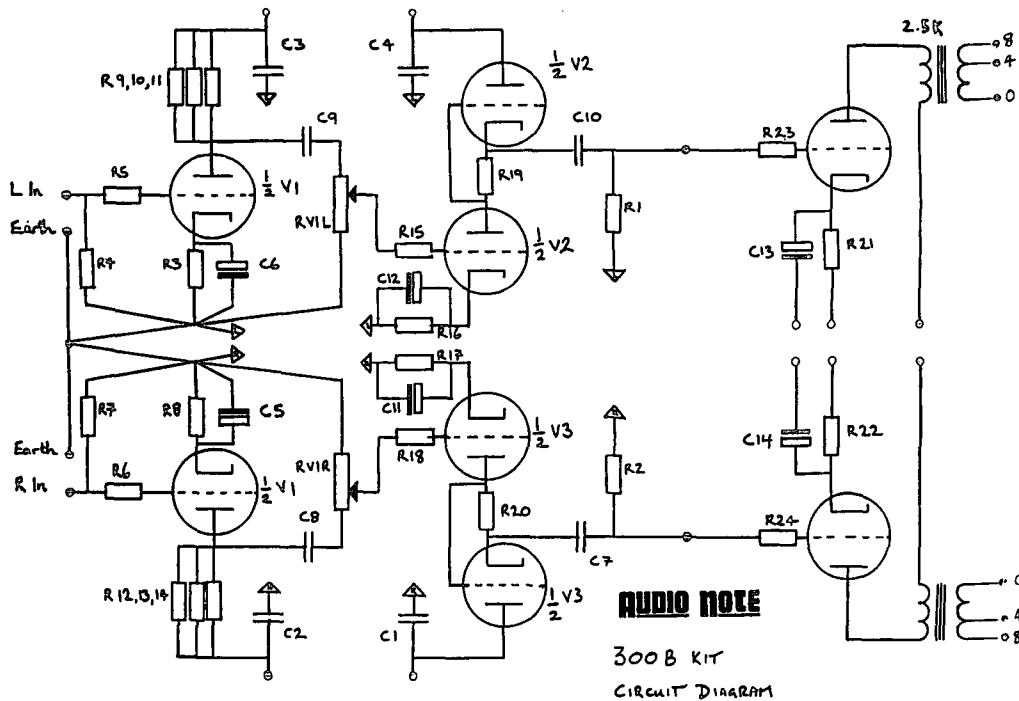
win any friends in the interior decoration business. Unless, of course, I'm your interior decorator. It measures 16" wide by 12" deep by 8 1/2" to the top of its (optional) tube protecting cover supports.

As one would expect, there's a lot of Audio Note branded stuff including about half the electrolytics and four paper-in-oil signal caps. The Beyschlag resistors are kind of wussy looking, but no doubt work just fine. All the transformers are, of course, Audio Note. The manual states "no real compromises were made in part selection" and who am I to argue? Later in the manual, they warn against part substitution, claiming that the amp was sonically balanced with these parts in mind. I ran out of certain colors of wire, but simply ad-libbed with another color and ended up okay. Be sure to get a ruler with metric markings before you start this kit. I can guess how long a foot is, but I ain't got a chance of getting 25 centimeters right. The AN manual is reasonably informative, almost detailed enough, and even has two or three JOKES. It walks the builder step by step through the process rather than referring to construction diagrams, although there are a few helpful drawings. It would be possible to build the amp even if you never read past the current step you were on. However, I strongly recommend you do a full readthrough before starting in.

Unlike the point-to-point wiring of the AES, the AN uses circuit boards. Because of this, the construction process as a whole was less useful to me as a primer on how to



Under the hood view of Kit One



AUDIO SECTION
 V1 6SN7
 V2 5687

- RV1 100K log
- R1 & R2 330K 1W
- R3 & R8 680 1W
- R4 & R7 470K 1W
- R5 & R6 10K 1W
- R9 - R14 82K 1W
- R15 & R18 1K 1W
- R16 & R17 820 1W
- R19 & R20 820 1W
- R21 & R22 each made from two 1.5K 9W wired in parallel
- R23 & R24 3.3K 1W

- C1 - C4 0.082 uF 630V
- C5 & C6 100 uF 10V
- C7 - C10 0.22 uF 400V
- C11 & C12 220 uF 16V
- C13 & C14 220 uF 100V

AUDIO NOTE

300 B KIT
 CIRCUIT DIAGRAM

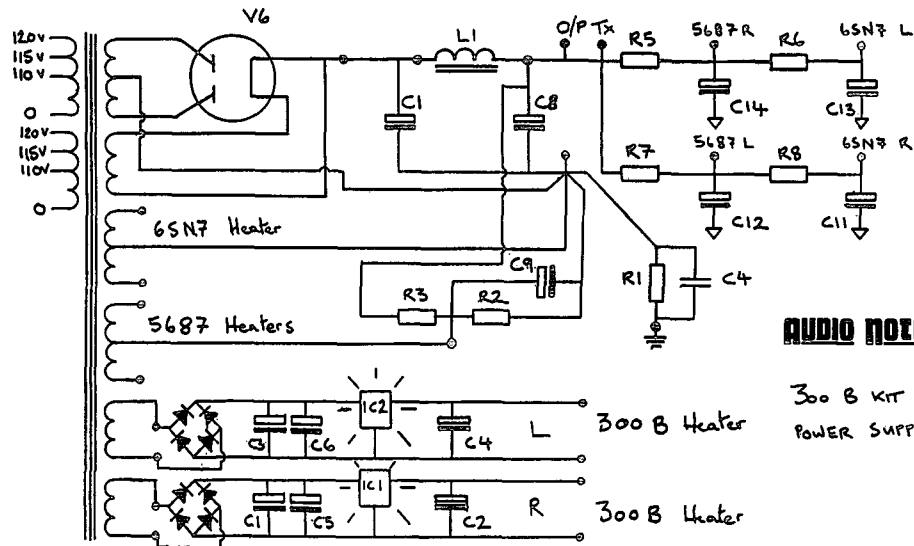
POWER SUPPLY

- V6 5U4G
- R1 100 1W
- R2 82K 1W
- R3 330K 1W
- R5 & R7 2.2K 1W
- R6 & R8 2.7K 1W

- C1 33 uF 450V
- C4 1nF 1000V
- C8 220 uF 450V
- C9 10 uF 160V
- C11 & C13 56 uF 450V
- C12 & C14 100 uF 450V

FILAMENT SUPPLY

- IC1 & IC2 78S05
- C1, C3, C5, C6 4700 uF 16V
- C2 & C4 100 uF 10V



AUDIO NOTE

300 B KIT
 POWER SUPPLY

Audio Note Kit One Schematic

do my own stuff and also made it harder for me to understand the intricacies of how the circuit works. It did however help me to get into the head of board stuffers everywhere, and allow me to understand why this is completely dreadful work that every country, no matter how poor, wants to source off-shore to an even poorer country just as soon as possible.

The kit as a whole was beautifully packaged, with parts separated by step, or PCB, rather than just by component class. To build it, first you stuff the chassis with the

transformers, choke inputs, outputs and so on. Then you stuff three smallish circuit boards. Then you wire it all together, test it, and get ready to groove.

Where appropriate, you solder things down as you go, not storing it up for one big, annoying solder-fest. I ran into one easily avoidable manual problem when I was trying to sort out the rather complex power transformer wiring. This process is covered by step 19 and 20. Step 19 is at the bottom of the (unnumbered) page and reads "...carefully twist together the following

wires—see over." Then you turn the page and there's a chart of "Mains Transformer Wiring." I spent probably 30 minutes looking back and forth from the manual to the transformer trying to figure out WHY I would want to twist wires across the transformer to each other, before I threaded them through the holes provided on each side. Finally, I turned the page again and read through a few more steps and finally got that the list of wires on the top of THIS page was what Step 19 was referring to, NOT the chart on the preceding page which is what you use in Step 21.

Another manual complaint I have is in the Input Driver Board section. Just previously, you built the Power Supply, which uses an irritating method of attaching the resistors which requires you to trim, shape and tin each of the resistors to solder it to a pad on the PCB, rather than through a hole. Steps 5 through 8 cover the resistors for the Input Driver Board section and it starts by saying "Bend all the resistors to shape as described under the PSU board..." Well, DON'T. Unlike the PSU, the ID board has some pad mounted resistors, but most mount like usual just going through the board. If you're totally zonked on getting some sound out of this baby, and racing towards the end, and just blindly doing what the instructions say, YOU WILL BE MIGHTY SORRY!

In general, the manual, which starts out being extremely thorough and carefully holding your hand through each step, gets a little loose by the end. Clearly, someone got tired. Nowhere does the manual completely lie to you, but you have to think through a few pieces of it. There's nothing wrong with this, but the highly detailed beginning can lull you into a false sense of safety. For instance, in the early stages you are warned not to solder a connection yet, because other pieces will also be going to that point. Much later, no such warnings are proffered and you're pretty much on your own for reading ahead to get a sense of where things might pile up. I would say to use caution about soldering things on the terminal strip that runs between the two 300B bases.

It took me almost exactly as long to build the AN as the AES: 16 hours over two days. Again, a photo of the guts of a completed amp would be most helpful.⁶ I've got a pretty good idea that the insides of my amp could have been done considerably more neatly than mine were. Having a role model is always nice.

KIT ONE SOUND

No jokes this time. The Audio Note COMPLETELY SMOKES the SE-1. From the moment I turned it on I was drawn into the music, hauling out CD after CD just to see if the spell would break. It gave me all the super-fi thrills of enormously detailed yet thoroughly relaxed sound that I was hoping to get from an SE amp. The AN is still bested by the Fi 2A3 for its ability to see

into the music and reveal every sparkling little detail. But the AN comes close, is way smoother, AND it will drive my speakers!

After my experiences with the caps in the AES I was afraid that there was an SE conundrum: either it's smooth or it's detailed and never the twain will meet for drinks, have sex, and assume a mortgage at 6%. Not so. The Kit One is about as nicely balanced a bag of tricks as I've heard, presenting each and every musical thread, but never losing the sense of the music being of a piece. This ain't easy and I've never heard music in my place as pleasingly integrated. The soundstage was wide and moderately deep. Sonic images were thoroughly resolved in 3-D space, every cymbal's slightest shimmer was faithfully reproduced, vocalists seemed fully rendered, guitar sounded like guitar, blah blah blah. I liked it and never wanted to turn it off. Honest. I've been late to work every day and subsisting on about four hours sleep a night since I finished building the kit.

This lively character is what I really love about this amp. No matter how much dough I spend on building my system, Jimi still ain't coming back, ya' know what I mean? The Jimi experience I get to have is playing his recordings, and the hi-fi I want to own is the one that gives the most LIFE to those recordings, while not lying to me about what's on there in the first place. And that's the rub. I don't want any obscuring, no frequency tilts that sound musical but actually hide music, no compression that makes the edges easier to take but just hides the real swing of the music, no overly smoothed tube sound that obliterates spatial detail, no faked up overly deep soundstage. I think the AN comes up like a rose on all these fronts.

After some very close listening and a day of grueling matched level comparisons, I just don't think I'm hearing any less from the AN than I hear from any of the other amps I have around, including a pretty good solid state amp (the Acurus 3X200 I use for surround sound) and my completely excellent Lectron JH-30. And in addition, I believe the AN provides a gripping enjoyability to recorded music that I would characterize as the Single Ended Difference. Listening to the AN you don't think, "Hey, nice hifi," you think, "Cool tunes."

I'm not saying you can do no better than the Kit One. I'm sure you can. I'll even bet that

AN will offer an upgrade path. But for the dough, this is a totally pleasurable, involving, ENGAGING amp. What more do you want to know?

CONCLUSION

I got a pretty good sounding amp out of the SE-1 once I chucked the Vitamin Qs and put in Hovland film caps. It won't give you the best possible sound out of a 300B, being kind of weak at both frequency extremes, but it sure is nice through the midrange. It sounds like a good, low power tube amp with classical tube amp failings. As an introduction to both building your own amp and to the smooth, liquid beauty of tubes, it's pretty good. Unfortunately, it lacks the aliveness and immediacy that got me hooked into this whole SE thing in the first place. It is not a major failure, but it doesn't do the trick for me.

The Audio Note, on the other hand, totally thrilled me. It is a MOST engaging amp and gave me real, significant sonic pleasure right out of the gate which hasn't stopped yet. It was not as much fun to build as the AES and less educational because of the PCBs, but for crying out loud, who cares? This is a completely cool amp and I think you would want to own one. It costs almost 50% more than the SE-1, but I'd skip lunch for two months and get the Kit One.

This Just In... Welborne Labs Laurel

Late in the review process I received a pre-built sample of Welborne Labs \$1,700 stereo entry into the 300B kit amp sweepstakes. I didn't build this one, Ron Welborne did, and sneaking a peek into its guts blew my mind. This is what the inside of an amp kit is SUPPOSED to look like! Wow, is it nicely put together! For the first time, I have a real high water mark of craftsmanship to shoot for. Hey, Ron, why not include a picture of your handiwork to inspire kitbuilders? The Laurel is also available assembled at additional cost.⁷

Just on looks, this is the go-ahead winner, fer shur. It is drop dead gorgeous. The AES looks "cute" and the AN like lab equipment, but the Welborne looks like a meticulously restored '66 Jaguar sedan. It comes in a one inch thick walnut chassis, with a brass top plate and unhideous transformers. Really a beauty. It measures 17" across, 14" deep and 8" to the tube tops.

6- Angela Instruments, Audio Note's US kit distributor, includes photos of the wiring of the finished product with the Kit One, printed here for posterity.

7- See further comments on the Laurel and the AES SE-1 elsewhere in this issue.

Like the other kit amps I heard, the Laurel is a 300B SE design putting out about 7 watts. Part selection is first rate, including MagneQuest transformers, Golden Dragon tubes, Kimber and Solen caps, and it ships with both metal film and carbon composition resistors so you can confuse yourself endlessly about which to use. Internal wires are all Kimber and connectors are Cardas.

Along with the amp, Ron sent a preliminary assembly manual. It's way different than the other manuals I used, containing only one page of assembly instructions, but six pages of beautifully rendered CAD drawings showing in admirably clear detail both wiring and component placement. It's a little hard to tell without actually going through the process, but I wouldn't expect this amp to be any more difficult to build than the other two.

I listened to the Laurel on its own for a little while, and I included it in the day long matched levels comparisons with the AES and AN amps. It's a real good sounding amp, much better balanced than the AES with good behavior through almost the entire frequency range, and a reasonably tight, tuneful bass even into the Quads. It's got the SE sound: live, dynamic and detailed yet still smooth 'n' rich. However, for my money, it did not best the AN in what I think is its best quality: the integration of great transient attack segueing seamlessly into harmonic bloom into decay. In comparison, the Laurel sounded just the littlest bit wiry. I can't help thinking that some Audio Note paper-in-oil caps might shoot the Laurel to the head of the pack, but currently it runs a close #2. For looks, it slaughters the competition.

MANUFACTURERS' COMMENTS

Audio Note

It is always satisfying to see a positive write-up of one of your own products, but what I find particularly satisfying is the fact that here we have yet another convert to the truth that a well executed single ended amplifier is simply a better and more enjoyable communicator of music, regardless of origin and genre. More strength to our hand!

Peter Qvortrup
Audio Note, UK

Audio Electronic Supply

Wow!... two reviews of the same product in the same issue. I am flattered. I must say that I am also pleased to know that single-ended triode amplification is out in the mainstream of music reproduction.

After reading Seth Goldwin's review of the SE-1 amplifier, I must confess that I had a desire in my heart to respond in a fashion unbecoming of a southern "Yankee". I refer specifically to the portion of the review regarding Vitamin Q coupling caps. His suggestion that Audio Electronic Supply "hawks" these caps reveals his illbreeding and inane, witless style of writing. We do not "hawk" anything at AES. We offer legitimate products and parts to the audiophile community.

The SE-1's AC operate and standby switches are made by C&K and are used by millions every year in all types of electronic equipment. These are UL approved flame- and spark-proof switches, but if they are not soldered properly or need multiple resolders because of wiring mistakes, yes, they may become damaged.

In closing I would like to mention that if Mr. Goldwin would like to compare amplifiers that are built and look like fine jewelry, he might look at amplifiers out of the modest price range of the SE-1 (\$549 kit form). I should have sent him a pair of Cary CAD-300-SE, or for that matter, a pair of CAD-805 single-ended monoblocks. The Cary amps will smoke anything this boy has listened to or set his eyes upon.

Thank you once again for the opportunity to speak my mind and keep up the great magazine.

Dennis J. Had
President, Cary Audio Design, Inc.

Editor's Note

We were happy to run two articles on the SE-1. It is a landmark product, as all of the current SE kit amps are, and it is definitely worthy of editorial attention. The AES amp is of particular interest to the hobbyist community because of its low price. People seem to be a lot more willing to experiment when the price drops below a thousand bucks!

Designing a \$549 (without tubes) amp these days, is no small challenge and the SE-1 strikes me as a valiant attempt. It would be very hard to homebrew an amplifier of equivalent build quality for the money buying parts at retail.

One way to look at this amp, from the hobbyist perspective, is as a starter kit of chassis and iron. Even if you're a novice when you build it, as you learn tube electronics, many options will appear on the horizon. Give the "factory" circuit a listen but realize that there are many possibilities for mods and upgrades to this little amp if you don't like the stock job in your system or you just need a little variety in your life. If a mod turns out to be a mistake, you can always go back to what you had before.

I wouldn't be able to resist giving the 2A3 option a shot if I had the SE-1 and some efficient speakers, say anything that works with a 300B. The 330V B+ supply is perfect for 2A3 or 6A3 tubes, although most users will probably be lured in by the 300B mystique and the few extra watts this tube offers. 300Bs are great, but did you ever wonder why the 2A3 also remains a venerated classic after

60 years? 6A3s with pentode WE 91 style driver stages could be a killer combo in the SE-1 chassis.

The SE-1 could become for triode experimenters what the Dyna has been for p-p pentode guys for decades, a breadboard for all manner of experiments. A couple of tube sockets, transformers, and a power supply can take you in many different directions.

It is always instructive to compare the impressions of two or more listeners to look for some balance, if not consensus. Compare Herb Reichert's comment's on the SE-1 later in this issue with Seth's notes and see if you can make any sense of the big picture. After hearing a dozen or so opinions on the SE-1 varying between "unreal" to "just okay", I'm not sure there is any universal evaluation. Tastes and partnering equipment surely have everything to do with it.

Reviews are often granted significance and authority by readers well beyond their legitimate claims. "Professional" reviewers sometimes go to great pains to qualify, routinize, and objectify their reports but the issue of whether you would agree on good sound if you were sitting on the same bench listening to the same system is a question that the printed word (and Audio Precision graphs) can never answer.

Update: Just borrowed an SE-1 from Mike LaFevre (retrofitted with Magnequest outputs, of course.) Indeed, the overall build quality of the unit exceeded my expectations. All mechanical parts are really nice, especially the E.F. Johnson-style 4 pin sockets. The switches seem fine to me. The neo-designer visuals would probably be considered a plus by most owners unaccustomed to having Frankenstein's lab looking homebrew gear or old industrial amps on the shelf.

I must agree with Seth that the bone stock (except for output transformers) SE-1 sounds slightly muffled. But I recognized one potential cause immediately. Metal film grid stoppers (10K on the schematic) are a chancy proposition but most manufacturers use them without hesitation. Sometimes they sound wickedly bright and sometimes they sound overly dead. Replacing the fancy Dale grid stopper with a good old 1/2 watt "Golden Age of Radio" Allen Bradley composition unit increased the definition and bite of the SE-1 dramatically. A 15 cent Radio Shack carbon resistor would work well also. Appropriate technology for the job, if not glamorous. There you have it: a 30 cent experiment recommended for all amps with metal film grid stoppers. Use ultra-short leads between the resistor body and the tube socket.

Next "mod" is free: for greater "clarity" remove the .22 film cap bypassing the 560 uf 300B filter cap. Some of these compact modern high voltage electrolytics can respond in strange ways when bypassed with certain kinds of caps, so experimentation is required. Haven't figured out exactly why. If the stand-alone electrolytic is too scratchy for you, try a Vitamin Q or something to cool it down. Experiment till you're happy—that's the whole point . . . now where are those 2A3s?

Tuned In (con't)

I became interested in transmission lines primarily out of frustration with reflex boxes. In my experience, there is a "boing" or "echo" associated with bass reflex that is nearly impossible to get rid of. We all know the lengths some have gone in order to stop transient ringing in vented boxes, "matrix bracing" and the like. I decided to give up instead. Sealed boxes don't ring like that but they have other exaggerated resonances and are generally compressed sounding as well. I looked around at older technology for alternatives. A two-way open baffle sounded great but had limited bass. Later, labyrinth speakers interested me, just as they had caught the interest of many way back in the day.

Lines and pipes are basically loading systems which either dissipate or null the back wave of a speaker driver while providing the high acoustic impedance that cone drivers like to work out of. The advantage of dissipating rather than trying to tune the backwave is simplicity. The driver gets the extra damping and restoring force it needs at the resonant frequency but with less potential for interaction than a resonant box. An additional bonus is that lines and pipes also lower the frequency of those resonances. The mere fact that the box is open makes for a more open and dynamic sound. All told, the most important benefits can be listed as similar to the best vented boxes, but the result is smoother and the problems are more innocuous.

My present speaker system is a three-way transmission line. The drivers I use are made by Focal and are widely available. The basic idea is to use a single-ended amplifier to drive the mid and treble and a push-pull amp on the bass.

The tweeter is a Focal T-122-Ti, an un-chambered version of the T-130 with an oxidized 1" titanium dome. The efficiency is 95 dB/1W@1m. The pole-piece comes drilled with three holes through it so that the unit has as much output from the back as it does from the front. The line is made from 3" o.d. aluminum pipe and it is tuned for 600 Hz, i.e. 3" long. Dimensions are calculated according to Voigt's classic formula given above. A hamburger sized wad of long haired wool is stuffed in the line.

The midrange is a 7" polyglass coated paper cone, the Focal 7V313. It draws heavily on the Lowther PM-2 and the JBL LE5 for its technical heritage. The super light stiff cone, huge magnet, short underhung voice coil, and lossy coated foam

surround moves a lot of air and provides shocking transient performance. Its nominal efficiency is 95 dB/1W@1m. I have given up on small midrange drivers. They *all* sound anemic and lifeless to me, no matter how pretty they may be. The other advantage of a 7 or 8 inch mid is that it can usually cover the entire vocal range + harmonics. This means *no crossover between 150 Hz and 3 kHz*, a strangely uncommon practice that can only make for better music. I'd prefer one driver that works from 100 to 10,000, an old QUAD that actually moved air at 100 dB SPL. If only. . .

The midrange works into a 6" i.d. PVC pipe 22 inches long. The line frequency is 100 Hz and it is loosely filled with wool. Like the JBL and Lowther drivers, the Focal has one nagging quirk—a rising output with frequency characteristic that makes for that old bright and in yo' face "West Coast Sound." More on this later.

The woofer is a monster: the Focal 12V. Nominal efficiency is 96 dB/1W@1m. Same "polyglass" coated paper cone as the midrange, which makes for a seamless match. The 3" voice coil is vented through the rear of the driver. A coated linen accordion surround damps the cone. As with the 7V midrange, a huge magnet and a short underhung voice coil provide wild dynamic shifts if they come up. The 12V works into a 10 ft. line folded into a box 13 X 32 X 22" with 30 oz. of wool distributed through the line.

The midrange and tweeter are crossed over with a first order xover, the only kind I use anymore. The trick with the 7V is to cross it over early (1200 Hz in this case) to minimize the effects of the rising amplitude characteristic. The tweeter needs to be cut at least two octaves above resonance (3000 Hz) to really work well with a first order crossover. I actually spread it a little to get a small "Advent dip" in the presence region.

The bass amps are standard Mulard type circuits with self-biased 6B4-Gs in a push-pull no feedback configuration. I parallel a 6SN7 and directly couple the plate to a 6BL7 long tailed pair. There are no sneaky tricks, just a low impedance driver stage and the tactic of burning the tubes at 17W dissipation ($272 \text{ V} \times .126\text{A} = 17.13 \text{ W}$). I use an RC filter between the direct coupled stages to roll off the highs above 500 Hz, well out of band of my intended 150 Hz crossover.

The active crossover is a single 71A triode gain stage with an RC filter

tuned for 150 Hz. Without the RC network, this unit makes a great line stage project for those of you who must own a CD player. It may almost sound like music after a trip through a 71A. Other little triodes that lend themselves to this type of circuit are 12-As and 26s. These little tubes with solid nickel plates are super detailed and hyper beautiful.

The "Dinosaur" has been changed several more times since the last article and I am even happier with it. It now dispenses with the FET and the cathode follower, although I must confess a growing interest in FETs (cool sound). I had three directly coupled tube stages, but now I use a small cap between the first and second stage to limit the bandwidth to 150 Hz high pass.

The cables are all Kimber Silver, which should be a controlled substance. The phono preamp is a stealth device I worked on with Art Loesch. The attenuator is an Eltus, an expensive Japanese 'L' pad, 250K with 47K Holcos paralleled to the I/O. The turntable is a 301 with a Fidelity Research FR-64 arm and a new model Denon DL-103 moving coil. I have to make new arm cables as the ones I'm using are shot.

