SOUND PRACTICES

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Experimental Audio Invasion Issue 12

Sound Practices

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Alien influences

These days there are more audio magazines around than ever before, yet one has to wonder about the very future of print in an age where more than anybody wants to know about most topics is accessible for free on the Internet. Paper magazines are expensive and resource-thirsty to produce and circulate. It costs a few dollars to print up a magazine and a few more to mail it, then it takes days if not weeks to get where it's going. The same information minus the paper wrapper can be disseminated electronically in seconds for almost free. For that reason alone, paper media are more or less doomed to eventual extinction, sooner or later.

It is an old story how economic considerations drove electronics design from the $20 tube to the 20 cent transistor. Well, the same forces are assuredly at work in the information delivery business. It's still a challenge for a producer to get consumers to pay for digitally-served information in these early days of the technology, but this will surely change as people get used to the concept of paying for raw info rather than tangible paper artifacts, buying "ideas" not books. Inevitably, print journalism will have to find a new home, but in the meantime there's a golden age of audio journalism afoot.

Ironically, the same digital revolution that threatens to destroy the magazine fostered a parallel revolution in desktop publishing technology that has totally transformed the landscape of the magazine racks. There used to be significant barriers to entry in the publishing biz but not anymore. Today, anybody with a used computer and spell checker can hack together a decent looking publication on the kitchen table. Of course, certain talents are necessary to put out a *good* magazine and computers don't make that any easier, but the mechanical aspect of publishing certainly isn't the killer it used to be. The end result is more magazines, *different* magazines, a great thing.

New magazines brought a lot of new ideas and viewpoints into circulation but the diversity of fact and opinion accessible to the masses multiplied dramatically when online publishing came along. A cheap modem is all you need to get a message out to the whole world. It is quite inspiring to see what people can come up with when freed from the commercial considerations that shape mainstream print media, acting out of a pure hobbyist interest. Money has always been an effective motivator but nothing beats a labor of love for that feeling of connectedness. There is a lot of garbage out there but if you're not on the Net, you're missing a lot of hot audio info.

Already, after only a few years, the alien influences of alternative mags and online resources have seriously eroded the conceptual monopolies the audiophile media barons used to enjoy. The profound influence of the glossy magazines on "high-end" audio in terms of agenda setting, marketplace gatekeeping, and even definition of self for many audiophiles is depressing evidence what happens when the public discourse on a topic is manufactured and controlled by a few commercial institutions.

Given the romantic explorer self-image cultivated by the "High-End" all these years, one would think there could have been a bit more variety of thought and product out there. For decades, audio was like the adolescent who expresses his individuality by dressing exactly like all his friends. The hi-fi scene degenerated into a tribe of like minded recommended-component zombies, speaking the same bizarre lingo, listening to the same awful audiophile records. Finally, there are signs of life, signs of experimentation and growth, thanks to the widening information pool and channels for direct hobbyist to hobbyist interaction on a global scale. Now, that's romantic!

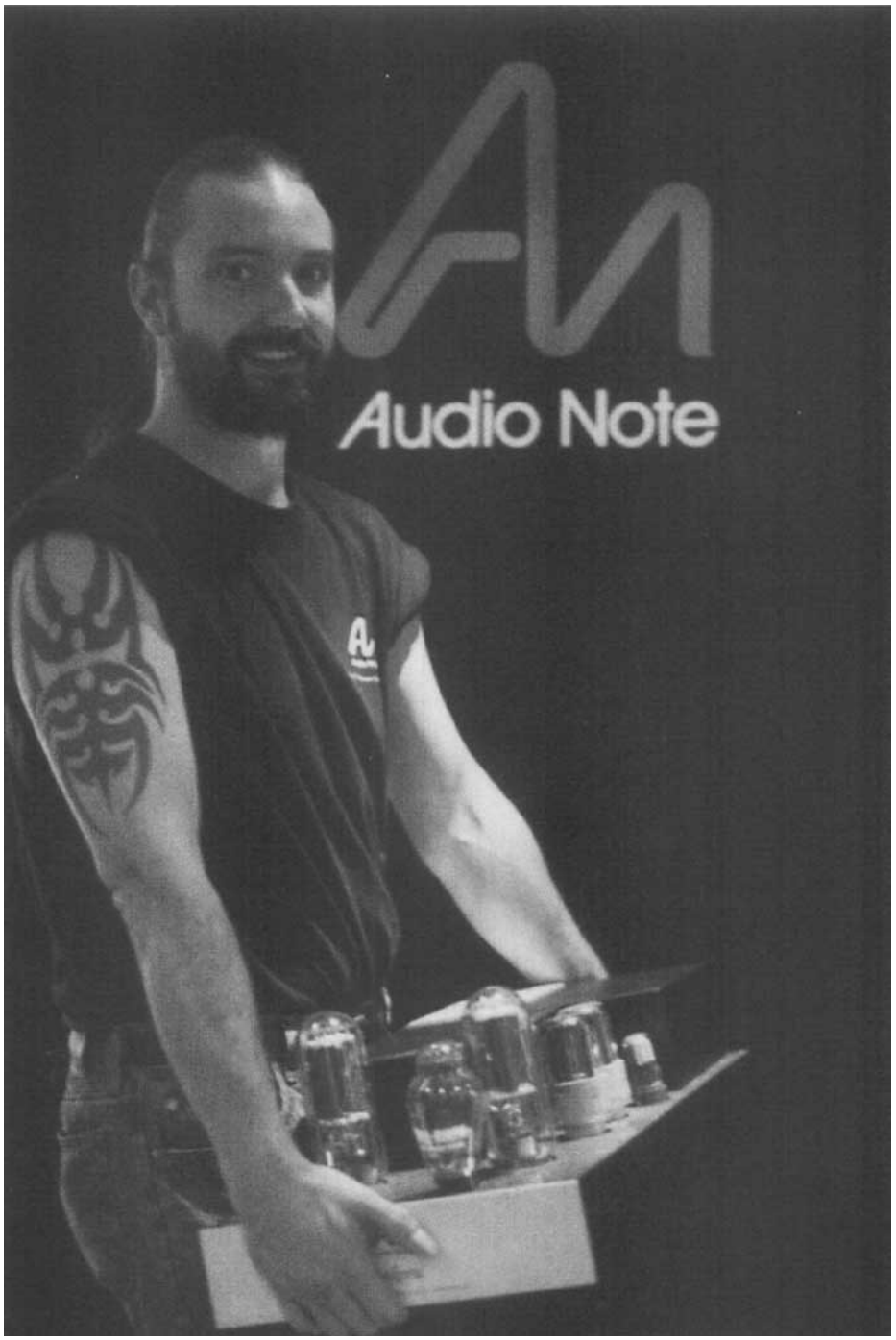
Just as the so-called "underground" media have always done, the hobbyist-driven efforts show the mainstream players to be exactly what they are: large creatures that must keep their hungry maws in a deep trough of advertising dollars or die. The bigger a mag gets, the more it must eat, so further out into the fields of lowest common denominator and mass appeal it must roam. Specialization is a luxury of small circulation media, as is the freedom to pursue perspectives independent of advertising considerations. The big mags still rule the contemporary marketplace, but if you want a glimpse of the future, go to the alternative channels of information and discover what the experimenters are doing years before you'll read about it in *Stereophile*, *Audio*, or any of the other well-fed paper dinosaurs.