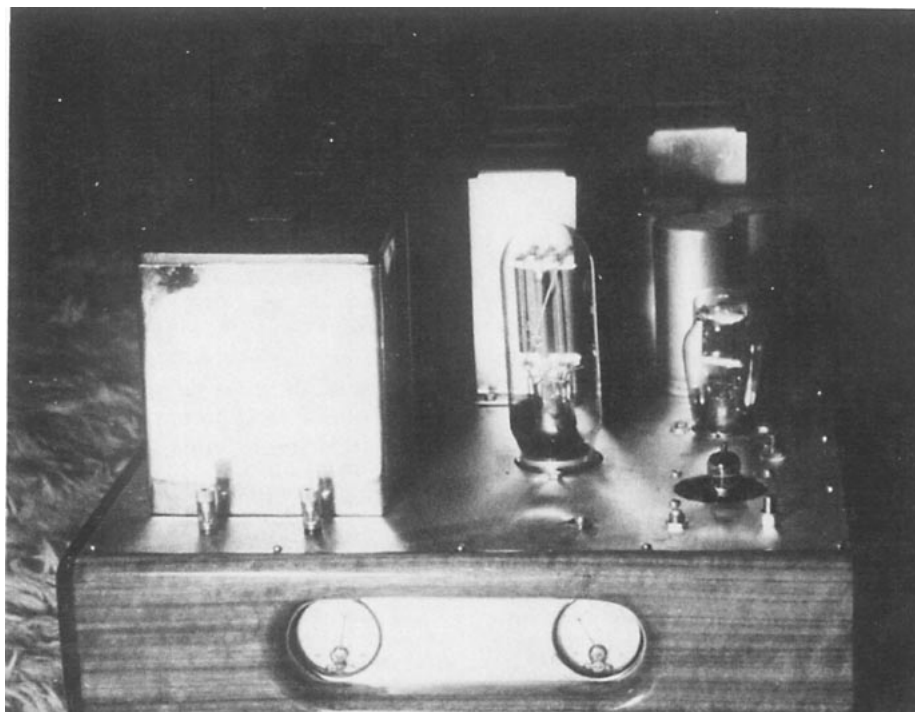
I also use a heavily modified Thorens TD-124 with a Sumiko FT-3K arm and a Stanton 981LZS low impedance moving magnet. If you are looking for a cartridge, please check this one out. Not only is the general presentation big and present, the subtle stuff around and behind the music is there in delightful proportion. I am shocked at how stupid good this cartridge sounds. I think it is impossible to get more phono music for the money.

All this stuff *plays* my records and I've been having big fun with the bass, which goes all the way down. Splitting the work up between top and bottom simplifies matters dramatically. There is a myth that one amp is somehow more "zen" or something. Unless you are driving one speaker, this is absolute crap. Two drivers and a passive crossover with one amp, especially if it is a multi-pole crossover, is more of a liability than using two amps. Single ended technology doesn't make much power and will cramp the style of many modern speakers. This can be heavily compensated for by limiting the work an amp has to do. Given the efficiency of any speaker, 66% of the power needed for audio occurs below 150 Hz. The increasing availability of drivers in the 90-96 dB range means that integrating these low power amps is not beyond anyone's reach. Make your own and bi-amp!

ORFEO 2 I I A

OR HOW TO BUILD SOME SINGLE TRIODE AMPLIFIERS
AS BIG AS AIRCRAFT CARRIERS (WELL, ALMOST) AND
LIVE HAPPILY EVER AFTER LISTENING TO THEM

by *Ciro Marzio and Cristiano Jelasi*



Part I: Overview and Power Supply Considerations

The Orfeo is clearly intended to be a definitive amplifier. Its musicality is truly resounding, just like that of the mythical singer to whom we have dedicated it.¹ Commercial amplifiers that can aspire to be its equal are truly few, extremely few, or maybe even fewer than that! While it is true that audiophiles who undertake this project will find themselves faced with a rather demanding task, they will be repaid with the attainment of a musical pleasure that will last for years. In other words, the Orfeo can be a steady focal point around which

the rest of your system can develop and evolve.

This amplifier was redesigned several times and this last version is decidedly simpler—and more musical—than its predecessors. This progress, however, has been paid for with an degree of encumbrance and weight that is truly extraordinary: each amp we built weighs nearly 55 kg and measures 85 cm x 45 cm x 30 cm. If you have problems with limited space, this is not the amplifier for you!

¹ — When we first built the prototype of this amplifier a few years ago, there were no commercial products of the same name. Since then, more than one "Orfeo" has appeared, and we wondered whether to give ours a new name or not. In the end we decided to keep its name: it has plenty of personality to distinguish it from any other amp.

And while we mentioned that the circuit topology of the amp is relatively simple, we must recommend it only to hobbyists who already have extensive experience with tubes. The voltages in play are very high (over 1200 volts !!) which is why this is NOT the circuit on which to make your bones! We caution even expert hobbyists to exercise maximum prudence. At these voltages, any carelessness can be fatal. In addition, take every possible precaution to safeguard all persons who may find themselves, even if only occasionally, in contact with these amps. Having made this dutiful introduction, we can go on to the description of the amplifier.

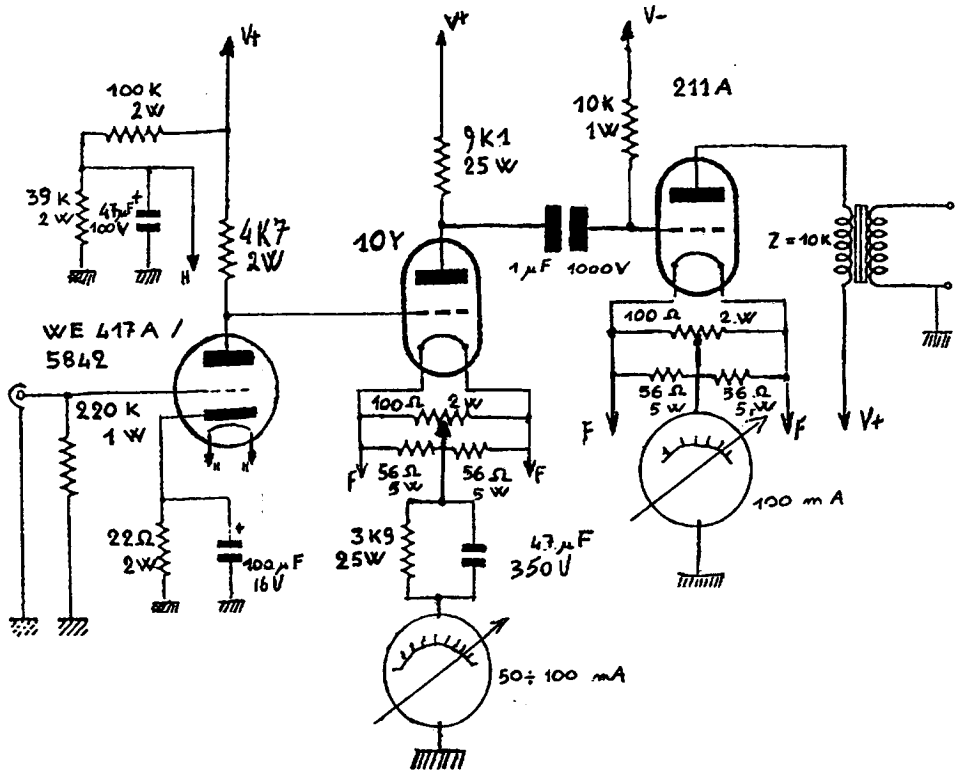
Design Philosophy and Goals

The principal criteria guiding the design of this amplifier are maximum simplicity and circuit linearity, in the belief that all that which is not present in the signal path cannot deteriorate it. (Remember Ford II's maxim that anything that's not there, in a car as in any other piece of machinery, cannot get broken.) Obviously, this philosophy has positive effects on reliability as well.

The Orfeo is a three stage circuit capable of output power of circa twenty watts. Each stage is single ended using pure triodes. This choice is quite unusual, yet we are convinced that the principal reason for the superiority of single ended resides in the fact that the circuits making use of more than one tube in the same stage suffer due to the inevitable differences present between one tube and another. As is our custom, there is no negative feedback.

The power supply was the object of particular attention. We conducted long listening tests of various prototypes using different supply configurations. The goal was to verify eventual listening differences between regulated supplies, unregulated supplies with inductive input filters, and unregulated supplies with capacitive input filters.

With respect to circuit evaluation, we took into account both listening results and test results, but we privileged the former in all cases where the results of the two methods differed. In our view, the ultimate goal of any piece of hi-fi equipment is that of making one listen to good music and to transmit the emotions that are part of the music. Musicality is therefore always the principal parameter we use to evaluate our amplifiers. Even when choosing among different types of circuits the definitive judgment is far



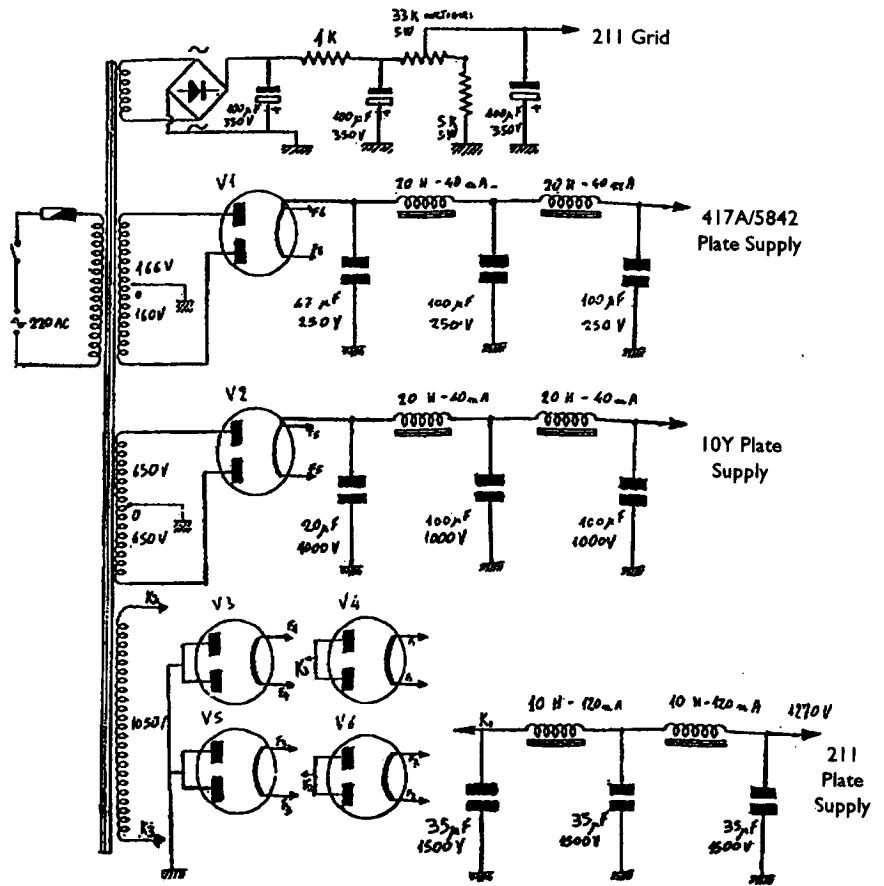
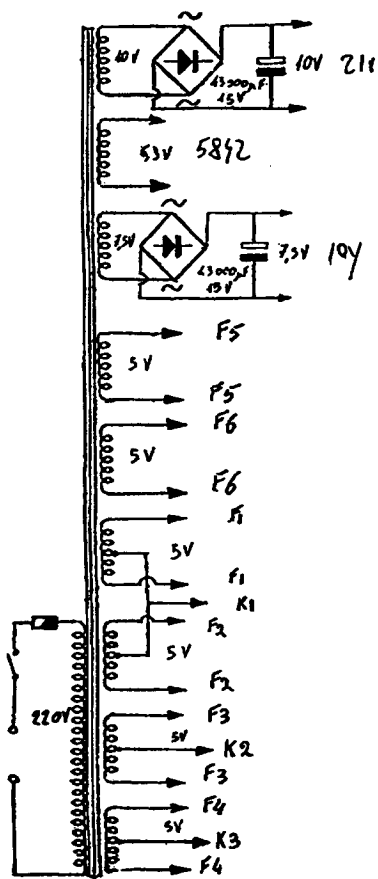
AUDIO CIRCUIT PARTS LIST

- Capacitors
 C1 100uF 16 Volt
 C2 47uF 350V
 C3 1uF 1000V
 C4 47uF 100V

- Resistors
 R1 100K—220K 1W
 R2 22—27Ω 2W
 R3 4.7K 2W
 R4 3.9K 2W
 R5 9.1K 20W
 R6 100Ω 2W wirewound pot
 R7 56Ω 2W
 R8 56Ω 2W
 R9 12K 1W
 R10 100Ω 2W wirewound pot
 R11 56Ω 2W
 R12 56Ω 2W
 R13 100K 2W
 R14 39K 2W

- Tubes
 V1 417A/5842
 V2 10Y/VT-25 or 801A

- Meters
 G1 50mA
 G2 100mA





The filter for all stages is of the capacitor input, pi filter type using high value inductors and capacitors. The first two stages have an input capacitor of a relatively small value (22 uf) followed by a 20 H inductor with a high value cap (140 uf) then another 20 H inductance and finally another 140 uf cap.

POWER SUPPLY PARTS LIST

Capacitors

C1-C2 43,000 uF 15V electrolytic
 C3-C5 100uF 350V electrolytic
 C6 47uF 250V film
 C7-C8 100uF 250V film
 C9 20uF 1KV paper in oil
 C10-C11 100uF 1KV paper in oil or film
 C12-C14 35uF 1500V paper in oil

Chokes

L1-L4 20 Henry 50 mA
 L5-L6 15 Henry 140 mA

Resistors

R1 1K 2W
 R2 33K 5W
 R3 5K 5W

Solid state diodes

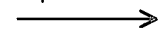
PD1 150V 25A
 PD2 150V 15A
 PD3 600V 5A

Rectifier Tubes

V1 5R4GY; 5R4WGY; 5V3; 5V4;
 5U4G; 83V; 80; GZ33; GZ37;
 5Y3; 6087; U52
 V2 5R4GY; 5R4WGY; 5R4WGA/B
 V3-V6 5R4GY; 5R4WGY; 5R4 WGA/B;
 GZ37; 5V3; 5U4G; AZ50; U52

5R4WGB stack

Capacitor bank



The filter of the final stage uses three 30 uf capacitors and two 15 Henry inductors.

Remember that the energy stored in a capacitor is proportional to the square of the voltage.³ Therefore, the energy storage of a small cap at high voltage can approach or surpass that of a large cap at low voltage. Hence, a 140 uf cap at 650 volts has an energy storage of around 30 Joules. A 35 uf cap at 1250 V stores 27 Joules. The current required by the output stage is relatively high so chokes of adequate current handling capability above 15 Henries would quickly become enormous. With the inductance values we use, the ripple is sufficiently low such that it is not worth worrying about.

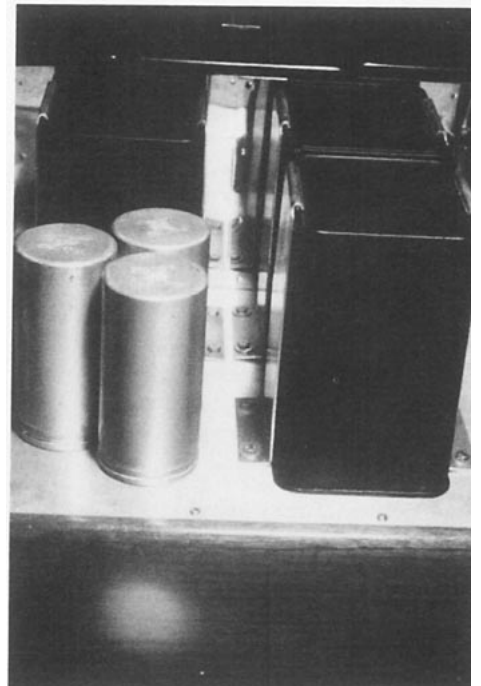
The dimensions of the group of three plate supplies is, as you can imagine, anything but compact — but it is definitely worth the effort! The improved listening results with such an elaborate supply justify the expenditure of resources.

Filament Supply

All the filaments of the rectifier tubes are supplied AC by secondaries of the filament transformer. We found that AC heater supplies do not cause audible hum with indirectly heated tubes. Even the input tube is heated by AC with a dedicated winding. We tested a regulated DC filament supply but it did not provide audible benefits, therefore it seemed reasonable to opt for the simpler solution.

On the other hand, hum problems *are* prevalent with directly heated tubes, hence the driver and output tube heaters are fed with DC to reduce hum problems. We use a simple full wave bridge supply with a large 43,000 uf cap. It is important to make sure that the actual filament voltage *under load* is close to nominal. Insufficient voltage causes an audible deterioration in the sonic presentation of the tube. Overvoltage notably shortens the lifespan of the device.

On the schematic you will find that the values of the secondaries are slightly high. We did this because it is necessary to consider a high voltage drop through the power supply components. Depending on the DC resistance of your chosen inductors, it might be necessary to use dropping resistors calculated according to Ohm's law to adjust output voltages to the nominal value.



Negative grid supply

The dedicated grid supply for the 211 final is, in essence, rather simple. Like the other supplies it is not regulated. Contrary to what one might expect, we found that a regulated grid supply caused a *greater* effective variation in the plate current than an unregulated grid supply. This is because if the grid supply is kept totally independent of the plate supply by regulation, fluctuations in the plate voltage are not accompanied by corresponding variations in the grid supply. An absolutely rigid bias supply, then, does not provide more stable operating conditions when an unregulated plate supply is used.

The circuit description is simple— the voltages are supplied by a dedicated secondary of the transformer, rectified by a solid state bridge.

It is possible to use tube rectifiers in the bias supplies, but we didn't find that it is of particular sonic benefit in this case, so it was not worth the extra effort. Note that the polarity of the rectifier is inverted because we need to obtain a negative voltage. Filtering is via a C-R-C filter, two 100 uf caps with a 1K resistor. A 33K potentiometer is connected to ground through a 5K resistor and it is from the wiper of the pot that the negative voltage is picked off. The voltage can be adjusted with the pot.

3— The formula for calculating the amount of energy stored in a capacitor, expressed in Joules is: $E=C \times V^2/2$

Components

The biggest challenge in building a musical amplifier is the challenge of finding capacitors adequate to your ambitions. Capacitors in the power supply affect the sound of the amplifier as much or more than the rectifier tubes. We immediately eliminated electrolytic capacitors from consideration. There are multiple reasons for this decision:

- a) They are not sufficiently reliable. It is not unusual to find electrolytic caps that cannot withstand rated voltage and they are vulnerable to peaks of short duration. In view of the voltages in use in this amp, it is not worth the risk.
- b) Electrolytic caps rated at high voltages are a rarity. In practice, the DIYer must series several capacitors to achieve adequately high rating, outweighing any space-saving advantages that electrolytic caps offer in contrast to non polarized capacitors.
- c) The musical performance of electrolytic capacitors is not exactly outstanding, so we say just forget them.

DIYers can at this point choose whether to begin a search of flea markets and surplus stores for good old oil caps or turn to cur-

rent production film capacitors. There are even film in oil caps. For high voltage use, as in our 211 amplifier, the oil type intended for this service would be preferable. In Italy, such caps are produced by ICAR and ARCOTRONIC.

Of course, all of the filter caps are bypassed with high quality small value caps. We have had good results mixing capacitors with different dielectrics, e.g. 35 uf paper and oil, paralleled with a .22 uf polystyrene and a 5000 pf silver mica.

Wire

We recommend silver plated OFC or solid silver, possibly Teflon insulated. Watch the insulation rating carefully. If you are not completely certain that the insulation is more than adequate, get yourself some teflon tubing to reinforce the insulation. Take care to separate any non-insulated high voltage points from ground to avoid arcing. Always leave enough room between one conductor and another. Back when we were building the prototypes, a resistor opened while we were listening one day but the unit continued to play thanks to a voltage arc across the terminals which completed the circuit!! In short, take every imaginable

precaution in the interest of safety when building or working with high voltage equipment.

Inductors and Transformers

This amp will require specialized transformers.⁴ It is possible to build it with surplus components but keep in mind that the size and weight will increase beyond the already substantial mass of our amplifier due to the number of filament and plate windings required. In any event, be sure that the high voltage terminals are adequately spaced and well insulated. Suitable filter chokes can be found on the surplus market with a bit of dedication, but to us it seems simpler to let your trusty transformer supplier wind them.

Rectifier tubes

We prefer the 5R4W, ruggedized military version of the 5R4, which are very beautiful aside from working very well. You can happily use a standard 5R4, which has a lower voltage rating than the 5R4W but still has a high margin of safety in this application. You can also use the following tubes in your bridge rectifier: 5V3, 5U4, U-52, GZ-33, GZ-37, or AZ-50. Each sounds slightly different and the choice is largely a question of taste. Keep in mind that these tubes are not adequate for the driver stage supply since the voltage exceeds safe operating range. There, the 5R4 is an almost obligatory choice.

The input supply operates at a considerably lower voltage than the other two and there are many usable rectifier tubes. To conclude, we recommend that you use ceramic base sockets of the best quality for the rectifier tubes. They will need to withstand high temperatures which can be a problem with bakelite or, worse yet, plastic sockets.

Part II

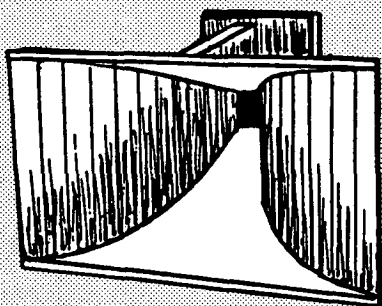
We will continue our discussion of the design and construction of the Orfeo 211 amplifier next issue with an examination of the audio circuitry.

The original version of this article was published in the Italian-language DIY journal *Costruire Hi-Fi: Rivista per auto-costruttori di sistemi audio diretta da Paolo Vippiani*. Issue 8 (Feb. 1994) and Issue 9 (April 1994).

⁴— Elettrica Brenta can supply a complete set of transformers and inductors for this amplifier at an approximate cost of \$1400 US for the set. For more info contact: Elettrica Brenta, Vic. Vespucci 5, Fiesse D'Artico, Italy. (39)41-516152 phone and fax.

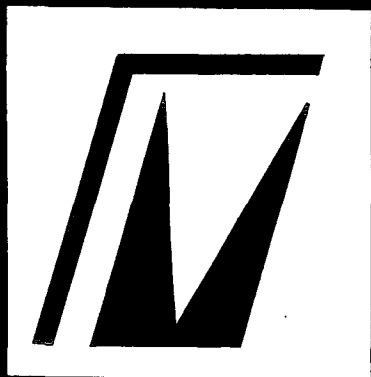
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HIDOTRAC

**A TURBO
CLASS A
PUSH
PULL
2A3
AMP**

**BY DIEGO
NARDI**

At the tender age of 25, I am privileged to qualify as a "tube electronics professional," an unusual occupation for a member of my generation. At the moment, my job is repairing, designing, and modifying audio gear, my specialty being tube amplification, of course. Presently, I am the official service technician for Audio Note Japan and UK products in the Italian market.

Much of my audio education comes from working on and listening to a wide variety of contemporary and classic equipment, including some top of the line Audio Note products which I have been fortunate enough to live with from time to time. At present, my home system is powered by self-designed, home-bred, no-feedback triode amplification. What I'm introducing to you here is a line integrated, 2A3 based push-pull amp that I built for purposes of experimentation and which I liked enough to retain as the main amplifier in my system.

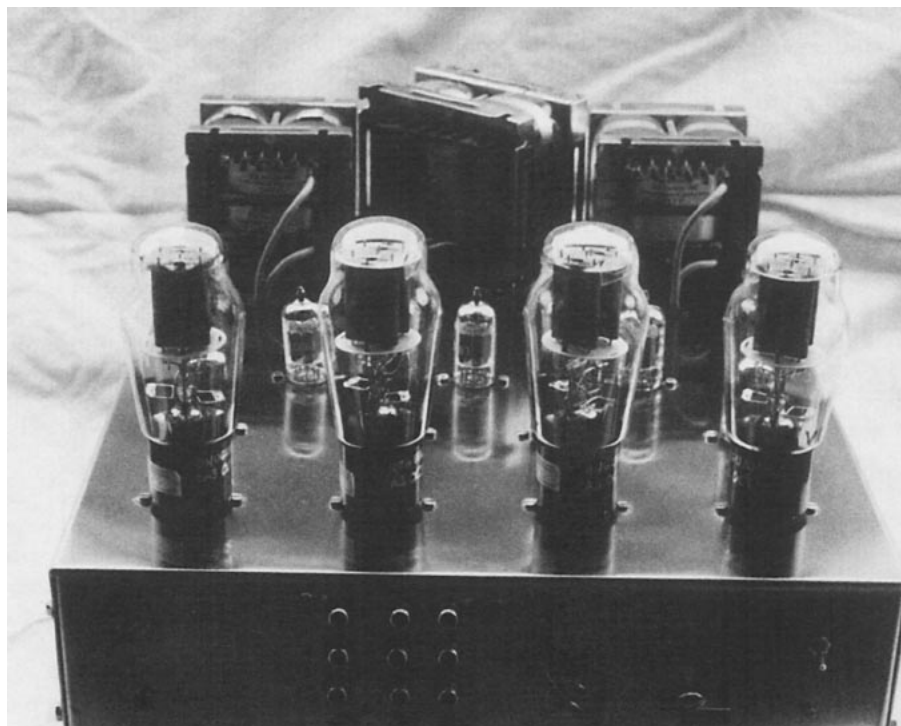
Despite its rather complicated structure — five stages in the main circuit plus a cathode follower tape out, two power transformers for five independent power supplies — this amplifier is no big thing and a standard 44 x 35 cm chassis is enough to contain it all.

This prototype contains a few fine components I secured from Audio Note including a couple of small Black Gate electrolytics,

four Jensen paper-in-oil coupling caps, and a piece of AN-V silver interconnect to give the final touch to sound quality. For the most part, however, components were standard industrial grade items. I wanted to see what kind of performance I could obtain without relying on special ultra high grade/expensive parts.

Transformers were made by my transformer supplier specifically for this amp. The outputs are fine special alloy 0.1mm lamination double-C cores, a Williamson-like 18 section winding, yielding an excellent 16-155,000 Hz response between -3dB points at 1W and a 25-45,000 Hz full power bandwidth (with two clean Watts still available at 140,000 Hz) and modest losses. All of this with no feedback at all.