The rise of alternative info outlets is not a question of "the small axe that cut down the big tree." The popularization of access to public communication media is the biggest axe of all time. Clear the landing pad, the invasion has begun.

Ankoru

by ANDY GROVE

Audio Note. U.K.



Hey, don't drop that thing on your foot!

Musical information is a dynamic four dimensional continuum, like the one posed by relativity theory, consisting of three spatial dimensions and time, all inseparably interrelated. A system for music recording and reproduction must transfer this continuum and faithfully reconstruct the original sonic performance in the listening room. Test instruments are supposed to ensure that the transformation of the continuum is linear and accurate to certain parameters.

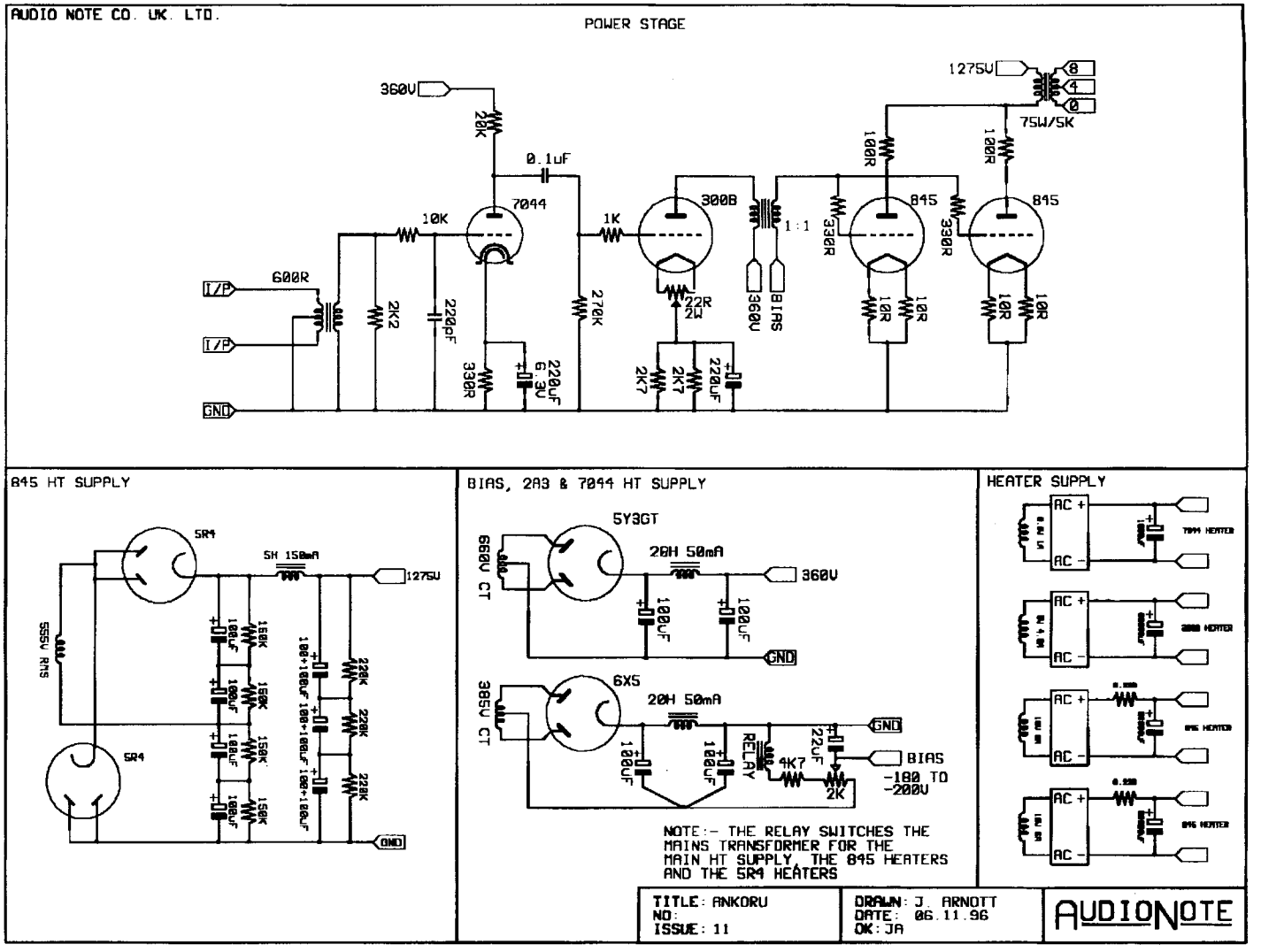
Alas, these instruments and the mathematical models that we use, such as relativity theory, lack the spontaneity and emotional content vital to music. Somehow our primitive method of recording scratches into a vinyl disc captures some of this emotion, and the lump of rock we call a stylus is able to extract the information and convert the vibes into a signal ready for the amplification chain. The amplifier, therefore, must not only perform well electrically. It must also convey emotion in order to fully satisfy both the analytical mind and the inspirational soul.