There are a couple of technical solutions that are quite unusual, at least for the way they're used. The first one is that phase inversion is obtained by means of a low-impedance interstage transformer (also C-cored) splitting the amp into two parts. At the left of the phase splitter transformer, an SRPP/cathode follower direct coupled stage acts as a very linear line amplifier. This driver combination not only amplifies the incoming signal but it also provides a nice low impedance source to drive the transformer primary. Because the interstage transformer is a low inductance unit, a low impedance driver is necessary for good LF response.



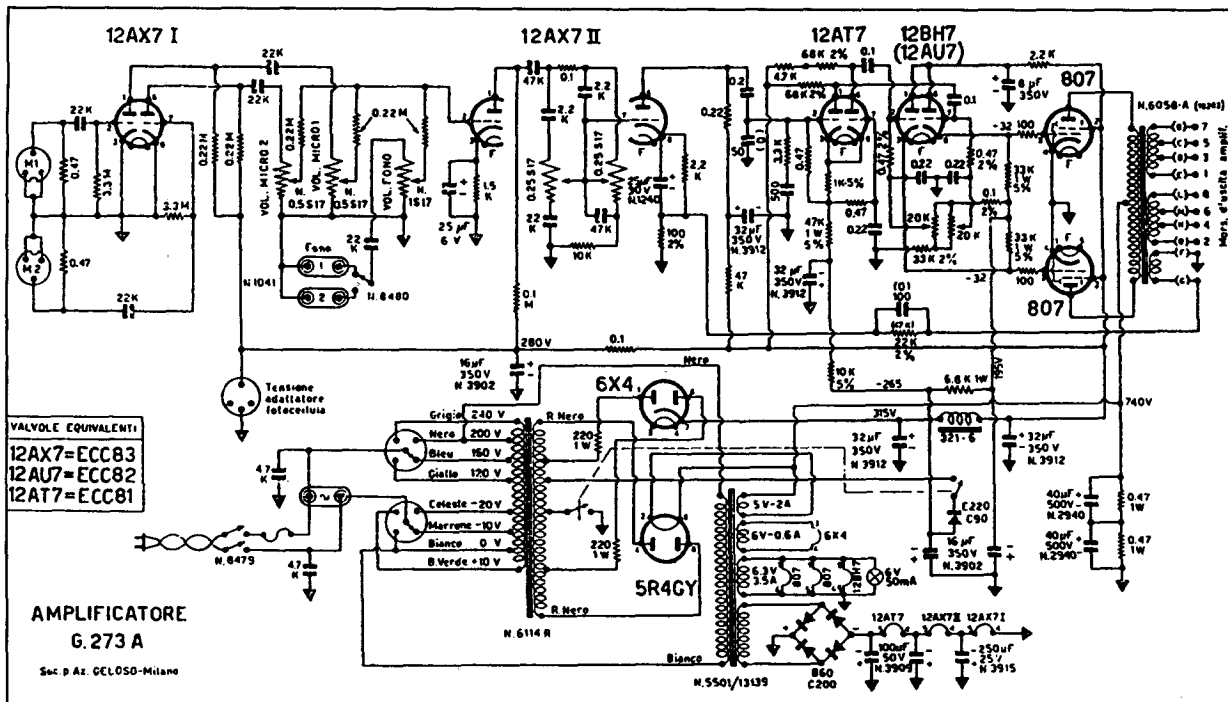


Fig 1 — Gelo G273-A Power Amplifier made by the Gelo Company in Milan in 1957-1959. An example of a direct coupled cathode follower driver in a class AB2 high power unit, this amp could produce 100W from a pair of 807s. Although intended for PA applications, it is a basically sound design that could be developed into a respectable hi-fi amp.

The use of a transformer for phase inversion is the point from which the whole project originated. Whatever this amp was all about, it had to have a transformer phase inverter. I wanted to do without electronic phase splitters with their problems of non-symmetrical output impedance and non-symmetrical distortion.

My transformer supplier already had a suitable unit in current production, intended for use in balanced lines in PA equipment. For reasons of economy, I decided to give what was available a try rather than having a custom made unit produced.

Design of traditional interstage transformers is critical in that they are meant to work exactly as output transformers, using their primary as a load for a single ended stage and their secondary feeding the output tube grids, usually with a step-up ratio. With this arrangement, the plate current of the driver tube passes through the primary and (this is a big "and") the grid current of the output tubes passes through the secondary. The input capacitance of the output stage also poses a challenge to the driver.

These requirements call for:

- 1 — High primary inductance and gapped core, therefore lots of turns on a big core.

- 2 — Extremely low leakage reactance, not only to get good HF performance but also to avoid oscillations that can easily occur due to the two tubes' input capacitance if the two halves of the secondary are not very tightly coupled.

Getting reasonable performance from such a transformer would require something big and expensive. I wanted something small and cheap!

A different approach was obviously needed. I took the following steps:

- 1 — Moved the transformer to a point where it has to work at a low level (hundreds of millivolts not hundreds of volts).
- 2 — No DC through the transformer.
- 3 — Made provisions for a constant low impedance point within the amp to install the transformer.

This approach allowed me to specify a slightly modified version of the tiny PA unit mentioned above. It weighs only 150 grams potted and it is no bigger than a 2 uF coupling cap. My arrangement is unusual in that the tranny is driven by a cathode follower with parallel feed and it has a 2.6:1 step-down ratio (input to either output). It is directly connected to the grids of the voltage

amplifier stage and therefore acts as a very low value grid leak resistor. This way, the VA stage sees a 30 ohm impedance and the line stage sees virtually no load at all.

Response of the driver stage is flat and in phase from 20 Hz to 40,000 Hz, some very slight ripple to 60,000 Hz, and then flat and in phase again out to over 200,000 Hz.

The line stage is coupled with the primary through a Solen capacitor. This type of coupling results in a second order RLC series high pass filter which provides the amplifier's main pole at low frequency. This arrangement effectively stops any subsonic signals that might bother the subsequent stages. You might get more very low frequency phase shift with this arrangement, but you'll save your output stage from wasting energy swinging your woofer back and forth while you're playing a warped record. This amp is not a power plant! You want to use its power to play music, not record warps.

Looking at the schematic, to the right of the transformer you find something like a "two and a half" stage amp which is push pull throughout. There is a balanced differential voltage amplifier, RC coupled to two cathode followers hanging on to a dual power supply. Each of them in turn feeds an output tube.

This type of driver is not very frequently used in commercial hi-fi amps. I saw it in several exotic single-ended designs from Japan including the Audio Note Japan SE amps. The cathode follower driver historically was most often used in push pull amps in which the output stage was deeply biased in Class AB2. Have a look at the Brook 10C schematic from SP#2 or the mid-50's Gelo-so PA amp from Italy (Fig. 1) which pulled 100W out of a pair of AB2 807s.

The strange thing with my amp is that it is Class A. Let me explain my reasons for driving a Class A PP amp this way. Basically, I disagree with the thinking that because a low power Class A amp is not intended to run into the grid current region, only a textbook voltage amplifier is needed to drive the output stage. I base my position on looking at the actual behavior of many amplifiers using many different driver/inverter circuits. They work fine when the output tubes are not driven hard, but they simply lose control of the grid when the amp is stressed in the slightest degree.

Moreover, when you have a triode at the output, its input capacitance due to Miller effect is very considerable — 150 pF or even more is quite normal in a hot 2A3. A plate loaded triode or, to a lesser extent, an SRPP driver will generally show quite poor slew-rate performance and somewhat high distortion with such a load, well before the output tube begins drawing grid current. What you get is a loosely controlled, slow output stage whose rise time is very much below the capability of your output tubes and transformer.

Manufacturers usually try to make up for lazy open-loop rise times by applying what they sometimes call an "optimum" amount of overall feedback, but in my opinion this remedy is worse than the disease it attempts to cure. Output tubes that mysteriously blow up due to 150 KHz oscillations into speaker loads are a fine example of what happens when you go for feedback to speed up uninspired amplifiers. I have had to fix quite a few so far in my shop.

Feedback can improve bandwidth but it does not guarantee dynamic stability when the amp has inadequate slew rate within the feedback loop. The problem is further aggravated when you consider that the slew rate of the stage can be considerably impaired if the load is suddenly changed. This

is precisely what happens to many amplifiers of apparently good static performance cursed with driver stages that run out of steam when reproducing musical peaks.

I believe that underestimating the difficulty of driving the grid of a power tube is one of the main reasons why tube gear is famous for sounding "warm," "sweet," "mellow" and a bit "loose on the bass." Not the only reason, but a sadly overlooked one as far as I can see.

One can also consider the situation from the point of view of the output tubes. The two most common methods of biasing output tubes — cathode bias and fixed bias — are well known to readers of this magazine. Cathode bias looks simple and safe but this approach has serious drawbacks in push pull amps. The problems grow when the tubes are directly heated. In cathode bias schemes, the tube is left to itself to determine its idle operating point and in my experience a power tube is no good judge of its proper operating conditions. Even if separate resistors are provided for each push pull tube, you still have to provide a means for balancing the standing currents. Otherwise, no matter how carefully you match the tubes, you'll never get it right.

Of course, the optimal resistor value for a fresh tube won't be right as the tube ages and the standing current decreases. It is possible to implement a Williamson-style resistor array to make everything adjustable but this is not very suitable for directly heated tubes. Also, cathode bias exploits the useful life of the output tubes less efficiently. And then there's the problem of cathode bias caps. Electrolytics? No, cathode bias is not for me.

As if the above weren't enough, you must also bear in mind that a vast amount of power is wasted in cathode bias, especially when output tubes run at relatively high standing plate current or when high bias voltage is required. For example, if I cathode biased the Hidotrac, cathode resistor dissipation would be 2.7 W per tube (10.8 W total) thrown away heating the resistors — about 18% of the total plate input power! It is as if you attached an empty trailer to the back of your car with the only purpose of increasing the gas consumption by 18% for the same average speed. Not very sensible in my opinion.

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PARTS LIST

R1, R4	1M
R2	2K2
R3	470R
R5	50K or 100K B taper pot
R6	0 to 470R
R7, R8	1K2
R9	15K/1W
R10	depends on xfmr; I used 1K8
R11, R15	120K
R14	470R (or use AC bal. pot)
R16, R21	470K
R17, R20	20K trimmer
R22, R23	100K 1/2W
R18, R19	39K
R24, R25	15K 2W
R26, R27	23k, 2W (2x 47k 1W parallel)
R28, R29	220 to 470R 5W
R30	680R 5W
R31	2K2 5W
R32	12K 5W
R33, R34	25 Ohm WW pot, 2W
C1	0.22uF 400V
C2	10nF 400V
C3	Solen 6.8uF 400V
C4, C7	0.22uF 400V
C5, C6	not used
C8	470uF 385V
C9	100uF 385V
C10	100uF 100V
C11-C14	470uF 200V
C15, C16	100uF 385V
C17-C20	220uF 400V
C21	100uF 385V
C22-C25	4700uF 25V
C26	220uF 16V Black Gate
D1-D4	BY225
D5-D10	1N4007
D11, D12	400V 8A
V1, V2	12AX7 or any high mu triode
V3	12AU7
V4	12AX7
V5	12AX7
V6, V7	6SN7
V8-V11	2A3
V12	12AU7

The author can provide the interstage transformers specified in this article for \$64 /pr. + \$10 Airmail post. Contact:

Diego Nardi
Via Volterra 12
20146 Milano M1
Italy

Fixed bias, obtained from a small power supply, makes it easy to set the standing current and requires no strange components from cathode to ground (except maybe a small resistor). However, the way bias supplies are usually made is far from satisfactory. Forget the old story that "bias supplies will never have to provide any considerable current". This is strikingly untrue! —especially as the amp is driven toward clipping. If you feed a grid from a poor power supply, as manufacturers of fixed bias amps nearly always do, you get poor control of the output tubes' "zero" point under dynamic conditions. Added to the fact that most amps have their output stage driven by a plate loaded driver stage or phase inverter which has limited authority to force the grids to obey its orders, there are obvious reasons why such gear sounds muffled and dynamically asleep.

But if you decide to make a more serious bias supply, you might as well use it to do something more interesting. So I said to myself: "Why not make a Class A, all-triode, no-feedback amp with a driver stage capable of gripping the output stage all the way to DC?" The way to do this is to use what our ancestors used to drive their AB2 units — a nice tough directly-coupled cathode follower pair hanging on to dual dedicated power supply rails. This does three things at one time that no other method can achieve:

1 — It biases the output tubes by means of adjustable voltage dividers that feed the grids of the *drivers*, which will never draw any appreciable grid current, unlike the outputs. This makes for very stable bias long term.

2 — It drives the output tubes with very low distortion and keeps them under strict control regardless of signal amplitude, even well into overload.

3 — Thanks to its low output impedance (around 200 ohms in my unit), the slew rate performance of this driver is not impaired by the input capacitance of the output tubes.

The drivers in this amp are 6SN7s with about 8 mA through each section. The 2A3s (Chinese) are run quite normally: plate voltage is 250 V when the standing current is set to 60 mA per tube. The plate-to-plate load is 3200 ohms with an 8 ohm load. OT ratio is 20:1 full primary to full secondary. Under these conditions, a pair of

2A3s is expected to put out approx. 8 W, then more or less gracefully slide into clipping. But here comes the surprise: while the THD at 7.5 W out @ 1KHz is still below 3% with a good spectrum (2nd at -34.5 dB, 3rd at -32.5 dB, 4th at -50, 5th at -49, and the rest below -60) this amp has the steam to go much further and only gives up at around 14 W. THD at 14 W is around 7% but the third harmonic is only 6 dB higher than the second. Not bad for a push pull being driven really hard into grid current, especially when you consider that all harmonics higher than the 5th are *still* below -60dB!

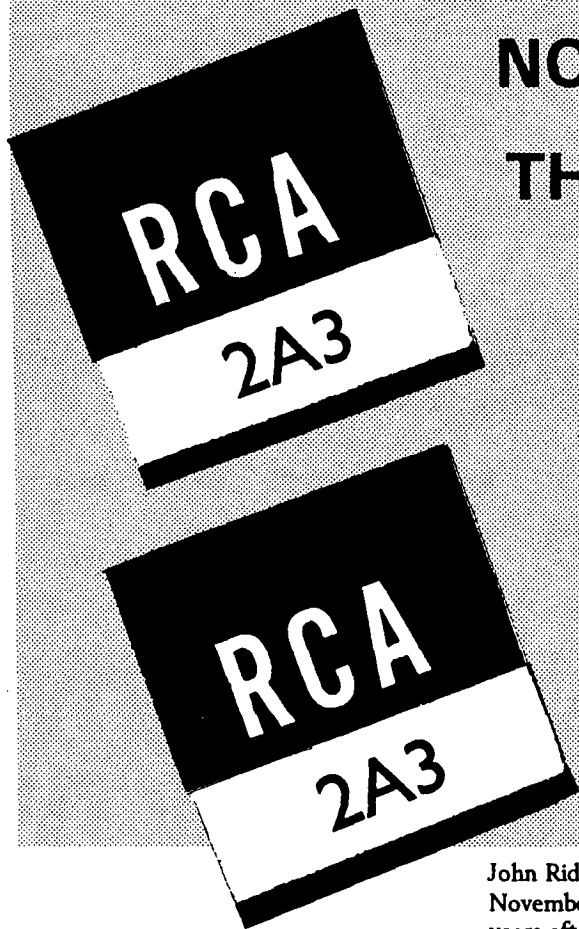
This class of operation might well be called "Class A2" or "Turbo Class A" or something like that. It yields a power output similar to that gained from Class AB1, but it offers true Class A linearity up to more than half-power. In addition, you have all of the advantages of the particular driver structure used, as described above.

The other lab performances are all satisfactory. I already mentioned power bandwidth. Slew rate is 3 V/uS. This amp can stand virtually any abuse without instability — including shorting the output at full power, then suddenly opening it.

Some of you might fear that the life of output tubes will be shortened by this kind of operation, but I have seen no evidence of this so far. The unit has been working nearly 2000 hours, often switched off and on two or three times a day, and the original 2A3s are as new. I periodically check the idle current but, since I set it after an initial 100 hour run-in, I've never had to correct it.

The sound of this amplifier is interesting in that it is completely different from what is normally expected. It is anything but slow and soft, having a tough and live feel which is unmatched by any pentode/beam tetrode amp I have tried so far. The performance approaches excellent and very expensive single ended units like the Audio Note *Neiro Silver* I recently had at home for some time.

The Hidotrac turned in surprising results driving current-eating 84 dB speakers that have caused serious headaches for big solid state amplifiers! In my opinion, this amplifier can be confidently recommended as a full range amplifier driving reasonably efficient speakers — say 90dB or better.



NOTES ON THE 2A3

BY ALAN
DOUGLAS

"Well, 45s are back again: or are they? It is indeed interesting to note that several of the recently announced radio receivers employ type 45 tubes in the output stage. Perhaps we are in for a 'back to the 45' movement.

Those men who have sworn by the old 45s will have a chance to crow. And you can't blame them much. The output with 45s is good, assuming that what precedes the output stage provides good quality. The power output is likewise sufficient for the ordinary home.

Quite a few of the receivers which used the tubes produced subsequent to the 45s are classed as having too much power, and are said to suffer slightly with respect to quality when the volume is reduced.

Will it last? Let's hope so."

John F. Rider, 1933

John Rider's editorial in *Service* magazine for November 1933 reminds us that barely two years after the push-pull triode output stage had been obsoleted by the pentode or by class B, many listeners wanted it back. Even though very few radio stations transmitted anything like high-fidelity at the time, the difference was quite audible. There was a story making the rounds of the 1931 Chicago IRE convention after the 47 pentode was introduced — though it was admitted to be exaggerated — that an engineer looked closely at a 47 and exclaimed, "Absolutely wonderful! Here we have 30% distortion in a bottle." Class B audio, the fad of the 1932 model year, was so bad that it was banished and never returned.

Economics had something to do with class B's demise also. Because of the current variations in a class B stage, a well-regulated supply that was decoupled from the remaining radio tubes was essential. Mercury-vapor rectifiers, prone to generating RF hash, were needed to lower the power supply impedance. Sometimes there were two rectifiers, sometimes two entirely separate power transformers!

If the old 45 was slightly underpowered for the job, then a new triode was evidently

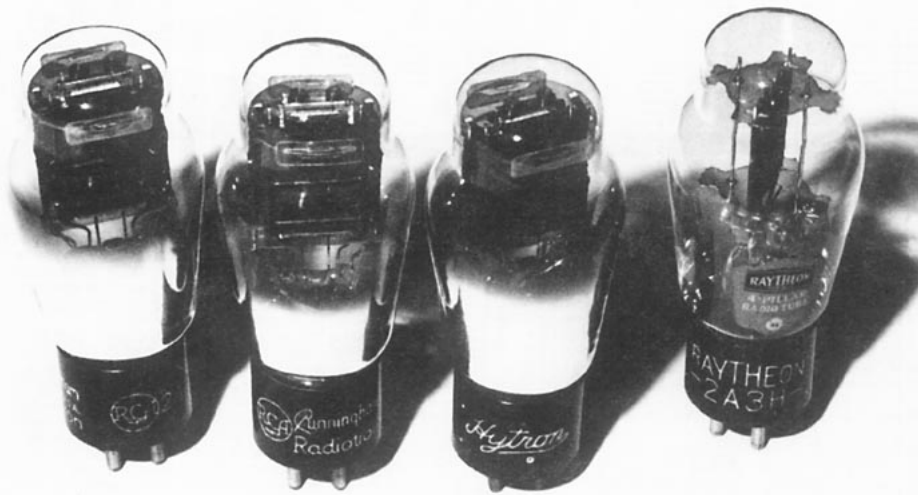
needed. The antiquated 50 consumed too much heater power and needed a high voltage supply beyond the ratings of the available electrolytic capacitors or practical rectifiers. If the 45 could run on 250 volts, why couldn't a tube of twice its output?

The problem was the cathode size required to handle the current demands of a low-voltage tube. RCA solved it by using 20 heater wires in series-parallel and wide flat plates. The 2A3 was introduced in the first week of February 1933, along with a companion 5Z3 rectifier.

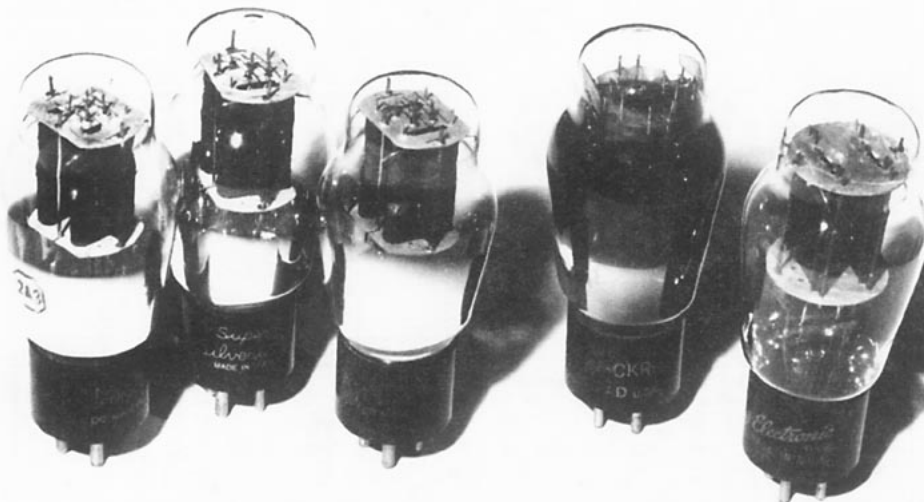
The curious fact is that although RCA intended its new tube for radio receiver use (high fidelity radios were then in the laboratory stage, according to the editor of *Electronics*), virtually no one ever used the 2A3: Scott used it in his Allwave 15, McMurdo Silver in his Masterpiece II, and that was about it. The 42 pentode (sometimes triode connected), proved to be an acceptable compromise, even to hi-fi fanatical Philco. Zenith regressed to using six 45s in push-pull parallel. On the average, a 2A3 cost three times as much as a 45 during the 1930s.

The 2A3 found its following in commercial sound, which may have been RCA's intention all along since RCA Photophone was in head to head competition with Western Electric's ERPI for theater installations. There was also an overseas market: witness the Brimar (UK) and Fivre (Italy) 2A3s that were identical to the first RCA model. Brimar, an acronym for BRitish Made American Range, is known to have imported US-made tubes for distribution and Fivre may have done the same.

Several US independents also made 2A3s starting in 1933, Sylvania and Ken-Rad to name two. Raytheon went them one better by making its own 2A3H with three parallel elements and cathode sleeves over the heaters. Raytheon's special sales feature was "four-pillar" construction, somewhat more rigid than the standard method, but unnecessary after the introduction of dome top bulbs in 1932. This feature made it impossible to swap tubes with other manufacturers, a normal industry practice; the Hytron pictured was actually made by RCA, as were the postwar Sylvania and Raytheon examples, while a single production line made the National Union, Silvertone, and Sylvania tubes shown.



RCA tubes from March 1934, August 1935, and ca. mid-1936. Raytheon 2A3H 1934-36. Base stampings have been whitened with chalk for visibility.



National Union, Silvertone, and Sylvania — Probably all NU 1950s, wartime Ken-Rad and 1950's GE. GE bought Ken-Rad in 1946.

In September 1935, Sylvania announced the 6A3, designed for the Philco 680X high fidelity radio. Electrically this was a 2A3 with a 6 Volt heater, but mechanically it was two triodes in parallel — considerably easier to build than RCA's original design. The independents soon began building 2A3s this way, as did RCA itself by May 1937 if not earlier. Other than a possible variation in hum balancing, there is of course no difference in performance for the two types. The trendy buzzword "monoplate" aside, this first version has *two* grids and *two* plates, and a heater facing in *two* directions. If the structures are not perfectly centered, these

two directions will not have the same characteristics. Furthermore, the electric fields are *far* from uniform at the edges of the structure, and the effective grid bias varies with position along the heater and varies at a 60 Hz rate too! The electrons don't care: the total characteristic is the sum of all the electron currents, and the hum can generally be averaged out. Any variations in sound between tubes are likely due to differences in plate resistance interacting with varying speaker impedance over the audio range. One can build excellent amplifiers without invoking supernatural powers or magical mumbo-jumbo.

RCA
2A3
POWER TRIODE

GENERAL DATA

Electrical:

Filament, Coated:

Voltage 2.5 ac or dc volts

Current 2.5 amp

Direct Interelectrode Capacitances (Approx.):*

Grid to Plate 16.5 μ mf

Grid to Cathode 7.5 μ mf

Plate to Cathode 5.5 μ mf

* With no external shield.

Mechanical:

Mounting Position Any

Maximum Overall Length 5-3/8"

Maximum Seated Length 4-3/4"

Maximum Diameter 2-1/16"

Bulb ST-16

Base Medium-Shell Small 4-Pin

Basing Designation for BOTTOM VIEW 4D

AMPLIFIER - Class A₁

Maximum Ratings, Design-Center Values:

PLATE VOLTAGE 300 max. volts

PLATE DISSIPATION 15 max. watts

Typical Operation and Characteristics:

Plate Voltage 250 . . . volts

Grid Voltage# -45 . . . volts

Amplification Factor 4.2

Plate Resistance 800 . . . ohms

Transconductance 5250 . . μ hos

Plate Current 60 . . . ma.

Load Resistance 2500 . . ohms

Second Harmonic Distortion 5 . . . %

Power Output 3.5 . . . watts

Maximum Circuit Values:¹

Grid-Circuit Resistance . . . { fixed bias 0.05 max. megohm
cathode bias 0.5 max. megohm

A, ¹ See next page.
indicates a change.

OCTOBER 15, 1947 TUBE DEPARTMENT RADIO CORPORATION OF AMERICA, WESTON, NEW JERSEY DATA

RCA
2A3
POWER TRIODE

PUSH-PULL AMPLIFIER - Class AB₁

Maximum Ratings, Design-Center Values:

PLATE VOLTAGE 300 max. volts

PLATE DISSIPATION 15 max. watts

Typical Operation:

Values are for 2 tubes

	Fixed Bias	Cathode Bias
Plate Voltage	300	300 . . . volts
Grid Voltage#	-62	- . . . volts
Cathode-Bias Resistor	124	780 . . . ohms
Peak AF Grid-to-Grid Voltage	80	156 . . . volts
Zero-Signal Plate Current	80	80 . . . ma.
Max.-Signal Plate Current	147	100 . . . ma.
Effective Load Resistance (plate to plate)	3000	5000 . . . ohms
Total Harmonic Distortion	2.5	5.0 . . . %
Power Output	15	10 . . . watts

Maximum Circuit Values:¹

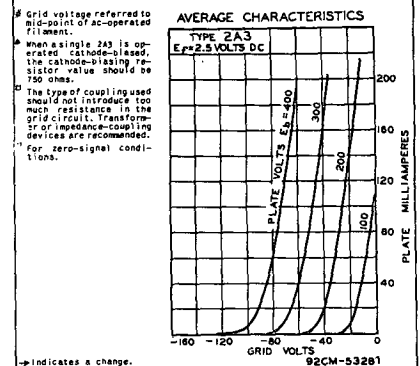
Grid-Circuit resistance . . . { fixed bias 0.05 max. megohm
cathode bias 0.5 max. megohm

Grid voltage referred to mid-point of ac-operated filament.

¹ When a single 2A3 is operated, cathode-biased, the cathode-biasing resistor value should be 750 ohms.

² The type of coupling used should not introduce too much resistance in the grid circuit. Transformer or impedance-coupling devices are recommended for zero-signal conditions.

OCTOBER 15, 1947 TUBE DEPARTMENT RADIO CORPORATION OF AMERICA, WESTON, NEW JERSEY DATA



OCTOBER 15, 1947 TUBE DEPARTMENT RADIO CORPORATION OF AMERICA, WESTON, NEW JERSEY DATA



Design of Audio System Employing 2A3 Tubes

Copyright, 1933 by
RCA Radiotron Co., Inc.

THE introduction of the 2A3 made possible the design of audio-frequency output systems of unusual power-handling ability and exceptional tone quality. The unique design features incorporated in the 2A3 make possible very high power output at relatively low plate voltages. Used in a suitable audio-frequency power amplifier, two 2A3's in Class A push-pull are capable of delivering 15 watts of audio power to the output transformer with a total harmonic distortion of less than 2.5 per cent.

Two of the more important design features of the 2A3 are its multifilamentary cathode and its extremely high mutual conductance. The multifilamentary cathode consists of a large number of coated filaments arranged in series-parallel combination to provide a very large effective cathode area.

Graphical Solution for the Selection of 2A3 Operating Conditions

In determining the performance obtainable from two 2A3's in Class A push-pull and in selecting output transformer constants, a graphical method of solution can be used. For a general consideration of the method for determining the performance of push-pull audio amplifiers by graphical means, see the paper entitled "Graphical Determination of Performance of Push-Pull Audio Amplifiers" by B. J. Thompson of our Research and Development Laboratory. This paper appeared in Proceedings of the Institute of Radio Engineers for April, 1933.

CLASS A OPERATING CONSIDERATIONS FOR THE 2A3

Class A General Operation

THE usual operating point of grid-bias voltage for a Class A amplifier lies approximately midway between zero bias and a bias sufficient to cause plate-current cut-off. If a single tube is used in Class A operation, the operating bias voltage

must be such that the DC plate current does not change appreciably when full signal voltages are applied to the grid. Only under such conditions can an output having low distortion be obtained.

Strictly speaking, no type of output tube has absolutely linear characteristics. Consequently, a small amount of rectification of the signal voltage usually occurs. The non-linearity of characteristics is therefore responsible for the distortion produced by the tube.

When two tubes are operated in a Class A push-pull circuit, the non-linear sections of their characteristics are made to complement each other to give a substantially linear overall characteristic. This method produces an output free from second harmonic distortion. For this reason, it is possible to use a higher bias voltage for push-pull operation than is usually employed for single-tube operation. An increased bias voltage lowers the internal dissipation of the tube and permits the use of higher plate voltages. Higher plate voltages, in turn, make possible higher power output.

In order to obtain the higher power output of which the 2A3 is capable, two of these tubes are operated in push-pull under bias-voltage conditions which cause considerable rectification in each tube. Additional plate current, then, is drawn because of rectification, but this increased plate current is useful in securing higher power outputs. Under normal recommended operating conditions in a push-pull amplifier, where a plate-supply voltage of very good regulation and a fixed-bias supply voltage are used, the plate current is not cut off during any fraction of the cycle. Consequently, even though the recommended operating conditions specify over-bias grid voltage, this system may be operated as a strictly Class A amplifier.

2A3's should not be operated with more than 300 volts on the plate. The grid-bias voltage should be -62 volts when operated from an AC filament supply and -60 volts when operated from a DC supply. The corresponding static plate current for an average 2A3 is 40 milliamperes. This voltage and current rating for no signal input should not be exceeded for best results.

Fixed-Bias Operation of the 2A3

With Over-Bias Voltage

FIG. 2 shows a circuit arrangement for the 2A3 in which the bias voltage is obtained from a small triode used as a rectifier. This triode must be a type whose cathode comes to an operating temperature quickly in order that bias will be available to prevent abnormal plate current in the 2A3's. Either a type 26 or 01-A is suitable for use as the bias rectifier.

With the circuit of Fig. 1, changes in the DC plate current of the 2A3 produce some change in bias. With the circuit of Fig. 2, the bias voltage is substantially independent of the plate current of the 2A3's.

The ideal case of fixed-bias operation with a fixed plate-voltage supply gives results as shown by the curves marked (I) in Fig. 3. The curves (II) show the performance with fixed bias but with a plate-supply source having an equivalent internal resistance of 562 ohms. This represents the condition for the circuit of Fig. 2 when a 5Z3 with suitable transformer is used. The performance with an 83 type is intermediate between the values of curves I and II of Fig. 3.

The plate circuits of the 2A3's should be fused in the center-tap lead of the output transformer. This is especially important when fixed bias is used. Should the bias-voltage rectifier tube be removed or damaged, the bias on the 2A3's becomes zero. In that event, unless a fuse is provided for protection, excessive plate current can flow and damage the receiver. A suitable fuse is one similar to the small glass-enclosed type often used to fuse the power-supply line in radio sets and rated at 150 milliamperes.

Self-Bias Operation of the 2A3 With Over-Bias Voltage

WHEN 2A3's are operated in a push-pull circuit and are self-biased, a rise in DC plate current with increasing signal voltages increases the voltage drop across the self-biasing resistor and raises the bias on the tubes. Thus, the operating point on the plate family of the characteristic curves is shifted downward. This shift tends to increase distortion and to lower the power output. Under these conditions, operation intermediate to Class A and Class B is usually obtained at full output since the plate current is cut off for an appreciable fraction of the operating cycle.

When self-biasing circuits are used for the 2A3, it is necessary, therefore, to employ a higher

value of plate-load resistance than is used with a fixed or semi-fixed bias arrangement. The purpose of this high resistance is to lessen plate-current swings, limit distortion, and prevent plate-current cut-off at negative signal swings.

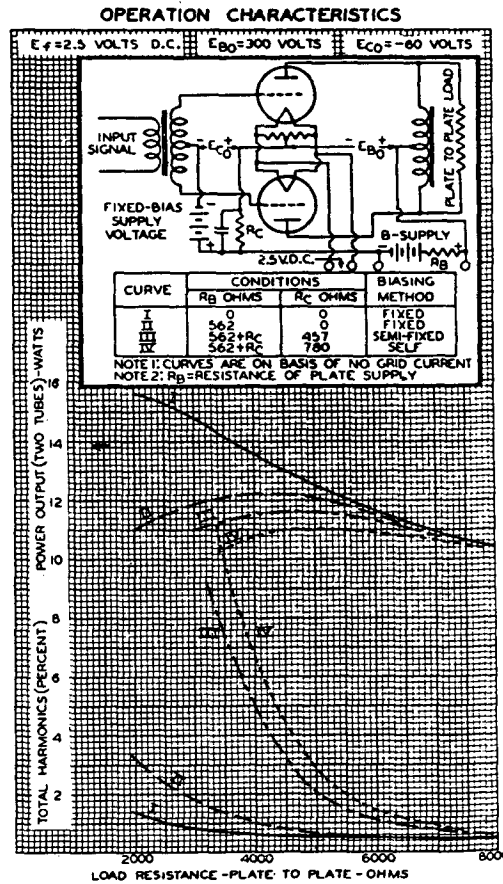
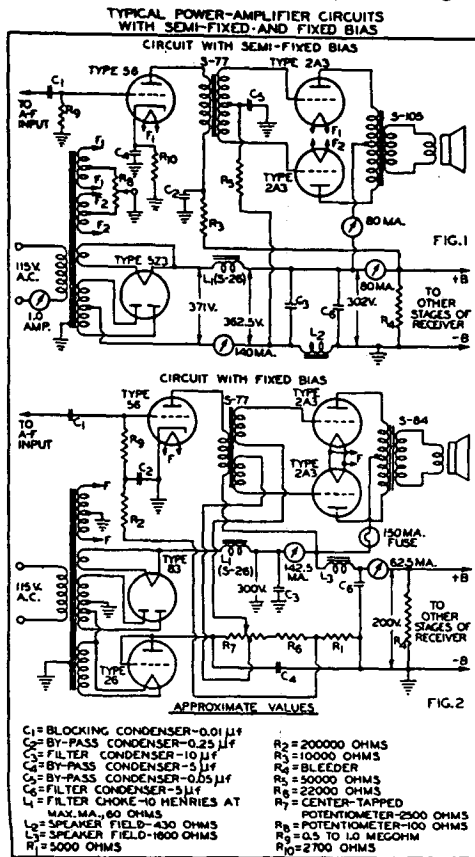
Performance of a 2A3 amplifier for self-bias operation (self-bias resistance of 780 ohms) and an assumed internal resistance of the plate-voltage supply of 562 ohms is shown as Curve IV in Fig. 3. A comparison with Curve I, which represents the ideal case of fixed supply voltage, shows the necessity of using a high plate load, as previously stated, in order to obtain high power output and low distortion. Increasing the internal resistance of the plate-voltage supply to the somewhat higher values often used commercially will not materially change results from the values of Curve IV.

The circuit diagram in Fig. 3 shows the equivalent voltage-supply circuit for the plate and grid-voltage supply. The plate and bias voltages on the power tube at zero-input signal are 300 and -60 volts, respectively. (For AC filament supply, grid-bias voltage is -62 volts).

Curves I to IV show the performance of the amplifier for four combinations of the internal resistance values of the plate-voltage and grid-voltage supply. The plate- and grid-supply voltages are adjusted to the values given above. These curves show that it is desirable to use a bias arrangement which will not give bias-voltage fluctuations when the DC plate current changes. Semi-fixed and fixed-bias arrangements allow higher power output levels to be maintained with a high degree of fidelity.

Semi-Fixed-Bias Operation of the 2A3 With Over-Bias Voltage

FIG. 1 shows a circuit arrangement employing semi-fixed bias for the 2A3. The bias voltage is obtained across the speaker-field resistance. Since the plate current for all of the tubes in the set flows through this resistance, the bias voltage is less affected by the DC plate-current changes in the 2A3's than it is in a self-biasing circuit.



The circuit constants shown in Fig. 1 are those for a typical receiver. Since the speaker-field resistance determines the 2A3 bias, it follows that the choice of resistance depends on the total plate-current drain of all the tubes in the set. The performance with this circuit is represented by Curve III.

Balancing of 2A3 Circuits

IT MAY be advisable to provide some means for balancing the plate currents of the 2A3 tubes, as this has the effect of balancing out hum voltages present in the plate-supply voltage.

Two methods of accomplishing this are shown in the circuit diagrams. In Fig. 1, a small potentiometer (R_6) is connected between the center taps of the filament windings to permit an adjustment of bias voltage. In Fig. 2, the secondary of the input transformer consists of two separate windings. One lead is attached to the center of the potentiometer (R_7) and the other to the slider or arm of the same potentiometer. Adjustment of the potentiometer varies the bias slightly on one of the 2A3's.

Small amounts of hum due to various causes can often be eliminated by adjustment of the potentiometer. Adjustment of the potentiometer for minimum hum usually gives equal plate currents. The potentiometer is adjusted by listening for minimum hum upon installation of the 2A3's in the set. It should not require readjustment until one of the 2A3's is changed.

Power Transformer

BOTH the circuits of Fig. 1 and Fig. 2 are designed for use with typical commercial power transformers. There are no special features involved in the design of the power transformer. Any make of transformer having the appropriate voltage windings, correct rating, and good regulation may be used.

Pre-Amplifier Stage

A TYPE 56 tube is used in the pre-amplifier stage, since this tube gives excellent power sensitivity. The 56 also is an economical type.

A plate-supply voltage of 200 volts for the 56 is adequate to give the output signal required to swing the 2A3's. This is the voltage available for plate supply to the other tubes in the set under conditions given in Figs. 1 and 2. The 56, with 200-volt plate supply, is operated with a bias of -11 volts. The plate current is 3.6 milliamperes.

Input Transformer

THE same input transformer, specifications for which are shown here, is used for both the semi-fixed and fixed-bias arrangements. Commercial-size audio-transformer laminations are used.

The ratio of the input transformer is 1.4 to 1 from the full primary winding to one-half of the secondary winding. The peak voltage which will be induced in the secondary winding is 2 x .90 or 1.80 volts at the point at which the 56 begins to draw grid current.

In determining the constants for the input trans-

former, cost, size, response characteristics, and signal requirements must be considered. In order to obtain a low-cost small-size transformer with primary inductance high enough to give good frequency characteristics, a step-down ratio is used. A step-up ratio would require a larger transformer design in order to provide space for the additional secondary turns. However, under the circuit conditions shown, the step-down ratio can give a signal input to the 2A3's sufficiently large to obtain their full output.

Transformer Specifications

Power Transformer S-79A*

CORE:
Material—Transformer Steel
Allegheny Steel Co. or equivalent
Punching—EI-13A
Stack—1 $\frac{1}{4}$ -in.
Weight—4.9 lbs.

PRIMARY:
Resistance—2.4 ohms

SECONDARY:
Resistance at 25°C—2 x 106 ohms
Induced voltage—2 x 375 volts RMS
Induced voltage from center-tap to tap for bias rectifier—approx. 57 v RMS
Total weights of copper—1.0 lb.

Input Transformer S-77*

CORE:
Material—Audio B
Allegheny Steel Co. or equivalent
Punching—EI-75
Stack— $\frac{3}{4}$ -in.
Joint—Butt
Weight—0.6 lb.

PRIMARY:
Turns—5000
Location—Between two halves of secondary winding
Turns per layer—240
Layers—21
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Resistance at 25°C—2000 ohms

SECONDARY:
Turns—Two windings of 3600 turns each
Location—One-half over, one-half under primary
Turns per layer—240
Layers—2 x 15
Insulation between layers—0.001-in. paper
Wire—No. 40 enamelled
Total weights of copper—0.14 lb.

Output Transformer S-84*

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Punching—EI-11
Stack— $\frac{3}{4}$ -in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Turns—2000 tapped at 1000
Location—Next to core
Wire—No. 33 enamelled
Turns per layer—118
Layers—17
Insulation between layers—0.0015-in. paper
Resistance at 25°C—172 ohms total
Inductance—19.5 henries (at full signal)

SECONDARY:
Location—Wound over primary
Turns—2000 divided by the square root of $[5400/(R_L+r)]$ where,
 R_L =external load resistance on secondary terminals
 r =resistance of secondary winding or approximately 6% of R_L .

PRIMARY:
Wire—No. 32 enamelled
Turns—1400 tapped at 700
Location—Next to core
Turns per layer—105
Layers—14
Insulation between layers—0.0015-in. paper
Resistance at 25°C—98 ohms

SECONDARY:
Turns—32
Location—Wound over insulated primary
Wire—No. 15 enamelled
Turns per layer—16
Layers—2
Insulation between layers—0.005-in. paper
Secondary load—Voice coil of electro-dynamic speaker having an impedance at 60 cycles of 1.06 ohms.
Resistance at 25°C—0.053 ohms
Output—13.3 watts into a 1.06-ohm load at 60 cycles
Total weight of copper—0.24 lb.

Choke S-26*

CORE:
Material—Dynamo Steel
Allegheny Steel Co. or equivalent
Punchings—EI-12
Stack—1 $\frac{1}{4}$ -in.
Air gap—0.004-in. x 2
Weight—1.88 lbs.

WINDING:
Turns—1780
Turns per layer—81
Layers—22
Insulation between layers—0.003-in. paper
Resistance at 25°C—approx. 60 ohms
Weight of copper—0.47 lb.
Inductance—approx. 10 henries (conditions as in Fig. 2)

Output Transformer S-105*

CORE:
Material—Audio C
Allegheny Steel Co. or equivalent
Stack—0.875-in.
Joint—Lap
Weight—1.0 lb.

PRIMARY:
Turns—2000 tapped at 1000
Location—Next to core
Wire—No. 33 enamelled
Turns per layer—118
Layers—17
Insulation between layers—0.0015-in. paper
Resistance at 25°C—172 ohms total
Inductance—19.5 henries (at full signal)

SECONDARY:
Location—Wound over primary
Turns—2000 divided by the square root of $[5400/(R_L+r)]$ where,
 R_L =external load resistance on secondary terminals
 r =resistance of secondary winding or approximately 6% of R_L .

* Our design identification number.



RCA 2A3 tubes in chronological order:
Red-label from May-June 1937, followed (left to right) by wartime, late 1940s, and 1950s production.



photo:Victoria Clay

... the story they said would never
make it to the screen!!!

SEE Future Boy go digital!

HEAR the real story behind the cheap,
skipping portable CD players!

FEEL the cruel torture of the
ripoff master technicians wringing the
last drop of our famous hero's blood!

Only in the genius autobiographical shocker . . .

THE RETURN OF FUTURE BOY
BY
VINNY "21ST CENTURY" GALLO
(OF VINNY GALLO'S "MONO MIA" FAME)

R

BARGAIN MATINEES EVERY DAY
ALL SHOWS STARTING BEFORE 6PM

WIDE RANGE
Western Electric
SOUND SYSTEM

Sound Practices gets 8000 fan letters a day praising my famous articles, 10,000 fanatic fan faxes addressed to me, and the office gets swamped with hundreds of phone calls from thrilled Gallo fans from around the world. And one time, one lousy time, the Gallo receives negative criticism, and boom! there it is in print: Volume 2 #1 page 44, that's right! center page. Joe Roberts, you sneaky rat bastard. How could you do it to me, Joe, you half a man, you Judas? How could you print that piece of crap letter, you ungrateful spineless worm? And as far as being able to afford the damn Ongaku, don't make me laugh. I'm rich, you fool.

Besides, the fans want the Gallo, the real thing, the one and only — ME. That's right, ME! Not all those pale imitations of me. They want Vinny G, Doctor Brown, Grandmaster Vincenzo, Kid Hi-Fi. Me, that's right, me. The Gallo.

So Ladies and Gentlemen, my faxing fans, my praising pen pals and all my loving callers, the Gallo is back. I'd like to first thank you for taking time out from one of those ridiculous waste of time amp columns to read my latest hi-fi poem. It's about the life, death, and resurrection of Vinny 21st Century, Future Boy.

Born Vincent Gallo in Buffalo, N.Y. in 1961. Grew up there poor with his mom and pops (immigrants from Sicily) during the 60s and 70s. His pops was very proud. His whole family lived on plain boiled macaroni but he insisted on driving a brand new Cadillac every year. He had to have it, always black with that white interior.

Every time Future Boy sat in it, he got a beating for dirtying the seats and carpeting. Pops, even though he's got three little kids, he's still gotta have a white interior. Future Boy loved going with his pops to the dealership to pick up the new car. In the 60s it felt like each year the new things got better and better, it was so exciting. Future Boy thought by the time he was 21 all disease would be curable, cars would fly and run on water and people would live forever and stay young looking. He'd fly the first spaceship to Pluto. He loved all the new modern things. He was a techno-loving guinny, Vinny 21st century, Dr. New. His friends called him FUTURE BOY.

And that was me, I was future boy. But one dark day my daddy picked up his new Caddy and started complaining about it, things like "Ah I shoulda kept the old one, Goddamit! Look at this cheap thing." Then one week later he traded it back in for a

new version of the last year's model. It was the last one on the lot and he had to take a gold with a black interior. He kept that car 10 years, 'till my half deaf, half blind grandpa drove it over my uncle Angelo's favorite lawn statue of St. Anthony of Padua, through his tomato plants and into the side of the Bunza's house next door. No one was hurt, but my pops' last great Caddy was gone. Forget the tomato plants and that beautiful statue. Pops' Caddy was killed and he would never love another one. He drove them, yes, but he never loved them. It feels horrible to be disenchanted with new things and the future. It's the tragedy of the 20th century.

By the age of 18, "Future Boy" was dead. After that I started running around pumping old folks with the "what was it like back then" question. I've spent most of my adult life wishing, wishing it was still like that, wishing they still made those, wishing it was still there, wishing people still did that, wishing you could still buy them. Wondering why they stopped making them, wondering why they had to change. And it wasn't even a nostalgia trip, after all I hated Elvis and that whole 50's thing. But it just felt like all the great things had already happened. I became stuck, locked into an image of the past and cynical about the future.

I began romanticizing things that were just normal for the people who experienced them. For instance, I love my 1951 blond D'Angelico New Yorker cutaway guitar, sounds great, it's incredible. It's super cool but a lot of tired businessmen now want it so they can pretend that they are a jazz legend. This guitar is now worth 75,000 dollars. Great jazz players can sound good on any guitar. They bought D'Angelicos in the 50's because at \$300 it was a fine hand made working guitar they could use to make \$75 a week playing in a band 7 nights.

I would buy some old guy's old car and spend months and tons of money and aggravation trying to make it original, like new. I'd look up from under my car, grease on my face, the old bastard who sold it to me would be driving by in his brand new car, steering with a pair of clean hands. And laughing. And me thinking I was so smart and cool.

Like an asshole I spent \$30,000 minting a 1967 Chevy II SS. The car is cool, no question. It's fast, good looking, but let's face it, it's just an old car. No air bag, no seatbelts, it's loud, bumpy, bad on gas. I think the people who I drive past enjoy it more than me. They get to go, "Wow, look at that neat ol' car," then go back to their happy lives, while I the asshole drive it back home to start fixing it again. I was insane to sink \$30,000 into it. The car is an emotional burden. A few months ago I drove the \$22,000 brand new 1994 Chevy Impala SS. It was cool, fast and good looking. And it was brand new. Nobody else's dirty fat ass rested on its brand new seats. I didn't have to leave it with the paint guy for 6 months, I didn't have to make 7000 phone calls tracking down rare original parts. It was right there man, brand new with a warranty. And I loved it and I want it, and as soon as I can find another loser like me who'll give me some cash for my '67 I'm gonna run and buy the '94.

I love new things again. And it feels great and I don't have to and haven't stopped loving great old classic products like my hi fi gear or my old D'Angelico or my great old stove. But the '67 Chevy, that's got to go. Old cars are like an old pair of underwear. They stink. Although I would travel long and far and pay top dollar for an old pair of dirty panties for my collection, I still prefer a brand new pair of cotton Jockey midways for wearing comfort.

Future boy is back and he's better than ever 'cause this time, not only do I have an interest in everything that's new and fresh, but have kept my interest, experience and knowledge about what came before so I can enjoy the whole picture, pick and choose. And then move forward. With excitement and hope.

This guy from the New York Times calls me today, Rene Chun, says "Hey Mr. Gallo, I heard you're an expert on vintage hi-fi. I'm writing an article for the Style section of the Times and wanted to ask you some questions." I say, "Sure, buddy." So he's pumping

. . .wow, vintage hi-fi in the Style section of the Times. . .

me about the Garrard 301 and I'm answering but I'm thinking, wow, vintage hi-fi in the Style section of the Times. . .

Garrard makes a turntable like the 301, produced first in 1953. It's well made, sounds great and looks great. Was one of the best in its day. However, they themselves change and alter the model and eventually replace it, meanwhile a bunch of other tables got offered and sold. Newer and newer stuff all the time. Some junk, some of it not so bad. Guys like me rediscover the original and buy them at junk sales for 5 bucks, set them up and love 'em. A bunch of people get hip and the piece becomes worth \$600. Suddenly a used primitive worn-out table from 1953 becomes a \$600 turntable and the feeling is that everything new is junk. Then the fashion boy journalist from the Times calls; next thing you know it's a prop in an MTV video. And starts selling like hotcakes for \$2000 to fashion models. You can't give away vinyl anymore and boom, suddenly the Times is doing articles on stylish vinyl record players from the 50s.

Anyway, don't fool yourselves, vinyl won't make a comeback, it may be trendy but not for long. Love and keep your records. But new things are coming out and you might, if you let yourself, really love them. For example, I love my VCR and Laser Disc player. Of course it's thrilling to see an incredible film at the most beautiful old movie theater on a lovely summer night. But I've also heavily enjoyed staying at home during a blizzard and watching a great film on laser disc, eating Provolone cheese in bed with a

fat hooker. I love them both. Besides, a great film at home on laser disc is more fun than seeing a shitty movie in a shitty theater. The thing is to allow yourself to enjoy them both for what they are.

I know a famous fashion photographer, he makes millions, says to me, "Hey Gallo, you like old things, I want to buy an old Mercedes from the sixties, I saw one I liked for \$35,000, what do you think?" I'll tell you what I think. No, don't buy that piece of shit old car for \$35,000. Stop trying to be cool, just get yourself a nice new car. And enjoy it. I think that it's great to be hip enough to appreciate old products, to be sensitive to their beauty and quality, but some old things are a pain in the ass and one shouldn't be a slave to them out of fashion or cool. Everything new is not junk and everything old is not great. For example, how would you like to do your laundry with a good looking, beautifully made old fashioned cool clothes washer? Try spending the day winding clothes through rollers 100 times to get them clean.

Why isn't it cool anymore to drive a new car? Or wear new clothes? When I was a kid, new clothes were very cool. What happened? And who thought of distressed leather or stone-washed jeans? Screw that. I want a brand new car. I've changed, I don't want every single thing I buy to have to be hard to find and difficult to use so I can feel special and cool. Man, I want to be open and interested in everything. I'm Vinny 21st century, that's right, Future Boy, Dr. New. But try touching my Western Electric gear and I'll kill ya!