These days, science is beginning to discover an essential, almost mystical, interconnectedness of everything. It is intuitively obvious that the character of the universe on a macroscopic scale should rely on the properties of the subatomic particles of which it consists. At the same time, the character and properties of those particles is defined by the universe at large, the whole system mysteriously holding itself up by it's own bootstraps, each piece of the giant jigsaw fitting exactly into place without deficiencies or excesses.

It is only by virtue of an intellectual gesture that we perceive a condensed, solid, and definable part of the web of reality, yet we have deceived ourselves into thinking that our mental creation is the be-all and end-all of existence.

Most of our old scientific "laws"– including those currently used to judge sonic performance – are only close ups of the whole picture. I'm afraid we are not seeing the wood for the trees.

Certainly these measured parameters do have some relevance in terms of overall performance, but to recreate a musical event, an amplifier must work on both a macroscopic scale as a part of a communication system between the performance and listener and on a microscopic level as a



Schematic diagram of author's design - Audio Note *Ankoru* SE parallel 845 70 Watter

collection of valves and parts which must be tamed and optimized for the task at hand.

A magazine article can only skim the surface of any design philosophy and, of course, there will be shouts of "what the *@$! is this guy on?", but I hope my discussion of the *Ankoru* design will be interesting nonetheless.

Starting with the basic precept that each part of the amplifier should fit exactly into place, and have a character defined by the overall requirements of the system, the validity of *feedback* and *push pull* operation, two pillars of traditional amplifier design, are immediately called into question. These concepts are purely intellectual constructions, created in laboratorieswith no motivation from natural music, and I am convinced that they detract from sound quality as a result.

In practice, the ultimate purpose of feedback and push pull operation is to make amplifiers easier to make not better. In any event, reducing harmonic distortion to vanishingly small levels and increasing bandwidth from DC to cosmic rays does not make a more musically satisfying amplifier. Specs must give some satisfaction though, 'cos we all know a guy who slinks off to the bathroom with a copy of his tranny amp spec sheet!

I agree that limitations such as distortion and bandwidth abberations unquestionably colour the sound and should be eliminated, but beyond that I maintain that there are more important areas to be considered if musicality is the ultimate goal.

According to my way of thinking, all of the above leads to the assertion that the overall topology of an amplifier must be single-ended and there must be *no* feedback. Transistors and all things silicon sound unnatural...put sand in the signal path and you get gritty sound! So, let's proceed directly to *valves* and, in particular, the simplest and purest amplifying device.

The materials used for the construction of the passive elements of the amplifier are just as important since the signal must pass through them. Every material has a tonal coloring effect, so only highly-specified, high-purity, listening-tested materials are suitable.

For example, in the *Ankoru* we use only Black Gate and Cerafine electrolytic capacitors for the audio circuitry. These caps eliminate that electrolytic mushiness without going over to the brashness of certain plastic caps. The valve selection was guided by the notion that the different sonic signatures of each type should be complimentary, leading to the goal of a sound that possesses both strength and finesse.

Before I go on to describe the *Ankoru* circuit in detail, I would like to say a few words about transformers and transformer coupling, since transformers play an important role in the design.

In any valve, waveform distortion is caused by the characteristic parameters of the valve changing in sympathy with the applied signal. In a standard RC coupled triode circuit, the valve is set up with a quiescent current (Iq) flowing through it and the load resistor, yielding a particular quiescent voltage on its anode (Vq).

With a negative-going input signal, the current is reduced and the anode swings positive due to the reduced voltage drop across the load resistor (Rl X Iq). The reverse is true with a positive-going input signal, the valve's anode current is increased so the voltage on it reduces due to increased drop across Rl.

There is a problem with this, however, because as the anode swings positive and the current decreases, the transconductance of a valve goes down due to the curvature of its characterisic. Of course, the reverse is true with a positive-going input signal, the transconductance goes up with with the current.

This means that the positive part of the anode swing is compressed and the negative part is expanded– waveform distortion. Usually, this distortion only becomes serious with very non-linear valves and/or large voltage swings. When we want to drive a fairly meaty output valve we need to swing a lot of volts because the mu of these types is necessarily low to keep the anode impedance down to keep loudspeaker damping up. In this circumstance, waveform distortion can easily rear its rather ugly head.

We need a system for keeping the current through the valve as constant as possible over the anode swing, i.e., a high load impedance. Increasing the load resistor on an RC coupled stage can only go so far, however. One soon runs into problems of resistor dissipation and PSU voltage if the anode current is kept at the optimum level.

The SRPP stage and his other active loaded cousins, such as the mu follower, have never really delivered the goods for me. Close listening reveals a lack of focus and immediacy compared to even the humble RC coupled stage. Anyway SRPP is a feedback device and quite often that scheme doesn't work very well electrically either, especially with the low impedance valves we would like to use as drivers. Simply pretending that you've got a low output impedance just doesn't cut any ice in the world of real audio.

For large power valves, a low AC drive impedance is necessary because large valves have large and therefore highly capacitive grids. Thankfully, the low gain keeps down the Miller Effect, but it's still there, so for good HF response, there is no getting around using a good low impedance driver.

From the standpoint of sound quality, for a strong sound we need a beefy, low impedance driver. Wimpy driver equals wimpy sound. Drive two 845s with an ECC83 and it'll be like putting a model aircraft engine in a Chevy Impala. Not exactly awe inspiring.

The DC resistance of the grid circuit must also be kept low to control the effect of another rather annoying bugbear, grid current. Unfortunately, the vacuum in many modern valves is far from perfect, so there are quite a few gas ions floating around inside the bottle. Some of these ions will collide with the grid and draw electrons from the grid circuit. If the grid resistance is high, the grid bias will be modulated in tune with the signal, a real no-no in my book.

Also the grid may occasionally be driven positive on signal peaks, causing the grid-cathode diode to conduct, rectifying the input voltage in the manner of a shunt diode supply with the coupling cap as the reservoir. This action makes the bias voltage more negative, reducing the quiescent current through the tube, sometimes to the point where it will only conduct on peaks (Class C). In fact, a severe peak can cause the amp to cut off altogether, resulting in a total loss of output.

Worse still, the grid resistor/coupling cap combination acts as an RC time constant, so the effect lasts for some time after the overload has passed in sort of a time-delay distortion mechanism.

Reducing the grid resistor to combat these effects is no solution. We want a DC grid resistance similar in magnitude to the impedance of the driver valve, i.e. a few hundred ohms not a few hundred kilohms.

Making your grid resistor 600 ohms will likely kill the driver stage and, anyway, would require a coupling capacitor so big that the RC time constant would put us right back where we started.

To cure the voltage swing problem requires a circuit element which has low DC drop but a high AC impedance. Plus, we need a low DC resistance in the grid of the output valve. And the device should efficiently couple the driver valve to the output tube's grid.

The driver transformer is exactly what we need for the job. Its primary inductance presents an extremely high AC impedance to the driver valve and reflects the anode impedance of the driver into the grid circuit of the output valve. A good driver trans will have a primary and secondary DC resistance on the order of 300 ohms, so the problems associated with grid current are more or less eliminated. This is a resistance 1000 times lower than I've seen in some designs.

Ideally, the transformer secondary is left unloaded, i.e. there is no "damping resistor" put across it to cut ringing. An unloaded transformer sounds better and it gives the driver valve a higher impedance load.

There are two large-scale problems with driver transformers, HF frequency response and LF frequency response. These two requirements are mutually exclusive to a certain degree and many commercially available transformers sacrifice one for the other. The Tango transformers, for example, seem to go for impressive-looking HF specs but they have diminutive primary inductances

which limit the LF performance.

The problem is compounded by the unbalanced DC current imposed by SE operation, which requires that the number of primary turns must be increased to counterbalance the loss of permeability caused by the air gap in the core. Leakage inductance is proportional to the square of the primary turns so it's a real pain in the butt.

The driver transformer in the *Ankoru* has to handle 45 mA and still have superb bass, so it took some heavy calculator work and a few trees worth of paper to get it all working! [The *Ankoru* interstage trans will be available as a DIY part–*ed.*]

I love the sound of large triodes like the 211 and 845. The 845 was used in this amp because it offers greater power in Class A1. The 211 is a more voltage sensitive valve than the 845, its *mu* is higher but then so is its internal impedance. It can't swing a lot of current at the low voltage end of the anode swing without having the grid driven positive into Class A2. When pushing the grid above zero volts, it no longer reacts as a high-impedance terminal. It starts to draw appreciable current, corrupting the input signal in a most unattractive way unless the driver impedance is extremely low.

The grid-cathode diode impedance of a 211 is about 2k, so we would need something around 100 times lower or hideous distortion would result. The waveform distortion could be corrected using feedback but why build an amplifier that is intrinsically nonlinear?

The 845 can sink a lot more juice where the 211 starts wheezing, but since the *mu* is so low, it requires a driver stage capable of considerable voltage swing. The 845s in the *Ankoru* are biased at -100 to -200 Volts for an anode current of 75 mA at 1200V B+, they look into a load impedance of around 6k, and put out a formidable 70 Watts. The output transformer has to cope with 150 mA DC and hold its 6k impedance down at LF, requiring a high primary inductance. This takes a serious hunk of iron, but the *Ankoru* output is just such a beast and the bass is awesome, if I do say so myself.

To keep the drive signal to the output valves clean requires a driver valve of excellent linearity. One could use an indirectly heated valve such as the 6BX7, very linear, or the slightly less linear 6BL7, but low impedance, low *mu* directly heated valves are definitely the best choice.

Since this amp has to be built using valves which will be available for some time into the future, so that replacements can be made throughout its life, it was necessary to use modern versions of either the 2A3 or 300B. I originally experimented with the 2A3 as I wanted a measure of its clarity and immediacy, but these valves have a very nasty habit of making toilet related noises even in the output stages of amps, and using one as a driver was impossible. I even tried some NOS samples but many were only marginally better, only the best and therefore rare and expensive examples were quiet.

So the 300B was chosen, and it brought its characteristic warmth and musicality to the amp as well a greater impact to the bass. The 300B is operated with 300V across it and an anode current of 45 mA so it will last for ages, no more current or voltage was necessary for driving the 845s to full output. The 300B's output is in fact so large that the 845s will be freaking (and so will your wife and the neighbours) before it runs into trouble which makes its jobs and the job of the input stage easier.

Various input configurations were tried, all using the E182CC/7044 valve for its powerful sound. The original and best sounding configuration gave the amp so much gain as to be impractical. Long speaker leads acted like antennae and transmitted the amp's output into the input leads causing instability. Super high quality cables and careful system setup would eliminate the problem but as this is a commercial amp it has to be dealer proof so a simple, single stage RC coupled affair was settled upon. The 7044 was always run at a high current to really bring out its flavour.

The *Ankoru* is interfaced to the preamp via a coupling transformer to allow balanced operation and to properly ground the grid of the red hot 7044. A switching system permits regular unbalanced input as well. The *Ankoru* is intended for use with the Audio Note M3 which has output transformers and balanced outputs.

Ideally transformer coupling between input stage and 300B would have been used but even super quality transformers impart a signature upon the sound (ultra mega quality ones don't however) so a special copper foil capacitor with paper/oil dielectric was used to couple from 7044 to 300B. This capacitor like all caps has a sonic character but it was used to avoid a buildup of one type of timbre caused by the cascaded transformer coupled stages.

The power supplies are fairly standard, and of course valve not silicon, remember microprocessor parts in the power supply equals computerized sound. If you want your record collection to sound like a bunch of cheap CDs then use silicon rectifiers for the audio PSUs like all the other junk in the shops. In fact, I would use valves for the filament supplies if I could– Tungar rectifiers such as the Ediswan 68506 would work for those who dare [*Cool! –ed.*] or AC straight from the mains trannie but then punters would winge about hum. I could have built gargantuan supplies which would have caused the primordial fires of a nuclear power station to die but this amp had to fit into a (almost) domestically acceptable chassis.

So a sensible but effective approach was taken, capacitor rather than choke input filters were used to get maximum voltage efficiency and chokes were used to get ripple down. The capacitors in the PSUs are directly in the signal path so they need to be of excellent quality and here the Cerafine types come into their own. They have a smooth and refined sound. Energy storage was not taken to extremes but the main HT for the 845s holds 50j of energy (the caps on the input side of the filter are isolated from the audio circuit by the choke and therefore don't count).