I had my first real run-in with CD about 4 years ago; I'm in L.A., friend of mine there works in a record shop. Desperate he calls me up for cash (junkie). "No loans," I say, "but come over and I'll give you a twenty." A minute later he shows up, takes the \$20 and offers me a pile of CDs for another \$100. There's about 200 CDs. "I don't want 'em," I say. Tears fall, he begs. "Okay, okay, I'll take them." He takes the money and runs.

GREAT!!! There I was, Vinny Gallo, Mr. Western Electric, Mr. I'm-only-into-monotube-gear, Mr. I'll-never-own-a-CD-player-in-my-life, Mr. I-make-my-own-pizza-from-scratch and a junkie just sold me 200 CDs. What could I do? The guy was crying. A week later I'm talking to the King, no not Elvis, the Bender, Walt Bender. Bender's cool. However, I've never seen him actually play a record. He has very cool gear, yes, but he listens to it only with a Patsy Cline CD through a cheap portable CD player.

We're talking CD and he tells me about a guy named Scott Nixon who hand-builds a D/A processor in N.C. It's supposed to be good and it uses tubes. It must be OK if it has tubes, right? I call this cat up. He agrees to build me a tube unit and will model it after my WE 41 42 43 amp. Big thick black face plates, cool old meters, bakelite knobs, old style switches. Ya know. We discuss installing some WE input transformers and he agrees to build it mono (monomia!) Thanks, Scott, bye.

That's the last time we spoke. He's never returned one of my many calls since. I refused to give up on him for three years, partly 'cause I thought his was the only good one made and because his had tubes, and he shared his last name with my idol Richard.

Anyway, after no returned calls for three years I broke down. It was one night again in L.A. I was at this 24 hour electronic store, "The Good Guys". It's 2 a.m., I'm with a chick buying batteries for her massager, we walk past the portable CD display. There are 70 choices and you can A/B them through head phones. The Gallo's ears pick out a Magnavox Model AZ6827C. I actually buy it. My first CD player. Got a \$200,000 collection of vintage hi-fi gear and I buy a \$200 portable CD player. It's got an adapter to play through my car cassette deck. Five minutes later, me and the chick are driving around listening to a CD in my car while she's installing the batteries in her massager. I loved it. I was skipping and back spacing and skipping. I've always hated the fastforward and rewind on cassette. This was great. The next morning first thing, I'm at five different hi-fi shops looking at CD stuff, saw it all. That night I try Nixon again, leave a message, "Scott, hi, it's Gallo. Please, I'll take any unit you got ready, please, please call me." He never calls The Gallo back, the *minchia*.

So I call up my pal Mark Lyons. My pal who looks like a cop. Best guy I know. He's my favorite cop. Also has some great hi-fi gear — he's kinda the poor man's Vinny Gallo. Mark will spend on the right piece. He's got taste. And a good wife. So we're talking CD. He gives me his famous ten year old line, "I'm not spending money on an expensive CD player." I said, "Listen you cheap bastard, you listen to CDs all the time, get rid of that bullshit Sony player and come shopping with me." "No way," he says.

Anyway, he tells me that Joe Grado, Dick Sequerra, and some other guys have discovered a \$150 CD player that blows them all away. Mike LaFevre told him about it. The

Realistic Model 3400 portable. "A portable!" I say, "I already have a portable." "Mike LaFevre says this one is supposed to be awesome," he says.

And like a retard I rush to Radio Shack to buy it. Let me remind you that Joe, Dick and Mike (sorry Mike) are all cheap penny pinchers and I'm sure they never listened to a real D/A and transport in their lives. And the real Tricky Dick, Dick Sequerra probably saw an opportunity to sell people his over priced \$500 power supply to fire up their crap machines. Thought batteries worked best but they get eaten fast so with mine I made up a power supply using a motorcycle battery and a cheap charger.

Within a week though, both my and Mark Lyons' machines were skipping. I shoulda known. It's built like a real piece of shit but

... I compared the cheap, skipping Realistic to the cheap, skipping Magnavox and the cheap, skipping Magnavox blew it away. . .

the killer punch was when Lyons and I compared the cheap, skipping Realistic to the cheap, skipping Magnavox and the cheap, skipping Magnavox blew it away. So if you want to own a smelly cheap ugly piece of shit CD player that lasts about a week, definitely get the Magnavox.

The horror of this part of the century is that people are so willing to buy the cheapest and poorest engineered and manufactured products, therefore all the new technologies never really seem exciting. And people confuse themselves by romanticizing old products that were made well without recognizing the glory and possibilities of the new technology around them. It's really not that things are not more evolved or can't be made as well, there are just fewer people who put value on these kinds of products.

For example, push button phones blow away the old rotary type, yet when rotary types were made they were made to last by the phone company and they were expensive. But there are millions of the shittiest push button type built now. They break like crazy, so in our delusion we begin to romanticize the rotaries, while purchasing the cheapest push buttons we find on sale.

Well, if we were all willing to pay for the highest quality push button type and that was all that was around, only a big asshole could possibly romanticize the rotary type.

So why do guys who are so willing to spend tons on vintage hi-fi— say \$500 for a Western Electric 300 B tube, HA HA HA! or \$10,000 for a pair of shitty sounding Marantz model 9s, or \$3500 for the winner of the overrated amp of the century award, the Mac 275 or the Marantz 7C for \$2000, man that pre-amp is so dry it's like a pair of dead chapped lips. (. . . and don't tell me about your "modified" 7C or I'll fart) —why are *they* the guys who own the cheapest shit CD players? Don't they know the way those beautiful collectibles held their value was because originally they were designed, engineered, and built on the highest level and of course they were expensive? Dick Sequerra's FM tuner was incredible and shockingly expensive, a real classic, yet we should buy a \$150 CD so he could sell us the \$500 power supply? The 3400 and the \$500 Tricky Dick power supply together will be worth a nickel by Christmas.

Once I got the cheap portable shtick out of my system, I pulled out ten copies of 'Stereo Sound', a Japanese magazine I pay \$40 each for, to get maybe 2 pages of Western Electric gear photos to squirt on. Suddenly, I'm on the floor groping, looking at all the photos of CD gear. I'm obsessed, excited and loving the future. There's pictures of all the players, converters and transports. I start talking CD to everyone, to hi end guys, tube nuts, technos, Romantics — anyone who will talk CD. I beg to borrow everything and listen to it through my Western Electric 300 B amps and several different WE horn systems. I spend six months researching. I ship things from France. I drive all the way to Chicago. I went crazy, bought, sold, bought, sold. I forced myself through piles of *Absolute Sound* and *Stereophile* reviews. I did it all. And it was tons of fun.

The whole time I would compare CDs and records either against my EMT 927 turntable arm and cartridge or a Garrard 301 with Ortofon arm and cartridge. By the way, the EMT 927 is awesome. So the CD setups had to battle against the best. The very best. I listened through push pull triodes, (Western Electric 86s), then single endeds (Western Electric 91s), then pentodes (Western Electric 124s), through Marantz 1s and direct into the amps. I even set up stereo using Western Electric 757s. Then a

pair of Western Electric 755s, then back in mono with one 757. Then my dream system, a single Western Electric 4171 bass, Western Electric 26A horn, Western Electric 594 driver and Western Electric 597 tweeter, Western Electric TA7331 baffle, a Western Electric 26A horn biamped with a Western Electric 86C, Western Electric 91A and Marantz 3 crossover.

I had my gear all wired up with the fantastic incredible sounding Kimber KCAG interconnect wire and Kimber 4AG speaker wire which blow away any other wires I've ever heard in my life. And I've heard them all. The Kimber stuff is perfect for all you triode tube freaks, incredibly smooth and detailed. That cool cat Jack King and the boys of Kimber know all about triode tubes and horns. Imagine a hi-end wire company with guys hip to tube gear. Wow! Jack King and Kimber, we love ya.

While living with CD plugged into my best system alongside the turntable of all turntables, the EMT 927, I noticed that I loved the ceremony of records, the smell, touch and beauty of them. You drop the arm down, go sit, ears cocked and listen, really listen. Oh boy do I listen, but most often to the same few records. The ones that make the system sound best. With CDs I'm a bit more liberated. I listen to music I want to hear, not just what made my system sound best. I did other things while listening, like clean the house, chat with friends. I would never chat over a record. I love the ease of skipping songs or repeating them with the remote, I can move around. I can even fall asleep with the hi-fi on. I found I was using my hi-fi much more. I could also use the CD to learn songs on guitar, it's so easy to return to a spot in a song. What kind of jerks would totally refuse owning a CD player? And isn't that like saying that you have absolutely no interest in new music? I want to be interested in new music and I don't have to throw away my old records. I can have it all. You know, my girlfriend Victoria has been banned from my system since the day she trashed the stylus off my EMT TMD 25 cartridge. But with a CD deck in the house she's back on the system.

The Mark Levinson 30.5 and 31

Let me stop here for a moment to tell you about this great chick I know. She's really nice and sweet and super smart and has a great sense of humor. She loves sex and cooks and cleans like a professional. She's great, right? Oh ya, by the way, she's 6' 9", weighs 600 pounds and has got a wonderful

case of severe acne and lovely greasy hair. Her tragic breasts look like empty hot water bottles and her teeth are a beautiful battleship gray. The Mark Levinson 30.5 and 31 are by a million miles the best looking digital hi-fi gear ever made. "So what?" you say. Listen you phonies, don't give me that looks-don't-count crap... Hi-fi is a hobby and part of the attraction to the hobby is when the gear is so good looking. The Mark Levinson CD stuff is also built like a mother _____

As far as quality and craftsmanship, comparing it to old McIntosh and Marantz gear is a joke and the joke is not on the Levinson. The Levinson is built more in the tradition of companies like General Radio and Western Electric. The 30.5 and 31 are all modern classics. The Mark Levinson digital audio gear is the best sounding CD gear I've heard. Yes, it was better than the supposedly great Denon DPSI DASI that Thomas J. Norton, a.k.a. Big Tom Brown Stain, said was so warm and wonderful. Listen Norton, if you need your digital CD stuff to warm up your hi-fi, you're in trouble. My system is already warm, all warm means with digital is colored sound. Most guys who write about digital audio equipment must have horrible sounding systems. They love the "it's so warm" line. A black man don't need no suntan.

...comparing it to old
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gear is a joke and the joke
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Yes, my loyal fans, Hi-Fi writing is just passing gas. And you know that only The Gallo can turn that kind of brown gas into the finest perfume.

OK then, I thought that the new Krell MD20 and Studio D/A are very very good sounding and very well made. If there was no such thing as Levinson, I might have bought the Krell. Unfortunately for Krell, there is the Levinson. The Levinson blew away the Goldmund Mimesis D/A and transport. My retard friend who loaned it to me has all the Goldmund gear, always has (fool). I still have never liked a thing from this overrated pretentious company, lay down and die. And the Spectral SDR 2000 is the American Goldmund. Yuck! Forget the Forsell — Forsell-forschmell. And forget the Jadis. Neither sound better than the

Levinson. They are both built for trouble, and you can't give 'em away used. Fat chance getting a quick overseas repair. Don't buy foreign computer stuff. Didn't like the Studer or the EMT but the Esoteric P2 is a great transport for you tragic smaller budget guys.

But forget all the Asian built CD stuff. As a matter of fact forget all asian-built products period. Remember companies like Nakamichi, builder of fine cassette players? Well, just five years after the production of their shocking expensive top of the line cassette units, parts were no longer available. Levinson services every single product they've sold since 1972. I'd bet my life in twenty years only Levinson owners will be able to say things like "bought that little honey CD stuff 20 years ago and it still works perfect." Funny the 30.5, 31 and 35 are sold in droves in Japan. Smart rich Japanese don't buy no Sony Panasonic digital crap.

I couldn't wait to hear the Cello/Apogee D/A converter. Too bad it was just OK. The Counterpoint D/A and transport — just OK looks, nothing special sound, and built pretty cheap. The point about Counterpoint is that there's no point in buying it. The Theta Generation V D/A sounds very good but the transport was just average. Very good + just average = just above average. Don't play matchmaker with digital gear. It's always better to use a transport and processor designed to work together. Trust me.

A used Wadia 6 is a good player if you're a cheap penny pincher. I talked my cheap penny pincher pal Mark Lyons into one, but when he got it he discovered a problem. Like his idol, me, Mark listens only in mono but D/A outputs are stereo only, they cannot be Y adapted to mono. When I ordered my Levinson I had to ask them to solve this problem for me, so they designed their first D/A mono adapter for The Gallo. It's basically a pair of resistors, simple, right?

Well, a frantic and teary eyed Mark Lyons called Wadia in a huff, talked to their technical gurus, explained his problem. A stumped fellow explained to Mark that nothing could be done. It was impossible, he said. Lyons, tears still flowing said, "But my idol Vinny Gallo bought Levinson and they made a mono adapter for him." The stumped fellow replied, "Oh great, I have a friend over at Levinson, I could call him and ask him how it's done." Wadia has got a lot of nerve making a twenty five thousand dollar D/A and transport combination if they have to call Levinson for that kind of technical help.

Plus the 7+9 combination is barely better than the 6 player. Companies like Wadia and Theta change models much too often. Their approach to model changes and upgrades is a bunch of technopolitics that gives digital audio a bad name and makes people scared to invest. They are really just correcting their own mistakes, unlike the two enduring Levinson classics.

I think that digital audio is at the point today where units like the ones from Levinson and Krell are so good sounding that if I like it so much today why should I ever dislike it? It's classic gear. Even if new things came out that sound incredible this gear will always have appeal. A lot of the gear I listened to sounded at least pretty good. I could have lived with several. I just liked the whole Levinson package best. You should see the lid open on that transport! Even the less expensive 35 sounded incredible. It's so great to have both the best CD player and record player in the house. I'm very lucky (. . . lucky my ass, I'm Vinny Gallo).

Great records are great records. I like them most but great CD can crush bad vinyl. Anyway, they are different and for different things. CD is a miracle and should be very celebrated. Come on you children of the tired hippies, let's celebrate the new again and still dig our old. My thrilling CD

experience got me to even buy a laptop computer now. I can't believe I lived without one.

I had been buying used vintage hi-fi things for so long it was tons of fun opening the boxes of my Levinson stuff, even their packing is incredible.

I can't believe I have something under warranty, oh my god, 5 years with the Levinson. Now I can kick back and really enjoy the music, just like the people with cheap boom boxes. Before, I was too busy tracking down gear or begging asshole technicians on my hands and knees to take time out from their ego maniac amp designs to fix my gear. Good-bye to incompetent technicians like that inbred Eric, author of the novel "1000 Ways to Tell a Lie," or that hi tech electronics abortionist Nick the rip-off master gimp from N.Y., not to mention wacko Rick Nasty-as-they-come from NJ. Man, I got 5 years from Levinson and it feels good. The last guy to fix something for me was Joe Roberts. I sent him my mintest Western Electric 91 via Priority Fedex. Took him 3 years to finally open the box. If it were Levinson gear, at least I would have still had 2 years left on the warranty.

By the way, I finally heard the Scott Nixon tube unit with his TEAC-based transport, borrowed it. Sounded like an over tubed

Realistic. Tubes just color digital audio period but his solid state piece Model TX-ATAX is pretty good. Solid state gear has finally come into its own with digital audio. Scott Nixon sure is a very bright and clever guy, a genius technician and engineer. But Madrigal Audio labs, a.k.a. Mark Levinson, has about 18 genius technical people working there. I even went up to the factory to tell 'em that they done good.

Everyone at Madrigal was super cool and together, the place was phenomenal, not a sour puss in the joint. I got to meet the guy who does all the cosmetic design (I am a fan) plus I got to see where all the metal work, anodizing and engraving is done. The guru who is in charge of that department is a god. It's the best metal work I've seen anywhere. Even the packing and shipping guys were super efficient and organized, not your usual warehouse clowns.

I also met some cool older ladies putting together circuit boards and soldering like they were at a veteran needlepoint convention. It reminded me of those old black and white Western Electric factory photos only these girls were soldering with the help of computers!

Super nice guy Martin French, Madrigal's domestic sales coordinator who invited me in for a visit, spent hours and hours with me, showing me every part of the whole joint while I pumped him with a million questions and even begged him to describe the last day Mark Levinson was actually there. I also loved meeting my hero technician, the guy who solved my adapter problem by building me a stereo mono box adapter using some Madrigal RCA jacks mounted on a cool vintage hammertone bud box. The guy's work is perfect, I mean OK, it's just a little mono box, but it's beautifully done. I should be so lucky to have him repairing my Western Electric gear.

But the best thing about the Levinson is that it's brand spankin' new without cigarette smoke stains from the projection booth. I didn't have to buy it sight unseen over the phone from one of those lying and cheating audiomart small time charlies. It's not rare and irreplaceable and it's not unfixable. I'm not changing no caps inside the thing, instead I'm home on my ass laughing and listening to music.

Hi-end Audio does have a future and Future Boy will be there.



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The Jura Pharmacy is listening to 300B SE-Amps...

Casual Reactions

by Herb Reichert, Eddy Electric



AUDIO ELECTRONICS SUPPLY SE-1 STEREO SINGLE ENDED AMP KIT

I must say up front that I am not a reviewer by nature. A critic, yes . . . aren't we all? Reviewing always seemed too pedantic to me. Besides, who wants to become a geisha for two-bit industrialists? Beauty, drama, and high level sentiment are far more exciting to write about than the contents of popcorn stuffed boxes. The guys who review for a living have a hard time just unboxing another CD player or DAC. They are probably down before they plug it in or read the manual.

Really, what can you say? It improved MY system? It made it worse? I never heard anyone say "I put the new Super-X in my system and there was *no* change." When I put a new piece of equipment in my system, I am hoping that I will discover some new level of excitement and escape in the privacy of my home. I am hoping that the system will become more enticing and that I will look forward even more to putting a record on. I go to that place between the speakers for escape, fantasy, enlightenment and inspiration. I always hope the new component, especially when I designed it myself, will kick up the intensity level of the listening experience.

However, I promised the editor that I would give the readership some clue as to what to expect if they bought the Audio Electronic Supply SE-1 stereo single-ended 300B amplifier kit. The kit costs only \$549 without tubes and \$899 with Cetron 300B tubes. At this price, ANYBODY would wonder how it sounds. After all, Shindo sells his 300B single for almost \$10,000. L'Audiophile in Paris gets \$7000 for theirs, and my own Copper Edition 300B is \$5300. Everybody wants to know what, if anything, the big buck amps have on this Adcom-priced directly heated triode amp.

Let me start by saying that what you give up or what you get with this amp or the Audio Note Kit One is directly related to what you have for speakers. Anyone who is contemplating building or buying a single ended triode amp must understand that a SE amp sans feedback *will have a high output impedance*. Additionally, it seems that people are so afraid of losing a couple of watts or burning up a rare or expensive tube that they are using low turns ratio outputs and low plate voltages and low currents. All this adds up to output impedances on the order of 3-5 ohms! With this kind of output Z, power transfer into most kinds of speakers will be anything but linear. Back EMF from the speaker voice coil will not be "absorbed" completely by the amp output stage and "ringing" will result. In other words, the speaker will be poorly damped. Therefore, unless you have a speaker with a benign impedance curve and simple first order crossover (better yet, none at all), you can count on soft, woofy, distorted and indecisive reproduction.

The Western Electric 300A/B has a plate dissipation of 40 Watts. The AES SE-1 uses fixed bias (-67V) and low plate voltage (337V) for a plate dissipation of 23 Watts. This is where it seems many home and professional designers are operating their tubes. They are using 3K primary windings to accommodate this operating point. I would suggest a less fearful approach: try 425V plate voltage, 80 mA plate current, and 5K primary Z. This is still only 34 W dissipation but the output Z is lower and the sound is fast and tight into a few more loads. Triode lovers should have NO FEAR. Triodes can take it.

Operating points aside, with the right speaker, this almost-free SE 300B amp can deliver most of the beauty of the big buck amps. I tried the SE-1 on every speaker I could find and one trait could never hide: the bass was soft. On both small two-ways like the Audio Note AN-K and big full range horns by Altec and Electro-Voice, the bass was a bit on the puffy side. Big deal. The bass is somewhat soft and puffy on almost all tube amps. When you don't use negative feedback (the SE-1 has no feedback), you must forget about really tight bass. With 7 watts, low current, and high output Z, there isn't a speaker out there that can save you in the low end.

On the other hand, the midrange beauty and the gentle but forward highs couldn't hide either. No amp plays all ten octaves perfectly and the SE-1 is no exception. It's strengths are definitely found above 150 Hz.

I measured an output Z of 4.2 ohms at 40 Hz and 10 KHz. Those are the frequency ranges where most speakers present low impedances, very often below 4 ohms. Baaad! Evil! Damping factors of less than one make us sad and despondent. This is why "they" invented feedback. It is really too bad that feedback is such a fun killer because it sure makes some things easier.

I can hear your wheels turning as I type: "These guys should not be so dogmatic about no feedback. Why not just throw in a few dB of NFB to lower the distortion and output Z?" That's exactly what I was thinking. In fact I was about to give it a try when I measured the input sensitivity at 1.3V for full output (8W). Adding even 3 dB of NFB would bring the sensitivity down to 1.8V and 6 dB would get us over 2.5V. This is too low for my system and too low to use with a CD player direct in. So let me get off this low output Z stuff (for a while) and get to the good stuff. Didn't I say that reviewing was pedantic?

So now that I have convinced you not to drive your WATTs with the SE-1s, I am going to tell you about a few speakers that it drives very well. The first speaker I tried with this amp was the good old Western Electric 755. Presentation was a pinch mellow but very very charming. The old Frank, Nat, and Julie trio was completely seductive. Jazz material was transparent, quick, and harmonically rich. I still recommend a 2A3 push-pull amp with this speaker, but I believe many readers would be very happy with the 755/SE-1 combo. This speaker showcases the amp's strong points and minimizes its weak points.

The Audio Note AN-Ks, smallish two ways with outstanding mid-band coherence, worked very well and played at generous SPLs with the SE-1. These amps clip *very* gracefully but when they are pushed too hard, the frequency extremes began to become a bit distracting. I personally can listen around this kind of thing and I usually do. Recovery of hall sound, reverberation, and ambient information, precise location of players, musical body, and authenti-

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cally scaled soundstages can be expensive qualities to come by. They are luxury stimuli. However, you can get them with the SE-1 without a trust fund. Using the SE-1 above 150 Hz and a high quality push pull amp to drive the bottom should get you into the jet set audio club on a budget.

This amp has a near world class mid, upper mid, and lower highs. I have never heard this much beauty in this range for anywhere near this price. However, triodemia requires strong will and good taste. The SE-1 owner must choose his speaker wisely. The amp played the BLISS system (see SP 2:1) full range with plenty of power and the beauty level was such that I could listen entranced. However, the SE-1's flaws were very obvious on this setup. I mentioned the bass and the output impedance, but the biggest problem shows up very clearly on the scope: slew limiting! This thing just doesn't get the leading edge of transients. This soft attack is offset by the amount of overtone structure it appears to present. Now remember, the reason we all sold our 5K\$\$\$ solid state amps is that we wanted to recover harmonic structures that we felt were missing. So we should be kind, but the leading edge is where the excitement lives.

First thing I discovered in bench testing — listen up all you tweaks, modifiers, and never leave good enough aloners — the output trans are very good. Full power bandwidth was 1 dB down at 20 Hz and 3 dB down at 28 KHz. Phase shift below 100 Hz was very well controlled. Ultrasonic behavior was also good with no sharp peaks or obvious ringing.

The next best thing I saw on the bench was the overload character this amp demonstrated: Gentle, symmetrical, and deep. This amp is like the Duracell bunny; it just keeps going and going. There is plenty of A2 voltage beyond the 8 Watts I measured at clipping. You don't want to know what some of this voltage looks like but its there if the Melvins or Biohazard need it.

Honestly folks, the SE-1 tests about as good as can be expected. This kind of amp is designed for beauty of sound rather than good bench results. I personally spent more than two years listening to a 300B single with an almost identical driver stage. It was a monoblock design with Tango iron and Black Gate caps. It sounded pretty much the same as the SE-1. I recognized its faults but kept it in my system because it just played all my records. Then I came home

from work one day and wanted more excitement. . . and so the story goes.

I saved the best news for last (we are near the end, right?) The last setup I tried the SE-1 in was the big winner. Remember how much I liked the Edgar mid-horn with the D-54? In the BLISS system set up for biamping, the SE-1 drove the Edgarhorn/PR-120 combo to perhaps 80 or 90% of the quality level of my own Silver Single. Maybe even better, if you correct for author-bias effects! Either way the Reichert amp has \$2500 worth of Tango, Black Gate, Kimber Silver, and Audio Note silver caps. So what do you want me to say, that this \$900 amp beats the best that I have heard? Maybe it does. Next issue I will tell you about the Audio Note Kit One, another 300B SE stereo amp. In the meantime, try the SE-1 with the Altec 601 or 604 coaxials, the Goodmans Axiom 80, the JBL LE-8T, the Focal 7V, or ????? Sweet dreams.

Manufacturer's Comment— Audio Electronic Supply

One can just imagine the astonishment a designer and manufacturer would feel when one of his designs (i.e., babies) is about to come under the eye of a dispassionate competitor. I must admit that when I received a call from Herb Reichert with a request to review the SE-1, it was like a bolt out of the blue. I mean, Herb designs and manufactures his own 300B amplifier. . . that guy is a competitor!

As my mind went into that state of momentary apprehension, shouting inaudible words like vulnerability, conjecture, and mistrust, out of my mouth came phlegmatic, cool, and composed words. I came to realize that I am not building castles in the air — the SE-1 is a real-world amplifier and deserves to come under ethical examination by another talented designer.

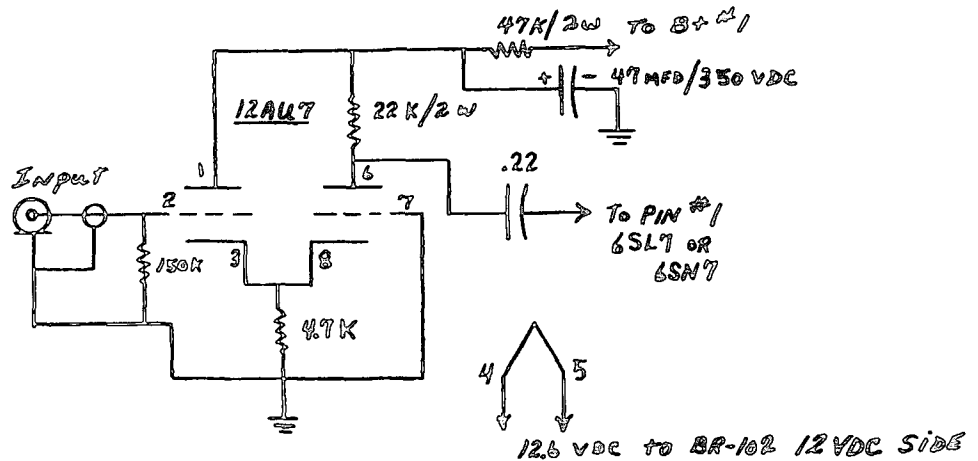
After reading the review, I am honored and pleased that Herb Reichert gave Audio Electronic Supply the opportunity to share his critical assessment of the SE-1. It put a smile on my face. I must say that the joy of reading about one of my designs goes beyond the SE-1 itself. The true pleasure came with the knowledge that the audio community is being informed and educated about the incredible merits of listening to music through single ended triode vacuum tube amplifiers.

First and foremost, the SE-1 was brought to market to offer an accessible entry to the glorious, sensuous music reproduction of single ended triode audio. As with any product, there are strengths and some weaknesses. The price class of the SE-1 is certainly a salute to the single ended triode movement. Second,

the SE-1 is FUN. FUN to listen to, FUN to build, and FUN to tweak and modify.

In response to Herb's comments I developed a circuit to boost the input sensitivity of the SE-1. I call this a pre-driver. The addition of this buffered grounded grid amplifier circuit will present the user with a number of options:

- Add pre-driver stage and increase the input sensitivity of the SE-1 to 350 mV drive for full output.
- Replace the ground lead from pin #7 of the 12AU7 (grid) with a 1K 1/2 watt resistor to ground. Add a 22K 1/2 W resistor from the positive speaker output to pin #7 of the 12AU7. This will yield 3 dB of global feedback. (I never dreamed that I would instruct the world on how to add feedback to one of my SE triode designs!)
- Add the pre-driver stage and remove the 500mF/2mF AC bypass cap combination on the cathode of the 6SL7. This will add current feedback to the 6SL7 and still yield a 750 mV input sensitivity for full output.



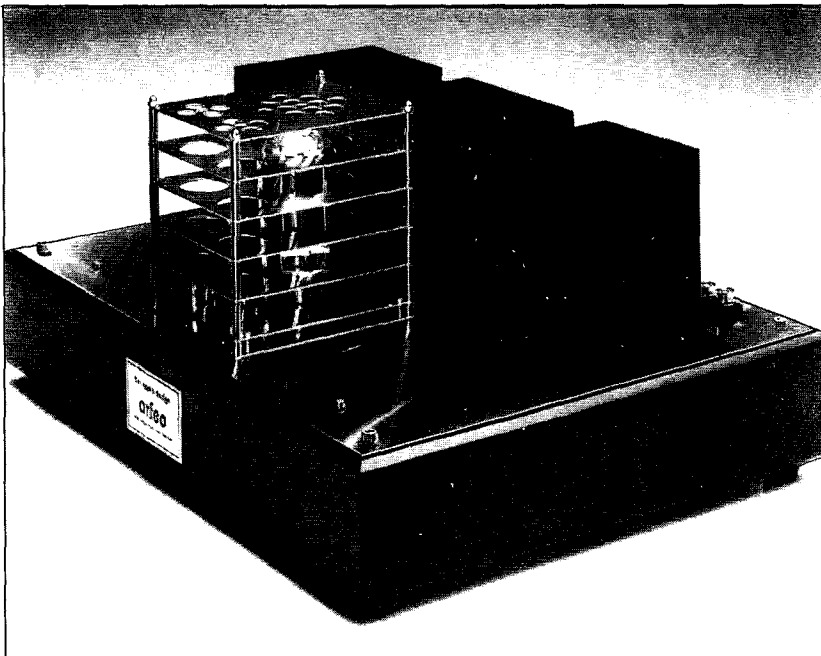
SE-1 Pre-driver Stage

DTH 8-15-94

- Here is the best option of all, in my opinion: add the 12AU7 pre-driver with the grid directly grounded (pin #7 to ground, no feedback) Remove the AC bypass caps from pin #3 (cathode) of the 6SL7. Change to a 6SN7 low mu driver tube in place of the existing 6SL7 SRPP driver.

The last option simply sounds explosive. The 12AU7 circuit provides the front-end gain

required for the lower gain 6SN7 low mu triode. The plate resistance of a 6SL7 is on the order of 44,000 ohms as compared with 6700 ohms for the 6SN7. With the cathode current feedback and a much lower plate resistance, the 6SN7 delivers drive in spades to the grid of the 300B. The input sensitivity of an SE-1 with option D is 1.3 V for full output — adequate sensitivity for CD players direct in. Most active preamplifiers will have tons of drive for this circuit.



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Let's take a closer look at the pre-driver circuit. The first section of the 12AU7 is a simple cathode follower buffer, direct coupled to the cathode of the second section. The second section acts as a linear grounded grid non-inverting amplifier. In fact, the entire stage is non-inverting. This circuit can be useful in many applications. The AES AE-1 pre-amplifier utilizes this arrangement for the input and gain section with a few changes. Direct couple the plate of the second section to the grid of another follower-buffer stage and you have the makings of a respectable pre-amplifier. Another good use for this straightforward buffer/grounded grid pre-driver is as an amplifier for low output moving coil cartridges.

The mechanical placement of the two 12AU7 tubes on the SE-1 chassis is very convenient. Use a 1/2" hole punch (Greenlee or similar) and center the holes on the same lines as the 6SL7s. The center of the hole for the new 9 pin socket should be 1.5" out from the center of the existing 6SL7 socket.

I would love to hear from folks about various modifications for the AES SE-1 single ended amplifier. This guy is perfect for the avid homebrewer with an appetite for experimentation and tweaking.

Dennis J. Had
Chief Tube Polisher
Audio Electronic Supply



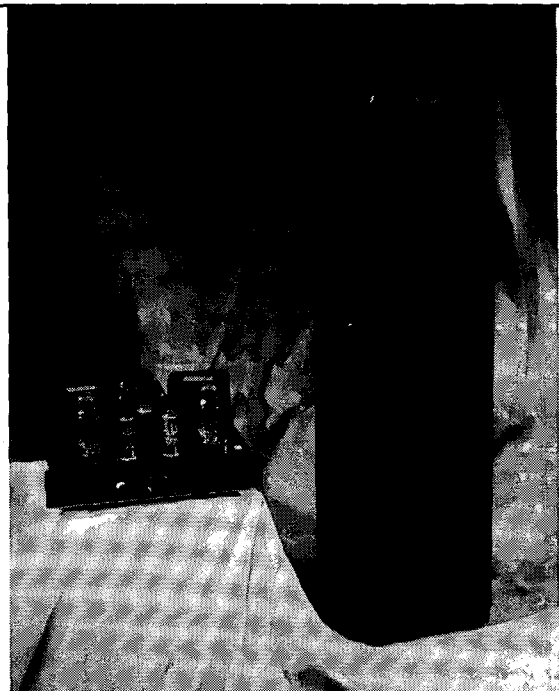
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Development of a 211 Amplifier

Part 2: Shunt Regulator Concepts

John Camille, Chimera Labs

SHUNT REGULATOR OVERVIEW

Many thanks to all the *SP* readers who wrote or called in response to the first installment in this series published in *SP* #4. Since the publication of that article, we have been overwhelmed with questions regarding shunt regulator implementation in our 211 amplifier. By way of response to these queries, I decided to pull the shunt regulator discussion forward to this installment.

Our decision to experiment with shunt regulators began with a hunch rather than a calculated rationale. Marsh in *TAA* [3/83, 1/88] found that shunt regulators sound better than series pass regulators. His work focused on low voltage transistor amplifiers but it seemed to us that the concept held promise for high voltage tube circuits.

In loose terms, the theory is that shunt regulators can both source and sink signal current whereas a series pass element can only source supply current. When properly applied, a shunt regulator should have the same impedance, hence equal slew rate, for both positive and negative slopes of the signal. A primary design goal for this regulator was to make it very much faster than the regulated circuit. Consequently, slew rate limitations become a non-issue and improvements in the transient response of the entire system are realized.

Our shunt regulator is optimized for AC response in the pass band that extends one decade outside the audio pass band, i.e. 2 Hz to 200kHz. This extended pass band allows for excellent square wave response for audio band signals. In other words, transient response is more than adequate for the relatively slow audio signal repertoire.

DC response is relatively slow as dictated by the long time constants within the servo loop.

Long term DC voltage drift is several volts (< 1%) as dictated by the thermal characteristics of the reference diode and the voltage divider components. Since DC plate voltage drifts of 10% or so are permissible, the regulator circuit is more than adequate in this respect. The overriding requirement for this device is to provide a low AC impedance (AC short), not to provide a DC voltage standard. Thus, the term "regulator" is somewhat misleading in light of its primary function. The term "Nifty Electronic Audio Terminator" and the resulting acronym might be more appropriate.

One critical benefit of the shunt regulator topology is that it provides an extremely clean ground return path for the signal. This is crucial in single ended amplifiers where the entire signal return path runs through the power

source and associated filter and bypass capacitors. The shunt regulator essentially places a short circuit for AC across the circuit with several immediate advantages:

1 — Unlike enormous bypass caps, the regulator presents a constant, low impedance across the audio pass band. Phase shift is a constant at all frequencies and all of the signal developed by the regulated circuit appears across the load.

2 — Power supply crud is shorted to ground, enhancing signal purity.

3 — Coloration of the signal by power supply components is reduced to a minimum. The effect is better than bypassing with thousands of microfarads of teflon quality capacitors.

4 — Above all, the return path, aside from being "short and sweet", is controllable. The "sneak" return paths found in series regulators are also eliminated.

Basically, the signal return path through the shunt regulator tube is about as clean as you can make it. Trace the ground return path through your favorite series pass regulator in comparison and you will see what I mean!

THEORY OF OPERATION

Figure 1 depicts a rudimentary form of shunt regulator for a tube load. The shunt regulator element in this instance is a rheostat placed in parallel with the load. If the rheostat is adjusted so that the resistance is equal to that of the tube, in this case 20K, the two parallel resistances combine to form a 10K DC

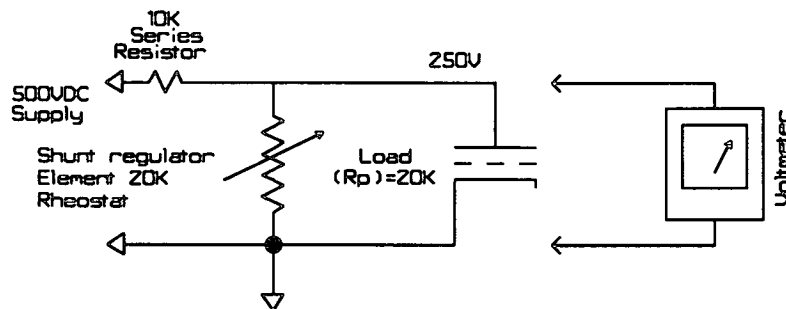


Fig 1 — Concept of a "mechanical" shunt regulator

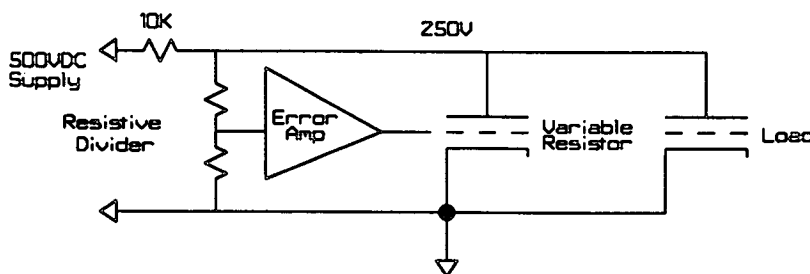
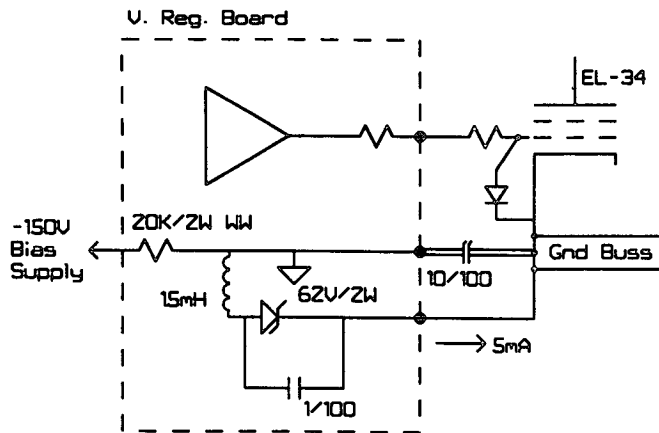


Fig 2 — Simplified electronic shunt regulator

Fig 4 — Revised bias arrangement.



the plate of the mu-follower. If zero lead length is not possible for this capacitor, use 11.5 ga. Cardas wire or a 1/4" copper strap.

CIRCUIT DESCRIPTION

The 2500 ohm series resistor provides the voltage drop for the shunt regulator to "work against." It becomes a 40 mA current source as it drops 100 VDC below the 650V supply.

The voltage divider provides approx. 2.5 VDC to the error input of the OP17 (pin 3) through a 100k resistor. The 100k resistor isolates the DC and AC feedback paths such that the AC feedback is almost unity down to about 3 Hz. Otherwise, the AC feedback would be shorted through the low resistance between the volt adjustment pot wiper and ground. The 1 uF/100K combination plus the 1 meg divider resistor provides a very long time constant integrator for the DC feedback path.

The AC feedback capacitor (C1) transmits voltage variations at the mu-follower plate directly to the non-inverting input of the op amp through the protective 1k resistor. This error voltage is amplified 1000 times by the op-amp and applied to the EL-34 grid through a protective network. The error voltage is further amplified by the EL-34 which has a gain of about 10.

The theoretical dynamic resistance of this system should be around the plate resistance of the EL-34 divided by the system AC gain of around 10,000. Actual resistance measures about 0.38 ohms. This number is more meaningful in practical terms when you consider that it is equivalent to a bypass cap of over 40,000 uF at 10 Hz!

The LT 1004-2.5 provides a precision 2.5 V reference for the system. Diodes D1, D2, and D3 provide HV fault protection for the op-amp. The 62V zener provides grid bias for the EL-34. Capacitor C2 rolls the system off to prevent high frequency oscillation.

During full power operation (150V p-p), the error hunt band plus noise of the system is less than 250 uV, measured at the mu-follower plate. The error voltage to the EL-34 grid is approximately 250 mV peak-to-peak. This error voltage waveshape should be the inverse of the mu-follower's output signal plus a large component of noise and possible 60/120 Hz hum.

REGULATOR ENHANCEMENTS

Various changes to the shunt regulator evolved during listening tests. When we decided to go "whole hog" with the 211 output regulator, it was necessary to float the error amplifier so that the 211 regulator filament could be tied directly to the 211 amplifier filament. Thus, the error amplifier board (ground plane) was floated at the nominal grid bias for the regulator tube involved. The EL-34 based regulator for the input stage was also changed to a floating configuration.

When we tied the EL-34 cathode directly to the ground buss, a detectable improvement in sonics occurred. We attributed this effect to the removal of the 62 V zener from the signal return path. The revised bias arrangement is shown in Figure 4.

The 211 HV shunt regulator circuit uses the same topology. The voltage divider and the AC feedback capacitor must be sized for the increased plate voltage and the 62 V zener which provides bias voltage must be increased to 75V.

MOSFET REGULATOR

The MOSFET is well suited to shunt regulator service. Performance is sonically the same as the triode version while dynamic impedance can be made slightly lower than the tubed version. The major problem, however, is calming the circuit down. VHF RF wiring and layout techniques are mandatory to prevent parasitic oscillations at frequencies up to several hundred MHz. A fast 100 MHz or better scope will probably be needed to "debug" the circuit. Zero lead length layout technique on a ground plane is the best way to go.

The MOSFET regulator is slightly quieter than the tubed version since the error amp can be placed at ground potential. Gate voltage swing is only a few millivolts around the 3.5 to 4 Volt quiescent gate bias level. Leave room for a fair sized heatsink if you're thinking of installing the MOSFET version of this regulator.

The voltage divider network for the MOSFET regulator has been upgraded from the brute force network shown in the tubed version. The new version is a knock-off of a scope probe that permits the use of much smaller HV caps. The 211 amp can then use a short piece of teflon coax as the HV cap (C1), using the inner lead as the HV lead and the shield as the LV lead. Thus, a wonderfully cheap, high quality cap is created. Near perfect compensation can be obtained by sliding the shield along the inner conductor to find the exact value for good square wave response, then cutting the cable to this length.

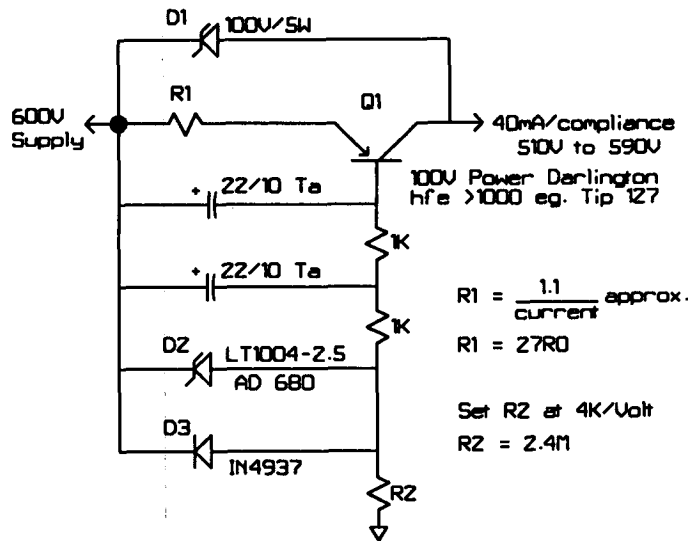
The Collmer 2SK951 (Allied # 925-0930) is rugged and dirt cheap at \$1.67 and it is tailor made for this application. One of these devices withstood every imaginable abuse during prototyping and debugging experiments. Overall, this fine part is a welcome departure from my usual experience with high voltages and "three-legged fuses".

Many types of reasonably priced surplus "switcher" MOSFETs are available for lower voltage supplies. The beauty of the MOSFET is that the gate bias is always around 4 Volts — ideal for op-amp drive to virtually any power MOSFET available.

CONSTANT CURRENT FEED

The series dropping resistor (2500 ohms in Fig. 3) may be replaced with a constant current source (CCS). This change provides much greater isolation between the regulated stage and power supply nasties. Equivalent series resistance can be made to equal several tens of thousands of ohms.

Fig 5 — Universal Constant Current Source



voltage variations are minimal. The lower voltage drop eases heat sink requirements considerably.

It is a definite advantage to use soft-start techniques with this circuit. Otherwise, the pass transistor's hold-off voltage must be equivalent to the voltage input (i.e., at least 600V in fig. 5) because the full power supply output voltage will appear across the pass transistor at turn-on before the down side capacitors are charged. Unfortunately, high-voltage transistors with suitable gain (hfe) are very costly and hard to find, therefore a soft-started power supply becomes even more attractive. A complete soft-start circuit can be assembled for less than \$20 with surplus parts and it will more than double the life of all the amplifier components, including tubes. Soft-start is the way to fly.

Voltage drop across the CCS can also be made much smaller as appropriate for line voltage variations. The 211 amp is being designed with an export market in mind so line voltage variations of 110 V to 130 V must be accommodated. This 18% variation in line voltage translates to a variation of over 100 V in the HV supply to the regulated stage. Therefore,

the 211 CCS must be capable of holding off the voltage variation and it must be heat-sinked in order to withstand maximum line voltage input, i.e. 130 VAC.

The CCS itself needs only a few volts to function properly. Therefore, a voltage drop of 10 to 20 Volts across the circuit is feasible if line

A universal high-side constant current source is depicted in Figure 5. It will work with voltage differentials between 10 and 100 V. The current capability is determined primarily by the heatsink provided. When the bias resistor R2 is sized at 4 Kohms per Volt, base drive starvation will occur at somewhere between 0.25A and 1A, depending on the hfe of Q1.

NOTES:

- 1) R1 = approx. 1KΩ/Voutput (Caddock MK).
- 2) The ratio of C1/C2 should be slightly greater than the ratio of $\frac{2.5k}{R1} \rightarrow \frac{C1}{C2} \geq \frac{2.5k}{R1}$. This overcompensation insures highest speed without using a variable capacitor for perfect compensation.
- 3) Parasitic suppression resistors must be soldered to the MOSFET leads where they exit the case. Resistor lead length must be zero. Watch ESD, etc.
- 4) Lower voltage MOSFETs may be used for lower volt supplies.

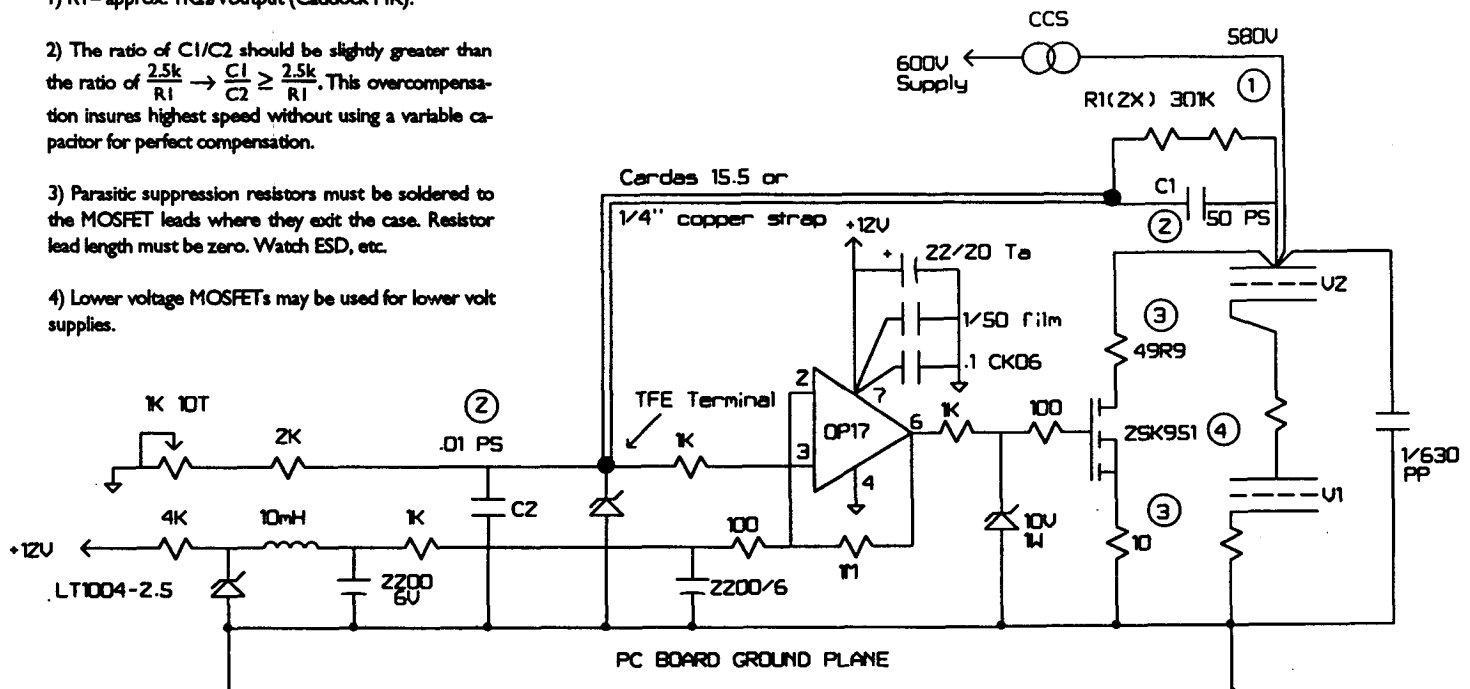


Fig 6 — MOSFET Shunt Regulator

The current set point of the pass transistor is determined by varying the value of R1 according to the approximate formula:

$$R = \frac{V_{ref} - 2 \text{ diode drops (w/darl. pr.)}}{\text{Desired } I_0}$$

For our example—

2.5 - 1.4 / 0.04 or 27.5 ohms @44 mW
(use 27R0 / 0.25 W).

Exact current settings may be established by paralleling a 500 ohm ten-turn trim pot with a suitable fixed resistor, 30.1 ohms in the above case.

This CCS has several additional complexities rarely seen in typical power supplies. Diodes D1 and D3 are protective devices for various fault conditions. The RC filter between the zener reference and Q1's base attenuates zener noise that would otherwise be amplified by Q1. The slight decrease in dynamic performance caused by this filter is more than compensated for by the 15 to 20 dBV decrease in noise.

POSTSCRIPT

Based on our listening experiences, we are beginning to feel that the quest for higher power may be misdirected in this niche of the audio

realm. Several times we put a scope across the output of the 211 amps while visitors auditioned their music of choice. Edgar horns (106 dB/m SPL) and other experimental tractrix horns (100-106 dB/m SPL) were used in a theater size room. We found that "normal" listening levels rarely required peak output levels over 400 mV p-p into 8 ohms. One associate, the leader of a rock group, preferred to listen to his CDs at about 4V p-p, well over my pain level threshold.

These voltage measurements translate into *peak* output power levels in the 5 mW to 500 mW range. Therefore, a half watt of power provides eminently listenable sound with the kind of horn systems we have been using. Extrapolating from this data, speaker systems with sensitivities in the 88-90 dB/m SPL can be powered with a 211 amplifier with reasonable overhead.