It is necessary to have a rigid supply. Smaller caps generally sound a bit sweeter in the mid and treble but if you want a decent bass quality the last thing you want happening is the PSU flapping about all over the joint. You don't put a lawnmower carburetor on a Ferrari engine.

Going for oil drum sized caps doesn't work either (Question: Can you think of a trannie amp with super solid bass and complete and utter crap everything else?). Super sized capacitor supplies can pump out heap big LF current transients but they take heap big time to recover as well, and the impedance of the giant electrolytics just skyrockets as the frequency rises.

Regular capacitor power supplies integrate the demands placed on them so a bigger supply reacts a smaller amount but everything takes longer. So the PSU for the 845s is suitably scaled for an excellent all-round performance, solid bass through to sweet and delicate treble. Things are made a bit easier because the energy storage of a capacitance is proportional to the square of the voltage on it and at 1200 V it doesn't take a big capacitance to store a lot of grunt.

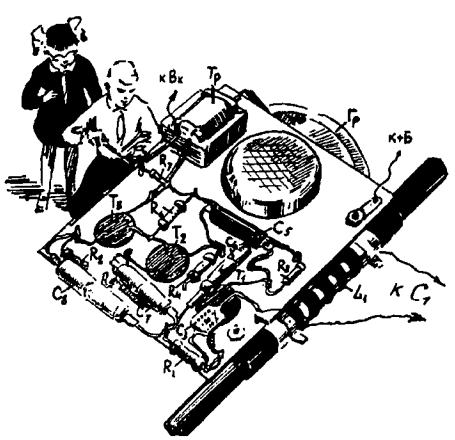
To minimize the effects of the 845s on the preceding stages the 300B and 7044 have their own supply from a separate mains transformer. Both are run from the same rail so that the 7044 has a really juicy supply to suck from, and remember the 300B is running into an unloaded transformer so there is minimal supply draw variation due to constant current operation.

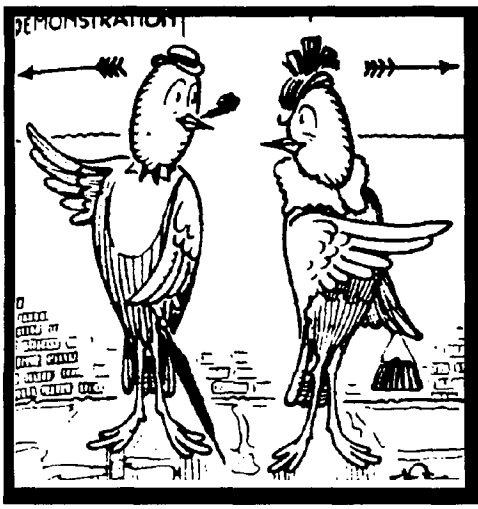
The 845 supply is rectified with two 5R4s in a voltage doubler configuration to ease the peak inverse voltage requirement, the output impedance and peak current go up but it is still satisfactorily within the valve's limits. The driver stage HT is via a 5Y3 rectifier and the bias supply uses a 6X5. The main HT is delayed by the bias supply, the driver stage and bias power is applied when the amp is switched on. The 6X5 is an indirectly heated rectifier and so takes a little while to come up.

When the bias voltage reaches a safe value the big 845 power transformer is switched in by a relay. If the bias fails for any reason the relay will drop out cutting the power to the 845s.

All in all I am pleased with the end result, the *Ankoru* when partnered with a good preamp such as the M3 and a good turntable gives a superb musical performance. It can resolve the smallest nuances and subtle timbres of classical music and deliver the visceral impact of techno, even with relatively inefficient speakers.

In short, this was the design brief: A single ended amp which would give that SE charm and musicality but which would also send the big solid state boys back to their silicon shrines to have a serious rethink.





Lowther, another opinion.

by Marc S. Wauters

More fuel for the inner fire

I've been following the almost euphoric acceptance of Lowther loudspeakers into the hearts and homes of American Audiophiles over the last few years with great interest, and some concern.

With the popularization of the single ended vacuum tube amplifier and the resultant quest for high efficiency speakers it was only a matter of time before Lowther drivers would be recognized as a viable contender.

Having spoken with many "new" Lowther enthusiasts during the past few years I realized that there are quite a few misconceptions floating around in regard to both Lowther as a company and Lowther drivers. I hope that anyone considering the purchase of new or used drivers may benefit from the information provided here.

IMPORTANT! *Be aware that while the following text contains many facts, much of it is also based on MY personal opinions developed through MY experiences. Opinions are like noses, everybody's got one and everyone's is different. Have an appropriate amount of salt handy.*

If you've been reading the articles in *Sound Practices* and maybe surfed over to one of the Lowther Club web sites, then you have a pretty good idea of what these drivers are all about.

High efficiency drive units that can cover the entire audio frequency range at deafening volume levels with only a few single ended watts of power. The purists dream come true ...well, almost.

Now not all of what you are going to read here is necessarily positive. But to dispel any suspicions to the contrary, I would like to say, capitals Mr. Printer please and in bold if you can:

I AM ABSOLUTELY A GREAT LOWTHER FAN !!! ("Worlds *greatest* fan" was already taken.) However, I am also painfully aware of the following facts:

#1: Separating Lowther "Cult Lore" from real-world usable information can be difficult, but it is possible. And as I have come to learn the Lowther factory is not always a good source of information unless you can get hold of the chief designer, Mr. Roy Hopps, but that can be difficult.

#2: In spite of being called "The World's Finest Drive Units", Lowthers are not perfect and you must accept their flaws in order to enjoy their strengths. False expectations based on wrong information (sometimes put out by Lowther themselves) poor product quality and plain old misuse of these drivers has caused quite a bit of frustration for some Lowther enthusiasts. This has to some degree already been pointed out in other articles.

#3: Unlike roses, "A Lowther, is not a Lowther, is not a Lowther" (thanks Harvey...and Gertrude). Or to put it another way: Not all Lowthers are, or were created equal. It is important to know at least some of the technical details of what makes a Lowther sing when considering a purchase. Especially older used ones which may have made it to U.S. shores over the last 20 years must be scrutinized carefully.