Several low efficiency speakers and ESL systems were auditioned with our 211 amplifier with mixed results in our room. Although the speakers could be driven into break-up, their output was lost in the theater sized listening space. Yes indeed, highly tweaked industrial horns and modern tractrix horn systems can definitely spoil you with their dynamics. When

your system is set up in a theater, horns are the only way to go.

Several listeners have remarked that the 211 amplifier is "too accurate". Poor recording techniques, artifacts of the cheap ICs used in the recording chain, and noise in general are more readily apparent than on their home systems. We believe that many nuances not audible on a typical system with a dynamic range of 60 to 70 dBV are revealed when the dynamic range is increased to 90-100 dBV. Most folks relish the difference immediately, some take a while to adapt, and some will never adapt!

High efficiency horn aficionados are particularly impressed with the dynamics of the system. With such speakers, the 100 dBV dynamic range of the amplifier can be most effectively put to use. The 20 or 30 dBV increase in dynamic range gained through a very low noise floor is vividly apparent through a good horn system

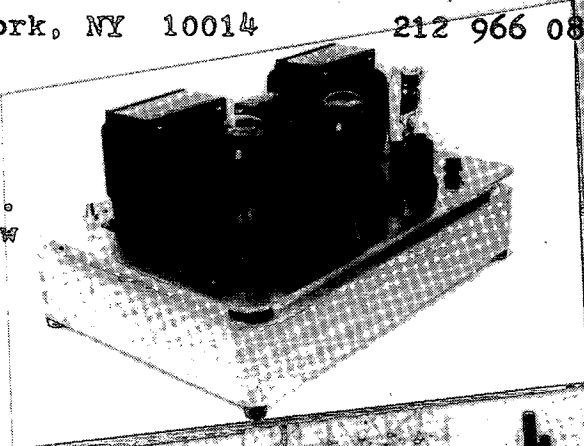
We obtained this very low noise floor by going to extremes in providing extremely pure DC to the tube elements in the 211 amplifier. We will explore noise reduction techniques in general, and diode hash removal in particular in future installments of this series.

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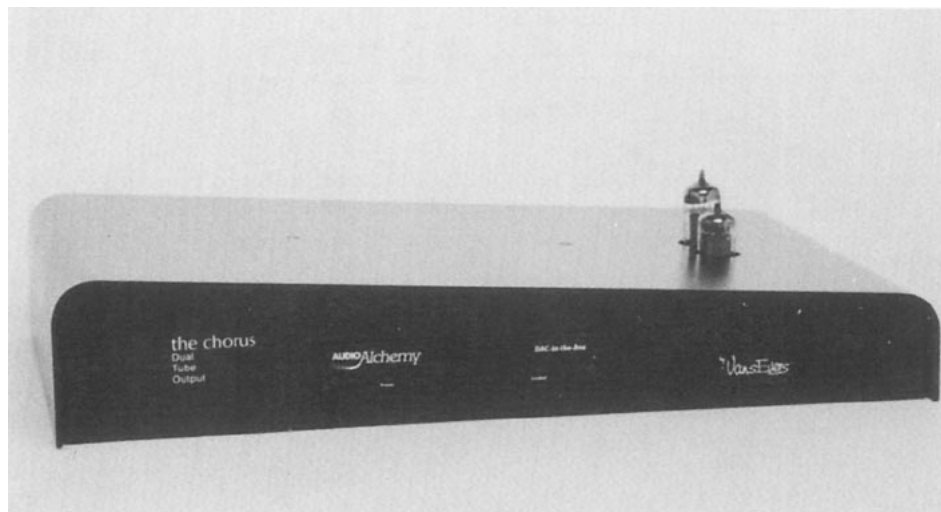
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A



THE CHORUS

A multivocal tube output stage
for your "DAC In The Box"



by Mike Vans Evers

The Chorus is a vacuum-tube output stage conceived as part of a project to upgrade the Audio Alchemy DAC-in-the-box (DITB). There are nearly 15,000 units of this famed budget king DAC in existence which makes it an attractive candidate for a modification.

The sound of the DITB is extraordinary considering its price. Hundreds of hours of development time were spent making the most of the inherent resolution of the DITB and sonic flexibility of the Chorus output stage. I have been working on this project with Don Hillebrand of Wavetrace Technologies. Don worked with Stan Warren on the solid state mods while yours truly handled the tubes. The photo shows a complete Chorus/DITB as available through Wavetrace Technologies.

Wavetrace Technologies (Don Hillebrand) has been doing mods to Audio Alchemy products like the DDE for about two years. Modifying new equipment usually voids the warranty. When Don modifies Audio Alchemy products the warranty remains in effect — a good reason to let Don do the mods, and what I recommend also.

I consider this project to be unique in that special techniques for adjusting the tonality of the final product are employed in the design and a few are available for adjustment by the end user. Most designs address only a few of the areas affecting tonality. This design takes a slightly different approach to the Audio Energy Paths (AEP) that exist in audio equipment. These energy paths are both electrical and mechanical. As I see it, these energy paths have natural groupings: #1 Signal Path, #2 Power Supplies, and #3 Structural Resonances.

In this article, I will share the circuit for the Chorus output stage. It is ideally suited for the DITB but it can also be adapted to a multitude of purposes where a unity gain buffer is required. I will also discuss a few other aspects of the design that deal with AEPs and affect tonality.

A few definitions are necessary in order to follow the text:

Audio Energy Path (AEP): All mechanical or electrical energy entering or leaving a device used for recording or reproducing music does so along a conduit or path. These paths can be electrical (through wire, bus bars, etc.), or mechanical (transferred through the chassis, feet, etc.).

Transient Impedance: Music is a series of repetitive transient energy variations. The resulting frequency dependent variations in current are audibly affected not only by standard yardsticks (resistance, capacitance, inductance), but by some other quality. I am going to call this quality, which affects tonality but not frequency response, "transient impedance." If you don't like my term, make up your own. One example firmly establishes the existence of this elusive quality, at least in my mind: production models *do not* sound like the prototype did!

Listening Skill: Some differences in any two like items, of musical nature or not, won't be discernible except to experienced listeners (tasters, drivers, players, etc.). Hearing a difference but not realizing its significance usually translates into *not* hearing a difference. Learning how to recognize differences in two components is a function of training, experience, and desire. Listening skills can be limited by bias. Those people who "know" without experience may never learn.

AEP #1: The Signal Path

The Chorus Tube Output Stage

"Voicing" a product often takes a manufacturer as much or more time than does its basic engineering. The Chorus is a unique output stage with many "voices" designed to be user-friendly. There are two sockets for twin triodes on the Chorus and they are wired so that one section of each tube is in each channel. You can plug around 70 different tube types from a wide variety of manufacturers into the Chorus and explore an amazing number of combinations. Each combination produces its own voice, the sound being dependent on the type and manufacturer of the tubes in play.

Because of an additional design feature, the position of the two tubes is important. Swap the position of the tubes front-to-back and you have yet another voice. So if you have three tubes on hand, instead of only three combinations, you get six! I recommend that you use both sockets, but the "purist" can choose to use only one tube. If you count in the two possibilities per single tube, a collection of three tubes gives you 12 different voices. Rather than insisting on a "one size rarely fits all" sound, this unity gain output buffer has many possibilities.

No strange biasing schemes are used for this unusual cathode follower, just an ordinary self-bias resistor. This output stage is composed of two dual-triodes, with a half-

section of each tube in each channel. The two dual triodes used can be identical or completely dissimilar, e.g., a Telefunken smooth plate 12AX7 and a Chinese 12BH7.

My current favorite tubes include 12AT7s, 12AU7s, and 12AX7s and 5965, 6414, or 12BH7s. In my system, I use a lower current tube, often a Gold Dragon 12AX7, in the back position and a higher current tube in the front position. Tubes made in China are often brighter, relatively speaking, than tubes made in other countries. As a general rule, 12AU7s have more weight in the bottom end than 12AT7s and 12AX7s. If the harmonic balance of a system is lightweight, I'll usually start with a higher current tube in the back position, say a 12AU7, and use a 12AX7/AT7 in the front position. For overly detailed systems, try to avoid using tubes from China and use higher current types (5965, 6414, 12AU7, 12BH7, etc.), especially in the front position.

Some suitable tubes for use in the Chorus

Common types Not so common types

12AT7 / ECC81	12AV7/5965
6201, 6679, 7728	12FV7
	6211
12AU7(A) / ECC82	6414
E82CC, ECC802/S,	6829/E180CC
5814, 5963, 6067,	12AD7
6189, 6680, 7318,	12AZ7
7730	12BZ7
	12DF7
12AX7(A) / ECC83	12DM7
5721, 5751, 6057,	12DT7
6681, 7025, 7729	12FQ7

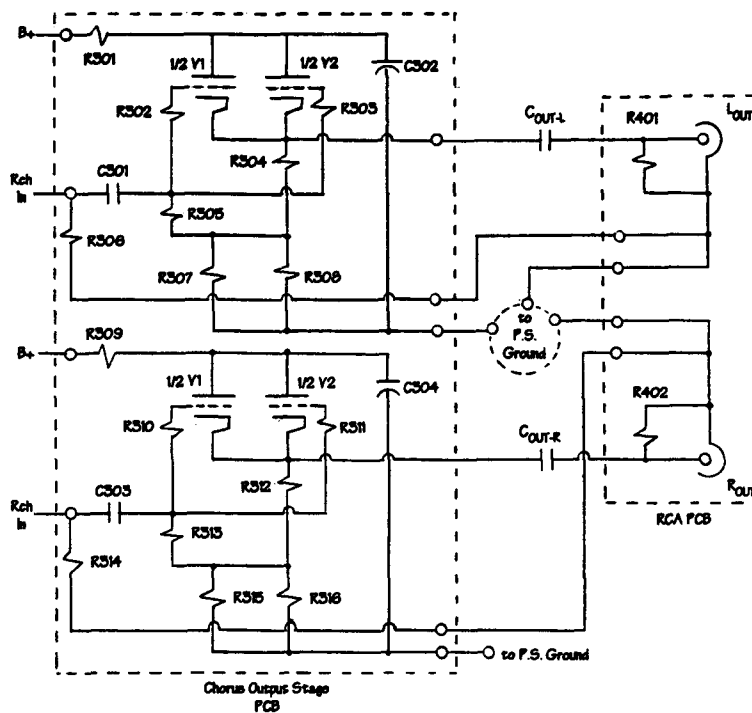
12AY7/6072 plus many more

12BH7/6913

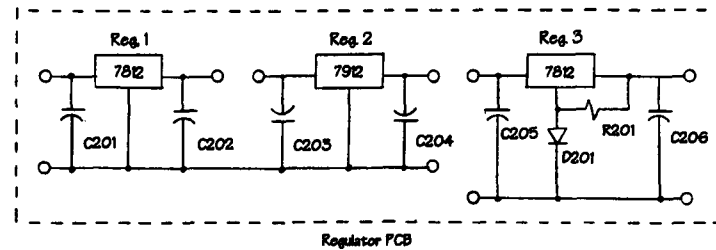
Solid State Circuit Mods

Warning: These mods should not be attempted by the marginally competent because putting a finger too close to the pins of the static-sensitive DAC will very often blow it up, a surefire way to void the warranty. How do I know that DACs are vulnerable? I've fried a couple myself.

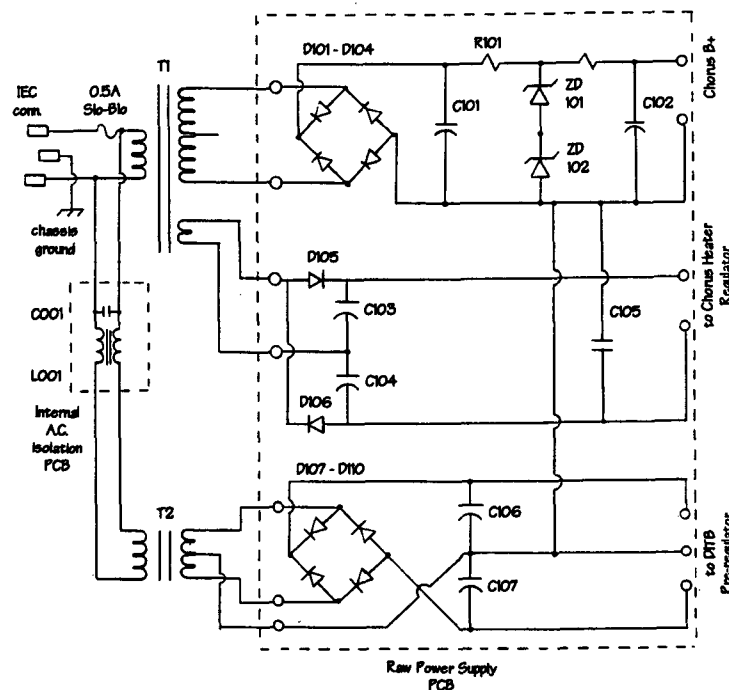
The DITB has separate +/- 5 Volt rails for the respective all-digital and D/A sections, a strength in the design. The stock "wall wart" DC supply was replaced by a beefier transformer, soft-recovery diodes, bigger filter caps, and preregulators. This allows the DAC +/- 5V rails to be increased to +/- 8V, which in turn increases headroom.



- C202, 204, 1.000uF/16V Panasonic SJ
- 206 0.1uF/400V Wima FK-1
- C301, 303 150uF/400V Sprague 81D
- C302, 304 30uF/400V PP Solen
- Cout L, R 1N4001
- R306, 314 39.2K RN60C Dale
- R307, 308 20K
- 315, 316 47K 1W MO
- R401, 402 1M RN60C Dale
- C201, 203, 205 100uF/25V Rubycon TWSS



- R201 1/2W MF
- R301, 308 10K
- R302, 303, 310, 311 1.8K
- R304, 312 182Ω
- R305, 313 1M
- 1/2W MF
- 1W MO
- RN60C Dale
- RN60C Dale
- RN60C Dale



- D101-110 SRP 100K General Instrument
- ZD101 IN5375A
- ZD102 IN5388A
- C101 68uF/450V Nichicon CE
- C102 220uF/400V Panasonic TSHA
- C103-104 3300uF/16V Panasonic SU
- C105 0.1uF/250VAC Allied CF-MH
- C106-107 4700uF/25V Mallory SKR
- C001 0.1uF/250VAC Allied CF-MH
- L001 3.3mH/2A Tamura CHF-8033
- T1 250VCT/6.3 Allied 6K1VF
- T2 25.2 VCT Radio Shack

These mods help remove much of the roughness and veiling present in the sound of the stock DITB, not to mention improving the bass. Removing the output IC (second order filter/buffer) and replacing it with a single pole passive filter/tube output stage removes what is left of the digital/solid state characteristic of the sound, and completes the modification.

Directions for modifying the DITB for use with the Chorus output stage

Caution #1: If these directions don't make sense, let someone else do it.

Caution #2: If YOU do this, you will void the warranty. If Don at Wavetrace does it, the warranty stays in effect.

1. Wear a GROUNDED anti-static wrist strap!!! Use only grounded tip soldering irons/stations!

2. Remove the PCB, holding it only by the edges. Hold the back of the Toslink connector to provide strain relief while unscrewing the machine screw holding the backplate on to it. Set the backplate aside.

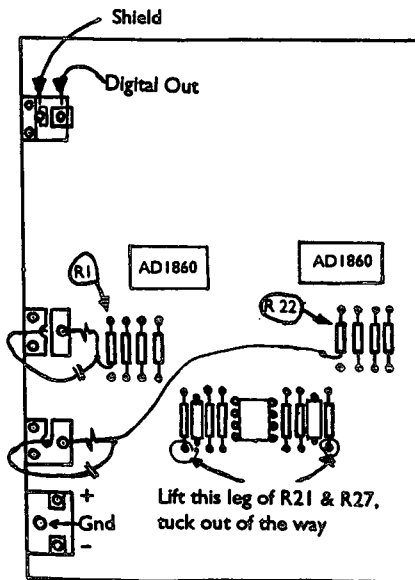
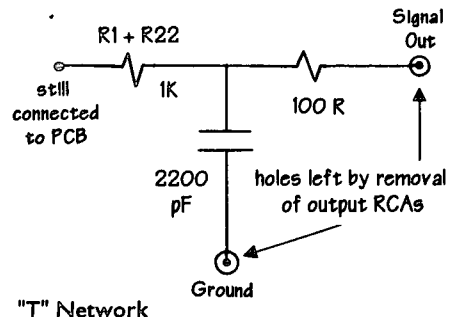
3. Desolder and remove the RCAs and the power connector.

4. Remove the OP-275 output IC. Cut its pins off right at the body of the IC; leave the pins sticking out of the PCB. Don't let the pins touch each other or anything else.

5. Isolate the audio output PCB pads because they are used to anchor the output wiring. Lifting one side of resistors R21 and R37 will do the trick (see diagram).

6. Install "T" network components and new output wiring into PCB holes left when output RCAs were removed (see diagram).

7. Lift the legs of resistors R1 and R22 that are farthest away from the AD1860s. Connect to rest of "T" network (see diagram). The right channel 1K resistor should be connected to its respective 100 ohm resistor with a length of bus wire with the same



PC Board Diagram

diameter as a resistor lead. Insulate the bus wire with something (tape, tubing, etc.).

8. Install RG-187 75 ohm coax into PCB holes left from removing the RCA connector (see diagram).

9. Install power supply wiring. To use large diameter wires that won't fit into the holes vacated by the old connectors, wrap a left-over resistor lead or piece of bus wire around the end of the wire, solder it, and stick that through the hole.

10. Enlarge backplate holes where necessary to clear wiring. Reattach backplate holding Toslink connector when replacing its machine screw.

11. Reassemble. Remember to hold the PCB only by its edges.

12. Connect wiring. Enjoy.

AEP #2: Power supplies

When engineering texts model electronic circuits such as tube or transistor single stage amplifiers, current sources, etc., they treat power supplies as if they were perfect. Man has yet to create the perfect anything, let alone the perfect power supply. In the design of the Chorus power supply, as in the audio circuitry, the foibles of the components comprising the circuit were taken into account. Thus:

1. There is a minimum of the same value/series/manufacturer of filter capacitors on any one voltage rail. This was done to keep any one sonic signature from predominating.

2. Wide use of a non-magnetic, low temperature coefficient, metal film resistor (Dale). These units were selected for stability and neutral sound, falling between the snappy sonics of the Holco and the extra warmth of the Vishay.

3. Tube output stage coupling capacitors (in and out) were selected for neutrality and, here again, units of different manufacture were mixed.

4. Circuit board traces are kept to minimum lengths. Component groups are connected by hard wiring. This helps reduce the amount of "edge" in the sound.

Plus, all B+ supplies are regulated at least once. The Chorus' high voltage B+ is shunt regulated, enhancing dynamics. The DITB +/- voltage rails are pre-regulated before entering the chassis.

A low impedance regulated heater supply was found to be only a first step. This is usually the limit of sophistication applied to heater circuits because the role of the heater is generally considered to be, well, . . . simply to "get hot." Evidently, there is more going on with heater supplies than one would think.

On a whim, an experimental transient impedance altering circuit was series connected before the 12V regulator circuit. It made a very noticeable difference in the harmonic balance of the sound of the Chorus. The listening skill necessary to hear the sonic differences is on a par with the ability to hear the sonic differences between tubes. At this point, the components used in the heater supply were upgraded. This made for another improvement in the sound of the Chorus and further underscored the need to treat the heater circuit with respect. (A proprietary production version of the initial compensation network comes with the full kits and completed units offered by Wavetrace Technologies.)

I am not alone in believing that the power cord is a major contributor to the "sound" of a product. The power entering equipment from the wall is not just 60 Hz. One hundred and twenty times a second, a burst of power is passed by the power cord as the rectifiers in the power supply become forward biased. This burst of energy has frequency components that extend throughout the audio spectrum. In order to allow for substitution of power cords, an I.E.C. receptacle is standard on the Chorus chassis.

AEP #3: Resonance Structure

This section is about microphonics (vibration induced, narrow frequency band signal colorations) and how to creatively take advantage of them. This will not necessarily be an easy road because the whole issue is so contentious these days. There are far too many who would rather trumpet the instances when a technique isn't significant rather than discovering where and when it is of value.

Microphonics are not exclusive to tube electronics. All systems are microphonic, only the degree and character varies. Harmonic imbalance can often be traced to a "lumpy" distribution of system resonances. This is analogous to standing wave problems in listening rooms. The best listening rooms have evenly distributed modes of resonances (standing waves).

Over the last few years, magazine articles containing snippets of information about changing the resonant nature (and therefore the sound) of everything from capacitors to op-amps have become more and more commonplace. Resonance control devices are hitting the market in ever increasing numbers. In many instances, these devices are designed to eliminate resonances. Control,

not elimination, is the key. Other designers, Michael Green for one, share the concept that wholesale resonance dampening is not necessarily a good thing.

Resonances are physical phenomena that have been exploited acoustically for thousands of years. The VPI brick was one of the first audiophile resonance modification devices. Cones, pucks, dots, bricks, and blocks can be found in a large percentage of modern audiophile systems.

The resonance structure of a piece of electronics is affected by the materials that are used in its construction, and by those materials that are in contact with the device. Changing either the materials it is sitting on, or those that are sitting on it, changes the equipment's sound.

A chance discovery manifests itself in an optional 3" circular hole cut in the Chorus' chassis directly over the DITB chassis. A friend blew my mind, and his, by placing a geologic core sample (a cylindrical piece of rock) on top of the DITB chassis back when I was working on the prototype. The sonic difference was like the difference between an 18" bass drum and a 24" one. This first experience led to weeks of experimenting

with all sorts of materials, from blocks of lead, wood, and stone, to small plates of fiberglass, Teflon, aluminum and other metals. Some changes were more pronounced than others but one thing became clear: this was not to be ignored. Many were the days when friends would come over to investigate the pile of materials atop the DITB chassis, and to debate which combinations sounded better.

I call these bits and pieces of different material "Transmutation Blocks" in honor of Audio Alchemy. These T-Blocks can be made from commonly available materials, such as oak, mahogany, poplar, copper, aluminum, ceramic tile, fender washers — whatever fits in the opening. They are a do-it-yourself item.

Wood blocks have a dual effect. They will dampen some segments of upper harmonics, but augment other harmonics — usually in the lower to middle midrange. Metal and fiberglass discs augment various treble harmonics, depending on the composition, size, and thickness of the disc. Heavy materials, such as blocks of lead, granite, and marble affect bass harmonics. The higher the mass of the block, the lower the harmonics that will be affected.


Many people will feel that the Transmutation Blocks are too farfetched. Those wanting to wring that last nuance out of the music will insist on them.

Conclusion

I hope that people will find other uses for the Chorus output buffer. It makes for adaptable equipment that won't be obsolete when you change other components in your system. When combined with the DITB, it is wonderful (my opinion is, of course, biased). That the heater supply is more important than previously thought should stir up some experimentation and comments. Saying that placing wood blocks and metal discs on top of the DITB can change its sound will make some doubt my sanity and everything else I've ever said. However, all these techniques work towards making better sound.

For more information on the products mentioned in this article, including boards, kits, and complete units contact:

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OHM'S LAW

AN EXPLANATION THAT
ASSUMES NO KNOWLEDGE OF
ELECTRICITY OR MATHEMATICS

BY "CATHODE RAY"

The apostrophe should be noted, as it distinguishes this law from O.H.M.S. (which deals with *really* unpleasant matters, such as income tax). There is no doubt that many people who are quite enthusiastic about various aspects of radio fight shy of Ohm's Law. It seems to me that there are three reasons—apart from psychological associations with things like schooldays and work—why this is so. One is that references in books usually appear something like this:

Ohm's Law

$$I = \frac{E}{R}$$

$$R = \frac{E}{I}$$

$$E = IR$$

Whereupon the reader exclaims: "I hate (or "I can't be bothered with" or "I don't know anything about") algebra!" And that's that. Another difficulty is that, even when it has been grasped that "I" stands for amps., etc., it is a troublesome sort of business to calculate, for example, the correct resistor to supply 15 volts bias to a valve taking 23 milliamps. The third reason is that amps. and volts and ohms are not things that one can see or understand naturally; they are just so many uncouth words to most people.

Quite Painless

I hope, however, to be able to administer Ohm's Law in such way that the patient (i.e., the entirely non-mathematical reader) has it inside him without any accompanying bad taste having been experienced.

In this present (or Hore-Belisha) era the idea of miles per hour is surely understood by all. What is reckoned in miles per hour? *Speed*. Good! We are getting on! Further interrogation of the kindergarten would reveal that miles measure *distance* and hours *time*. There are thus three quantities—speed, time and distance—and they are related in such a way that if any two of them are known the third can be calculated. Even the reader who prides himself on being one hundred percent non-mathematical would probably have to admit to having, on various occasions, carried out certain of these

calculations; nay, more—to having actually done them *mentally*! Thus, if he had just done a journey of 100 miles and had taken four hours over it, he would rightly claim an average speed of 25 miles per hour; calculated by dividing 100 by 4.

What he has done mentally can be summed up for all possible journeys by writing: Speed (miles per hour) is Distance (miles) divided by Time (hours) or, more compactly:

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

On another occasion he might be setting out to walk 6 miles; and, knowing that he can walk at 4 miles per hour, he is able to estimate the time it will take by dividing 6 by 4, giving 1½ hours. In other words:

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

In the same way, knowing the average speed and the time taken, the distance covered can be arrived at:

$$\text{Distance} = \text{Speed} \times \text{Time}$$

Most people (even non-mathematical people) probably don't think about having to remember these three formulae. But if they wanted to remember how to do all these three sorts of calculations there would be no need to remember three separate things; all could be done with one:

$$\frac{\text{Distance}}{\text{Speed} \times \text{Time}}$$

Hide the thing you want with your finger, and what is left tells you how to get it.