#4: Dealing with Lowther directly in regards to product purchase can be extremely unrewarding. While I know a few people who have ordered drivers and actually received them in this lifetime, this is the exception! Many stories are in circulation suggesting that common Lowther procedure is payment in full up front for the merchandise and wait to see what happens. Maybe you'll get it, maybe you won't.

Quite some time ago a friend of mine ordered a pair of PM-4As for which he paid in full up front. After a year and a half of lame excuses from Lowther he was talked into taking a bunch of Feroba drivers instead. Unhappily he accepted because his money was gone and it was quite apparent that he wasn't going to get what he had ordered.

In other words you should get your Lowthers or spare parts from a knowledgable dealer, representation available in most parts of the world nowadays. Your chances of getting a good specimen of Lowther product go up dramatically when someone with a little knowledge and love for these speakers has inspected them!

I'm sure all of the above may sound a little confusing. But if you read on, I assure you it will all fall into place.

My personal Lowther history:

Most of my early years were spent in Europe, Germany to be specific, where Lowther has always enjoyed some varying level of popularity. I first became aware of Lowther sometime in the late 1970s when they were really quite the rage. Kind of what's going on in this country right now. WARNING!

Design and production quality were almost at their best during the late-70s. It should be pointed out that much of Lowther's good reputation was based on products from that time period. The design of the drivers was practically perfect around 1975 and there have been NO REALLY SIGNIFICANT IMPROVEMENTS to the product since then.

I watched Lowther go from extreme popularity during the late 1970s to a low somewhere in the early to mid 1980s. Dealer after dealer tossed in the towel and gave up the line. Few were able to handle the constant changes made to the drive units, changes which never improved the sound. Production quality was more variable than the weather in Germany, going from reasonably good to lousy and back within weeks.

Lowther took some pretty big hits back in the 1980s and it was really all their own fault. Unfortunately, some production and quality control problems persist to this day, which is to say that a knowledgeable and quality-oriented Lowther dealer is definitely worth seeking out.

Through thick and thin, there were some people who've always kept the faith, maybe because they fondly remembered the good old stuff. And eventually I met one of them and he really helped me out a lot. More on that below.

By the time I was ready to purchase my first set of Lowthers, the only places you could still buy them were large mail order houses. Most of the dealers with auditioning rooms had stopped carrying the product. In late 1981, I finally bought a pair of "C" series PM 6 Mk1s, the ones with the "Special Silver Speech Coil". I had been warned by several people not to get the silver voice coil option because the silver voice coils were said to be unreliable, having a tendency to come undone.

Of course, this is exactly what eventually happened, but I *had* to have silver. I think all the stuff I read in *Hi-Fi Exclusiv* about Audio Note of Japan and their "Silver Philosophy" back in the early 1980s had something to do with it.

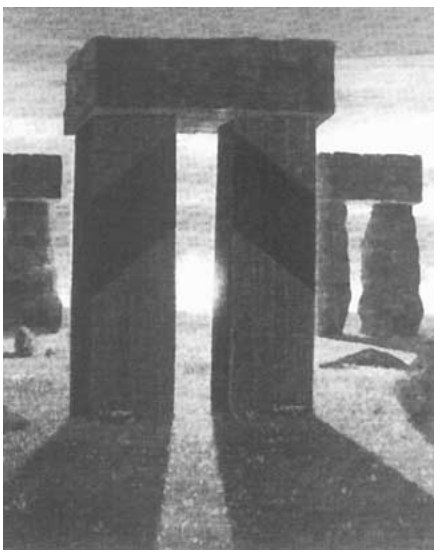
I never did get to use these drivers while I was still living in Germany because in early 1982 I moved back to Los Angeles. My Lowthers, my vinyl, and some select audio gear followed about 6 months later. Not long after I had put my drivers into some experimental cabinets, one of them started to "scratch". So I took them both apart and found that, as predicted, the inner winding of the voice coil had come off the former and was now flopping around in the air gap.

To my great dismay, I also found that the voice coils of the two drivers were of completely different lengths. One was 6 mm long whereas the one on the broken driver was 9mm long!!! Remember what I said about constant changes? Well, these were *supposed* to be identical drivers. I was able to find out from a friend in Europe who had a sort of "Hot Wire" to Lowther at the time that they decided to change the voice coil length of that model from one week to the next. Of course, there was no change in model designation and I just happened to get an "old one" and a "new one" ...hey, thanks a lot, folks.

Replacing the defective cone-voice coil unit was not possible at the time so the still good driver went into the closet and I went on to listening to something else. But I couldn't quite forget the brief experience of listening to those drivers. Although far from perfect the way I had them running, there was something special about the "Inner Fire" (a German expression) , intensity and fine dynamics these speakers displayed even at very low listening levels.

Sometime in 1984, I found out about someone who was selling complete Lowther speakers in Canada and I was able to secure the last pair of Accolade 2s they had for myself. This was the "New Generation" of Lowthers. This speaker consisted of a PM 6 C and a C45 driver in a very small enclosure. Although it was claimed to be a folded horn, it was actually something like a multi-vented reflex enclosure of some kind.

Upon inspecting the drivers I found that they were not very much like the Lowthers I had seen in the past. The color of the cone was now bright white instead of pale yellow and the new paper didn't seem to have the density of the old stuff. The whizzer cone was shorter and the suspension was rock hard compared to the very compliant suspension Lowthers usually had.



These speakers did sound like Lowthers, but real bad ones. A little experimenting soon showed that the C45 unit was a complete joke and that they sounded better with it simply disconnected. But that was not a complete cure. I took out the PM 6s, retired the boxes to shelf ends in the garage and I used the C45s as paper weights.

Later a friend built me a pair of "new" Acousta 115s for use with my salvaged PM 6s. These were not the same Acoustas shown in a previous issue of *Sound Practices* but were a slightly smaller version designed for the "C" series drivers with Feroba magnets. Results were a little better in some ways than with Accolade enclosures but not what I had expected. Four weeks of experimenting with everything rational and irrational yielded no benefit

Then one day a key event took place. The friend who built the Acoustas and I were listening to the speakers when I decided to dig that old PM 6 Mk1 out of the closet and put it into one of the Acoustas just for kicks.

Friends and Lowther Fans, the difference was remarkable! And I was not even sitting in front of the speaker, I was sitting next to it after installing the driver when my friend turned up the tunes. It was not like night and day but the old driver with the pale yellow cone and soft suspension was better sounding in every way. Clearer, more fine dynamics, better tonal balance and less aggressive. This was clearly much more of what I thought and remembered a good Lowther should sound like. The problem was, I only had one driver and mono was not my bag, sorry Vinny.

I was disappointed and confused over the driver issue and knew Lowther themselves would be of no help, so I put the Acoustas in the garage for a while and again searched for something else to listen to.

Quite some time later I decided to give the Lowthers another try, partially because I had just sold my regular speakers. Upon getting them into my listening room I found that the aggressive *"smelL. A."* (I can say that because I was born there) air had taken its toll on the foam surround.

Curiously the older PM 6 Mk1s suspension was still in good shape.

I tried calling the German distributor for Lowther in Berlin in order to get some replacement cones only to find out that they too had thrown in the towel. For reasons of my own more or less outlined in fact # 4, I refused to even attempt dealing directly with Lowther. More phone calls to friends in Germany revealed that a company by the name of Audio Technik in Bad Salzuflen had taken over the German distributorship, so I got their number and gave them a call.

This marked the second key event in my Lowther history.

I spoke to the owner, Mr. Dieter Kirchhoff, and ordered some replacement cones. In the ensuing conversation which lasted about an hour, I learned more about Lowther drivers than in all the previous years from all sources combined. In the

meantime I've spent at least the cost of a pair of PM 4s on overseas calls gathering all the information I could.

I learned that if there is one person who could potentially write the definitive book on Lowther drivers, it is Dieter Kirchhoff. Having been a Lowther enthusiast for almost a quarter of a century, long before he became the German distributor, he has pretty much seen and heard it all. He personally knew Donald Chave, principal designer of all drive units for many years, whom he visited in England on several occasions.

I knew from the experiences outlined above and from talking to other Lowther enthusiasts in Europe that there were quite a few variables associated with Lowther drivers. Dieter was able to explain to me what they were. He taught me all about voice coils, cone types, frames, magnets and driver break-in.as discussed below in the "Techno Stuff" section.

Audio Technik sells two types of Lowther drivers, the standard current production units as they arrive from England (within reason, of course) and what they call the "A.T. Special " line.

A.T. Specials are slightly different than standard-issue Lowther drivers. Mr. Roy Hopps and Dieter put together a list of 26 items which differentiate an A.T. Special from standard Lowther production units. A.T. Specials have the best cones, voice coils, least amount of glue, best magnets, they're aligned perfectly, and they have NO Hi Ferric applied. You can't do any better! But you'll have to pay a little more.

Needless to say the cones I received from Audio Technik were sonically a lot closer to what I expected from a Lowther driver. My faith had been restored.

TECHNO STUFF

"C" type Magnets

The Feroba type magnets are fairly consistent in actual magnet power i.e. relatively close to rated gauss specs. Ideally the magnets center piece should be flush with the outer edge of the air gap. Depending on production run, this has varied by up to 2mm plus or minus making voice coil height adjustment a little difficult because the top edge of the voice coil should be flush with the outer part of the air gap.

"A" type Magnets

The smaller Alcomax type magnets like those on the PM 6 A are not as consistent in gauss ratings, sometimes several Kgauss down from spec. On Alcomax types, the very edge of the inner voice coil should be flush with the edge of the magnets' assembly center piece, i.e. it should just be visible when looking "into" the driver. Having a longer voice coil former than Feroba units, some Alcomax units, such as the PM 2A have the pole piece chamfered so that the phase plug fits properly with respect to voice coil height (see photo). There do exist older units without the chamfering. A replacement cone for this type of magnet will have to be adjusted appropriately in height.

Voice Coils

As you probably know Lowthers have a "balanced" voice coil that is wound on the inside as well as the outside of the parchment paper type voice coil former. The whole voice coil assembly forms a mechanical filter described in "Driver Break In" below.

Much experimentation has gone into finding the optimum voice coil length. Donald Chave believed it to be somewhere between 5 mm and 6 mm. Longer voice coils make the drivers sound a bit "Slow". All A.T. Specials have a voice coil length of 4.5 mm which is what Dieter determined to be optimum. I think most standard Lowthers are currently made with 4.5 mm voice coils also.

For about three years now Lowther has been coating their voice coils with a magnetic paste they call "Hi-Ferric". It's supposed to keep the voice coils centered and increase efficiency.

I'm not so sure it really does much for the voice coil centering. In fact, it will ruin the centering if not evenly applied. It does increase efficiency, but only in a small upper mid-frequency range. And let's face it Lowther fans, the last thing a Lowther needs is more output in the mid-range!!! Worse yet the stuff doesn't seem to stay on for very long. It flakes off and gets stuck in the air gap of the magnet where it causes problems. This requires dissassembly of the driver and a good cleaning of the air gap with cellophane tape. For these reasons, A.T. Specials do NOT have coated voice coils. Draw your own conclusions about the stuff...

Here's the scoop on voice coil material: Aluminum is the traditional material, silver being offered as an expensive alternative. Donald Chave told Dieter that the only reason silver was ever used as voice coil material was for use in the Acousta 124 enclosure, also called the "Super Acousta". This folded horn was essentially an Acousta 115 with two drivers. One of the drivers was fitted with a silver voice coil, not for any special magic sonic benefit, but because of its higher mass specifically to *slow the driver down!* This reduced interference between the two drivers at higher frequencies. So again, draw your own conclusions.

The voice coils on Feroba and Alcomax units differ as follows. The distance from the top edge of the voice coil to the edge of the cone assembly is almost twice as long on Alcomax units, i.e.. the voice coil carrier on Alcomax units is much longer (see photo).

To (hopefully) clarify this a bit, an Alcomax type cone could potentially be used on a Feroba magnet if installed with spacers but a Feroba type cone CANNOT be used on an Alcomax magnet because it would not reach into the air gap.