Anybody who can understand this (and probably most of you feel intellectually insulted by now), and who feel confident in challenging the policeman who alleges infringement of a 30-m.p.h. limit on the ground of covering a measured mile in 2½ minutes, can understand and use Ohm's Law. The one thing to remember is:

$$\frac{\text{Volts}}{\text{Amps.} \times \text{Ohms}}$$

Proceed as directed before (hiding the thing you want, etc.) and if you are given two things you can easily find the third. But before you get busy memorising the above, I suggest that for radio purposes it would be time better spent to memorise it in this form:

$$\frac{\text{Volts}}{\text{Milliamps.} \times \text{Thousands-of-ohms}}$$

Usually one works in milliamps., and it is discouraging to have to convert them to amps., with decimal points and things smelling strongly of mathematics, before being able to use the key. Example: you have a

100-volt HT battery, and you want to know the milliamps. when you connect a 2,000-ohm resistor between the terminals. You hide "Milliamps.," leaving $\frac{\text{Volts}}{\text{Thousands-of-ohms}}$ or 100/2 or 50. Fifty milliamps. is much too much current for an ordinary HT battery, so you now know that it is not a particularly good thing to connect a 2,000-ohm resistor between its terminals.

Having shown (I hope) that calculations by Ohm's Law are no more abstruse or difficult than calculating the average speed of a motor car, I would like to go a little further by bringing to it the aid of visualisation. One reason why it seems easier to calculate speeds and distances is that while doing it one has a mental picture of the vehicle travelling along the road; and it becomes natural to assume that the longer the road the longer the time taken to traverse it. Although it is possible to make electrical calculations with the utmost precision and ease by blindly following the rule just given, it is far more satisfactory and useful to have some mental picture of what is going on.

The Volts Drive the Amps

That lay journalists lack such a picture is evident every time they declare that so many hundred volts "passed through the body of the deceased." The electric current that lights lamps, converts gangsters into corpses, and makes sounds come out of loud speakers, is measured in amps. (short for amperes) or, if in small quantities, in milliamps., which are thousandths of an amp. It corresponds to gallons-per-minute or other convenient measures of the rate of flow of liquids.

Volts are necessary to cause milliamps. to flow, just as a certain amount of pressure or difference in level is required to persuade water to flow through a pipe or along a river bed. The more volts there are, the more milliamps. Nature might have been so arranged that doubling the volts would cause four times the number of milliamps. Or, perhaps, the-square-root-of-two times as many or some other number. It happens that except for special things such as valves (which weren't invented in Herr Ohm's day) it always works out that doubling the volts doubles the milliamps. also. That is what Ohm concisely set down in his Law.

The amount of pressure that is required to cause one amp. or milliamp. to flow is fixed by the nature of the circuit or bit of circuit through which the flow takes place. A long thin pipe laid all round the country would

take quite a lot of pressure to force one gallon a minute through it. So would a very short pipe if it were full of dirt. If we had a unit with which to measure resistance to the flow of water, such as the "resistwater," we might make up an Ohm's Law for water systems: Gallons per minute = $\frac{\text{Pounds per sq. in.}}{\text{Resistwater}}$

Only it wouldn't be true. Electricity is a much simpler, more law-abiding thing than water. That is why, when once people have grasped electrical laws they elucidate difficult problems in mechanics and other things by thinking of them in terms of corresponding electrical quantities. It may sound incredible, but the easiest and best way to find out exactly what will happen to a complicated system of weights and springs and levers is first to translate them all into volts and amps. and ohms. But to get back to ohms—they are, of course, the quantities of resistance to the flow of electricity. Looking at the formula for Ohm's Law one can see that, if the ohms are many and the volts are few, the amps will be very few. That is what one concludes simply by blindly following the Law. But without knowing any Law, if you are told that the resistance to the flow of electric current is great, and the pressure producing the current is small, common sense will tell you that there will not be a very copious current.

Practical Applications

Having got Ohm's Law in easily memorisable form, and some idea of what it means in ordinary everyday language, one may still be unable to make much use of it through failure to recognise occasions when it can be usefully applied. Take the example I mentioned before—calculating the right resistor

for providing a valve with bias. It may seem excessively puzzling to talk about a resistor (which is a convenient chunk of ohms), providing volts at all, when all that has gone before suggests that ohms kill or neutralise volts, just as a choked pipe opposes water pressure. Exactly. If you wanted to appropriate a small portion of the pressure from a hydraulic main, what would you do?

To make a hole in the main would provide the whole pressure; far too much. But you could take out a section of the big pipe and replace it by a narrower one; this would offer appreciable resistance to the flow and demand a corresponding amount of pressure to overcome it. So between taps situated at each end of the resistance section this pressure would be available. Of course, it would not be available for providing a heavy flow of water; if your private by-pass pipe in which you utilised the pressure did that sort of thing the pressure would drop. In the same way a resistance placed in a circuit for obtaining a desired number of volts will maintain them only so long as it is not abused by connection to a relatively low resistance. The grid of a valve is a practically infinite resistance, taking no current; so this method is very commonly adopted in the so-called "automatic" or "free" grid bias system.

To take a definite example: suppose a resistance connected as in Fig. 1(b) would carry 23 milliamps.; in other words the anode current. And suppose 15 volts are required as grid bias. Then (by Ohm's Law) the resistance is 15 divided by 23, or roughly 0.65 thousands-of-ohms, or 650 ohms.

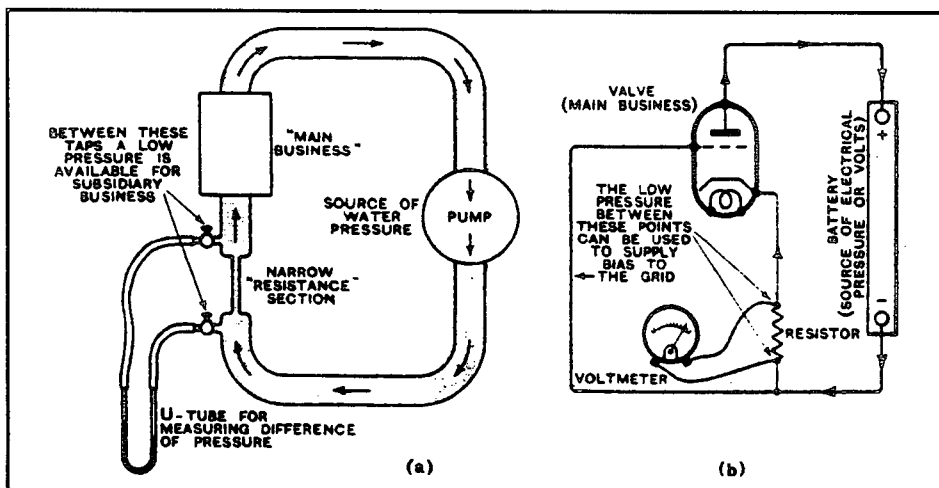


Fig. 1. — (a) Showing how it would be possible to cause a small difference of water pressure between two taps by interposing a narrow pipe in a hydraulic main supplying a high pressure to some machine or other (Main Business). Compare the corresponding electrical system found in most wireless receivers (b).

Another example: you want to find the number of ohms of a resistor. You have a battery and a voltmeter scaled up to 100 volts and marked "1,000 ohms per volt." You first measure the battery voltage accurately and it turns out to be 62. You then interpose the resistor, which cuts down the reading to 18. How many ohms has the resistor?

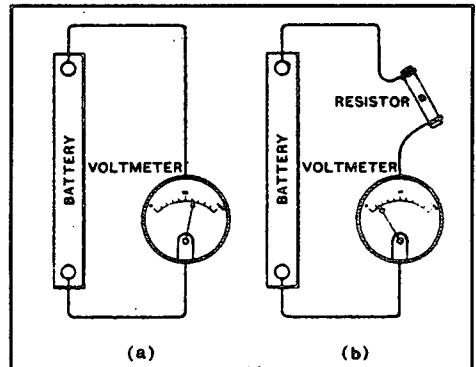


Fig. 2 — A simple method of measuring the ohms in a resistor by means of a battery and voltmeter. Two readings (a) and (b) are taken, and Ohm's Law applied to find the result.

This is solved by the application of Ohm's Law. From the information given we know that the total number of ohms in the voltmeter is $100 \times 1,000$, or 100,000. In the second test the pressure of 62 volts generated by the battery is applied to overcome the ohms in the voltmeter and also those in the resistor. We know that 18 are accounted for by the voltmeter. So the remaining 44 must be required for pushing the current through the resistor. The long way about it would be to calculate the current by Ohm's Law— $\frac{18}{100}$, or 0.18 milliamp.; then to use this to calculate the ohms in the resistor (because obviously the same current passes through both)— $\frac{44}{0.18}$, or 250 thousand (nearly). But it is possible to take a short cut by noticing that it is not really necessary to find out the actual number of milliamps at all. If 100,000 ohms require 18 volts of pressure to push a current through them, how many ohms will 44 volts pass the same current through? Obviously more, in the proportion of the volts: $100 \times \frac{44}{18}$ = same result as before.

All very useful. But even if one is not concerned with making actual calculations, it is helpful to have an idea of what Ohm's Law means.

From *Wireless World*, Feb. 21, 1936.
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CONEHEAD

La Fevre and Stillwell's article "Desperately Seeking an Efficient Speaker" in SP 2:1 struck a chord. Over the past few years, I have been conducting a discreet investigation into why 90% of all commercial loudspeakers have an efficiency rating of around 86 dB/W.

Basically it is down to two things: Thiele and Small and the popularity of 'bookshelf' loudspeaker enclosures. All of the theories associated with these and other 'hand calculator' methods rely on small/medium magnet to cone mass rating, i.e. medium to high Q ratings. Loudspeaker chassis with very strong magnets and light cones, the Lowther PM series being examples - Q about 1, do not work with Thiele and Small.

Thiele and Small rely on the trapped (or trapped and tuned for a ported enclosure) air predictably controlling the movement of the cone. With a large magnet the air cannot load the cone as well, especially when the cone is under 9" in diameter. The magnet is just too bossy. This is a bit of a simplistic statement, but submitting a 30 page epic would be the best way to explain it.

So, for a 5" cone, 84-85dB/W, 10" 90-95 dB/W, 12" 91-96 dB/W, and 15" 93-100 dB/W — all dictated by small enclosures and Thiele and Small parameters.

The strongest loudspeaker magnet I have come across is the Lowther PM4A motor. With its 18 lb. Ticonal G magnet and cobalt pole pieces, this beast packs a gap flux of 24,000 Gauss. Total flux is 385,000 Maxwells. There is only one possible use for such a driver and that is to horn load it.

Quarter-wave loading, large multiple unit systems, and horn loading are the only ways to increase sensitivity beyond the magic 100dB/W mark.

As 90% of all HiFi customers are spending less than £300 on a pair of speakers (in the UK anyway), there ain't no way the majors

are gonna bother trying to increase the efficiency. An LS3/5A with a 96 dB/W rating will never happen. You canna change the laws o' physics, Captain.

I foresee a renaissance for quarter-wave loading, a Voigt patent. Castle Acoustics has three models already available and selling like hot cakes, despite a dome tweeter (and a metal one at that). [Note: The Castle Acoustics speakers are not ultra high efficiency units. All less than 90 dB/W- ed.]

Personal pet hates are crossovers, dome tweeters - especially metal ones, super tweeters, Mr. direct/reflect himself Dr. Bose, computer designed boxes complete with 'bumps' in the bass. Even QUAD electrostatics can now have bumpy bass. Just add a Gradient or a REL subwoofer to raise the subsonics to a level way beyond what it should be. They'll love it at audio shows.

Some people like the phasey ting of a dome tweeter. They love the engineered bump in the bass. It is gonna take a long time for this single speaker quarter-wave loaded pipe dream to become a popular reality.

As Voigt himself once said, it is the midrange where we live, the rest is not as important.

The informed readers of Sound Practices can just relax and be ahead of the crowd.

Haden Boardman
Audio Classics UK

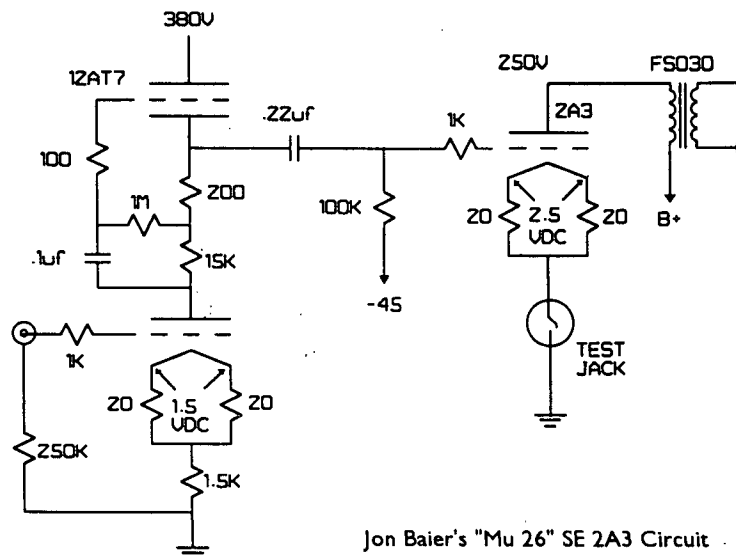
REPORT FROM THE TRENCHES

I got some ideas from the Garrard 301 article. Removed the magnetic brake from my TD 124. Used a small variac to control the speed. The table is quieter. All along I thought I had bearing chatter but it must have been the brake rattling. The problem with the variac trick is that you have to lower voltage so much that the strobe light goes out. I ended up removing the motor pulley and machining it down to 1.032 dia on a lathe. It was 1.075 originally.

The table now runs at proper speed on 117 VAC. I keep the variac in line for minor speed adjustments. One nice thing about the smaller pulley is some increase in torque. The speed seems more constant judging from the strobe. Does it sound better? Who the hell knows? Doesn't sound worse.

I tried just about all the popular output tubes — 300B, 275, 6A3, 45, Chinese, etc. I love the 2A3 double plate. It matches the 604s best. All single plate tubes (of these, I like the single plate 2A3 best) sound lighter and more analytical. The 2A3 bi is GREAT. Others have listened and all prefer 2A3 bi-plate on my system. Based on my theory that high current, low voltage filaments sound better, I used a #26 for the front end. The amp is much more open and dynamic with the #26 than with any indirectly heated triode I have tried. Also sweeter. It sounds faster than a speeding bullet. Enclosed is a schematic for chuckles. Keep up the good work.

Jon Baier
Schenectady, NY



Jon Baier's "Mu 26" SE 2A3 Circuit

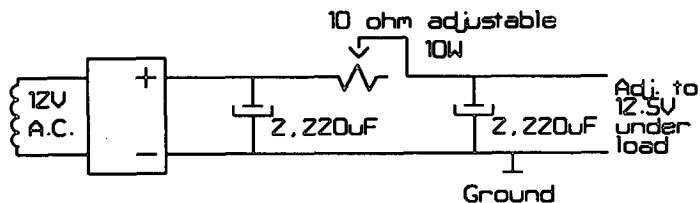
"Never build anything from a magazine
until the next issue comes out."
—Old folk wisdom

Loftin White

Page 6 — R3 should be 3.3K not 33K.

REMUS

Page 32 — V3 should be a 12AT7 as indicated in the text, not a 5751 as marked on the schematic. Also, here's an alternative heater circuit that was promised but not delivered:



Incredible as it may seem, V3 may oscillate at a supersonic frequency. Very strange, since it is not a voltage amplifier. A 100 pF cap from V3 grid to ground will cure this oscillation if it occurs.

Hodgson Article

Page 39 — B-H graphs were mistakenly switched in first print run. Corrected in later versions with notation.

The Search for Musical Ecstasy

by Harvey "Gizmo" Rosenberg

RE: TECHNO-SHAMANS

Since the late Paleolithic period, in every culture, a special group of men — those endowed with both courage and gifts — have been responsible for exploring the outer limits of knowledge: ecstasy. We are the modern incarnation of these shamans, and like our ancient brothers we use our music to open the door to higher states of being. Some anthropologists would argue that solder flux is hallucinogenic, the soldering iron is a magic wand, and our single-ended triodes are totems — all used to release a primal instinct for musical ecstasy.

My fellow techno-shamans, now is the time to cast off the mealy minded robe of mediocre audio orthodoxy and explore an expanded gizmological metacontext for the electromechanical arts that create an ecstatic aural metaphor. . . with me.

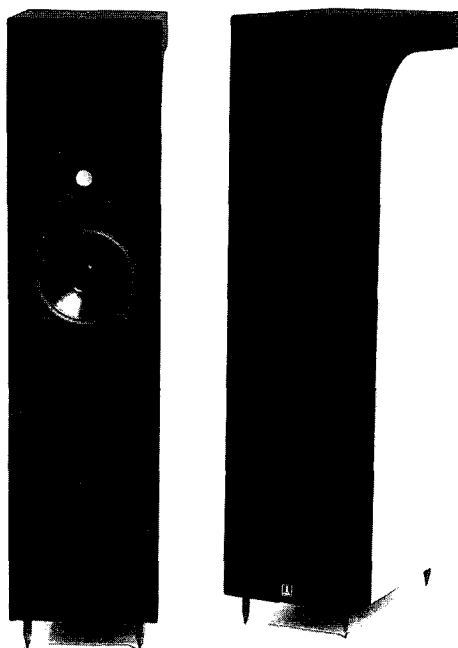


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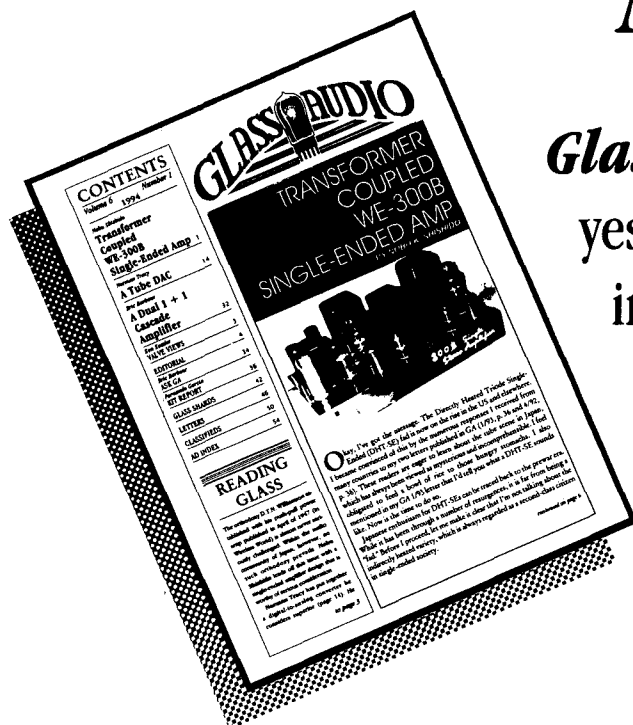
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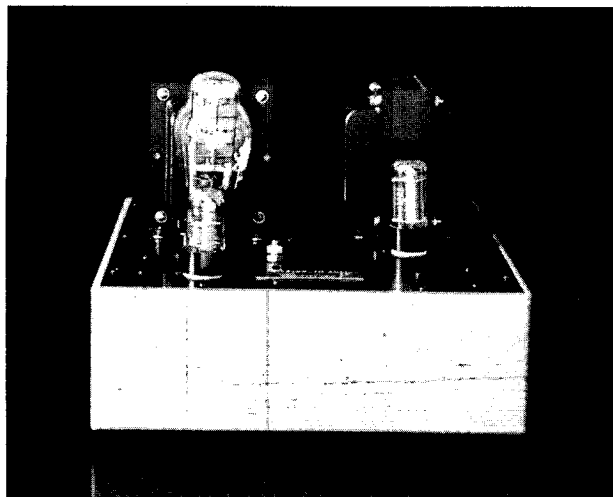
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5 watt Zener diodes, your choice 47, 82, 100, 120, 150, 180, 200, 220, 250, 300, 350, 400, 450, 500, 560, 620, 680, 750, 820, 900, 1000V peak of five .95
Diodes, 1N4007 1A 1000V, peak of ten, .95 2SA 1000V peak of five .95
High Voltage Diode, 500 ma 12,000 volt PKV rating (w/ov) 5.95 each
Claroast 2 watt linear control, for bias/balance, etc. 1K, 5K, 10K, 25K, 50K, 100K 5.95 each
Polycarbonate hospital grade power plugs, USA mfg, 2 or 3 prong, 4.95
Nentrik XLR connectors gold plate chassis, black case, specify male or female, cord or chassis mounting, 4.95 each
Chassis boxes (see cages below) for tube power amps, 9X5X2 alum 13.95 12X8X3 alum 22.95 16X8X3 alum or steel 25.95 17X10X3 alum or steel 28.95 17X14X4 steel 44.95
Berthou covers and feet included. Aluminum chassis are natural, steel are grey enamel.
Cages for above chassis, perforated enameled steel, 5" vertical clearance,
9 X 9 \$30, 12 X 8 \$30, 16 X 8 \$33.00 and 17 X 10 \$34 each
Punch Kits, will punch all chassis above (up to 18 ga steel), covers all popular tube socket holes, 3/8", 3/4", 7/8", 1", 1-1/8", 45.95 each
Lettering kits, dry transfer, for marking above or other chassis. Specify Black or White.
Choose Audio Words (#AUD-1) Terminal Letters and Numbers (#TC-13)
or Dial Marking (for volume/selectors, etc) (#DM-13) Large pack \$3.29 per pack.
FM Radio Alignment Tool Kit, has most popular types. #AT-1 1.95
Sockets, Octal (for GZ34, EL34, 6X50, 6L6 etc tubes) British Micanol (brown plastic) (McMuro) phosphor bronze contacts, standard 1 1/2" mt centers 1.95 each
9 pin chassis mount McInture sockets, similar to above 1.95
Ceramic Octal with Gold plated contacts, direct fit for Dynaco, 6.95 each
Ceramic Octal with silver plate contacts, slightly smaller than above item. 2.95 each
9 pin ceramic/gold, PC or Chassis mount, fit USA dimensions, etc quality 5.95
9 pin white plastic/gold PC mount very nice 2.95 Same item no gold plate 1.95
9 pin chassis mount, ceramic/silver with shield included, fits 12AX7, 6DJ8, etc 1.95
Jumbo 4 pin for 211, 845, etc Very good copy of Johnson 9.95
Ceramic/Gold 4-pin (300B, 2A3) metal saddle 9.95
Ceramic/Silver 4-pin (300B, 2A3) or 5-pin (807, etc) wafer socket 2.95
9 pin ceramic chassis mount socket, black plastic, ground lugs, 1.95
Chinch 9 pin chassis mount socket, black plastic, ground lugs, 1.95
Have Tube Sockets and Top Caps of all sorts. If you don't see it here please ask.
Dusty Files Part 1 Twenty interesting tube amp schematics 1938-1988,
with emphasis on the bizarre and high powered, plus 6 pages narration. 4.95
Dusty Files Part 2, Favorites Amp Plans, 25 tube power amplifiers that may be constructed from generally available, reasonably priced parts. Includes handy Resistance Coupled Amplifier charts. 9.95
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56 57 75 76 80 83 264C 864 5751 5814 5879 5963 6005 6072
102A12A17WA 6267E1F96 0A3 0C3 0D3 5Y3-GT 3K4GY/GYA 5V4-G/GA
5Y4-G/GT 6C5 6S5 6F8-G 6I5-RCA 6N7 68C7 68F5 68I7 68I7-GT
68L7-GT RCA 68L7-GT 5Y4 68L7-GT GE 68L7-GT TungSol 68N7-GTB RCA
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Computer grade capacitor 190D radial electrolytic 4.95
270 uF 350V 3.95 (Champs-150)
Capacitors, These are 1 3/8" dia. 32-32-16-16 at 450V 2.95
16-16 uF at 450V 2.95 16-16-16 uF at 450V 3.95
Sprague 800 volt 715P polypropylene cap, your choice .0033 or .0047 uF .29 each
Roderstein 037-400V axial polypropylene .29 each
ALPS 410P Axial .15 uF 300V .29 each F. Dyme 022-400V axial prop .29 each
ALPS stereo combo Volume & Balance control, large case, detents 4.95
Noble 250K, 100K, or 25K dual volume, detent, cast case, cond plastic 19.95
Switches, silver contact mini toggle, 6A, SPST or DPDT 1.95 4PDT 2.95
Terminal strips, Phenolic Bag of 30 pcs 1.95
Silver Mica Capacitor Assortment 20 pcs (KT7555) 1.95
Soldering Irons, big ones for thick metal, Wood handle: 60W 4.95, 100W 6.95
Transformers, #23V17 (Thordans) 117V 300 ma, open frame 9.95
Choke, #LCS214 1.5H 10ma, 1500V induct 1.95 ea
Choke, #LCS21, 600 mh 200 ma, 18 ohms DCR, 1.95
Teflon silver plated wire, 20 ga, ast colors 18" pieces 10 ft total, 1.95
Metal Film resistor kit, 100 pc, 20+ popular values 1/2 watt 1% 6.95
Power Resistor Kit, 100 pc, 20+ pop values 3 to 7W metal oxide 12.95
Thermistor Kit, slow turn on devices, 10 pcs ast ohms, 2.95
Time Delay Relay, 115VAC, 30 sec, 115V actuator, metal base 4.95
Time Delay Relay, 60VAC, 30 sec, 6.3V actuator, 9 pin base 9.95
Fun Tube Facts: World's largest trade in the Eimac 8972, with 1.5 million watts of plate (anode) dissipation. It is water-cooled, weighs 190 pounds (87 kg or 14 stone), operates at 18,000 volts on the plate with 110 amps of anode current, and has a 16.3 volt filament drawing 640 amperes. Usually used in massive LF or shortwave transmission stations, it is still in production.

NOTE: New PO Box Number: Box 578501, Chicago, IL 60657 USA
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Most parts except for tubes and sale items can be returned for credit within 30 days if with original packing and unused. Most Tubes (except sale items where noted) are warranted 6 months but tubes if defective are returnable for exchange only. Transformers and chassis are subject to 15% restocking fee. If you want to pick up parts at the office, please note: There are no facilities for persons to "browse" the warehouse. Please phone 1 day in advance to pick up parts, otherwise please expect to wait while your order is picked and phone callers are attended to.
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