Power handling

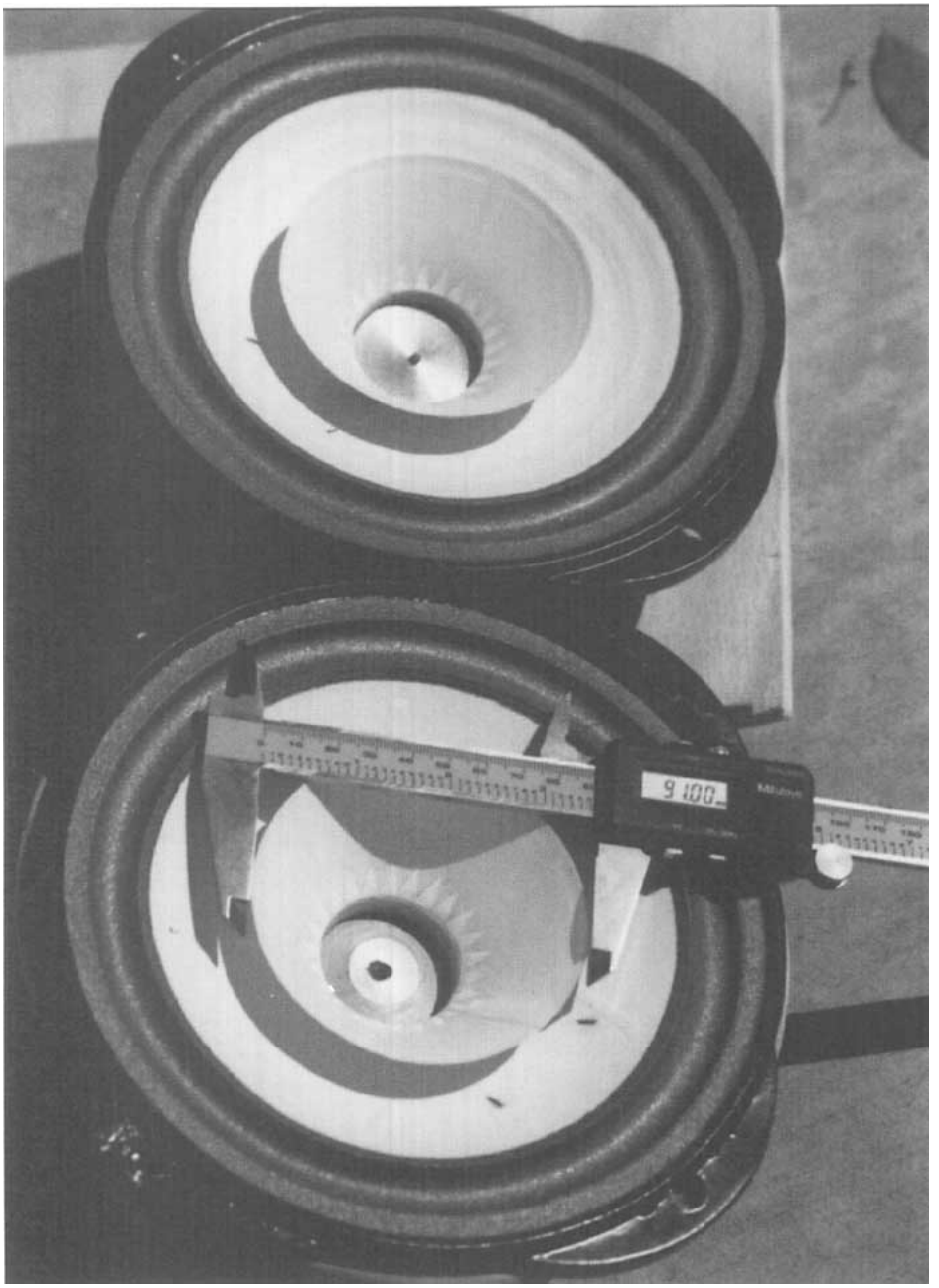
100 Watts?!?!?!? Well maybe for a milli second or so. Let's face it. A voice coil made to be light enough to reach far into the treble range simply cannot be made with a wire gauge able to handle 100 Watts for any length of time. Typical Lowther misinformation. Dieter says in his humorous way that: "At 100 watts the life expectancy of a Lowther is reduced from 10 to 20 years to about 5 seconds."

Driver Break-in

The voice coil former consists of a type of parchment paper chosen by Donald Chave specifically for its thinness of about 0.05 mm and for the following effect, according to his theory —As the drivers are used this parchment paper and the lacquer they are coated with literally "softens", allowing the voice coil itself to move more independently from the cone assembly at higher frequencies. It is this effect, above all others, that is responsible for the difference in sound quality of a Lowther that is broken-in and one that is not.

The cone assembly itself also experiences some softening. You can actually run your thumb nail along the voice coil of a new (non Hi Ferric) Lowther and depending on how crisp a sound you get, which is proportional to the amount of lacquer on it, you can tell if the driver will require a longer or shorter break-in time.

A fully decoupled voice coil produces two sonic effects that are not necessarily supported by measurements. First of all the drivers sound better, faster more extended and less aggressive, often described as



PM-2A (bottom) and PM6C with phase plugs removed. Note the voice coil former is almost twice as long as on the PM-2A. Notice also the chamfering on the PM-2A's center pole. 91mm is the proper size for the whizzer cones.

"silkier" in the treble range. And secondly the extreme directivity at high frequencies is somewhat reduced.

Suspension

Over the years there have been two types of suspension used on Lowthers. The proper "soft" type and the ridiculous "hard" type that was around for a good part of the 1980s. It is doubtful that any of the drivers with this hard type of suspension are still intact because it had a life expectancy of about 1/3 that of the soft type suspension.

Thanks to Dieter's efforts, the early 90s saw the return of the soft suspension and a few other things. If you find some used drivers with the hard suspension, buy them cheap for the magnets and get some new cones. The cones on hard suspension units were all wrong anyhow.

Frames

Frames have always been made out of aluminum. For a very short period sometime in the early 1970s the drivers used plastic frames. These were sonically better in some ways but just not strong enough.

About 5 or 6 years ago, Lowther switched from older style brushed aluminum frames to the stronger black painted version. This is the only change in about the last 20 years that has been generally accepted as an improvement. Some older enclosures will not readily accept the newer frame without modification, so be aware when trying to mix and match.

Cones

More than any other single element, the Lowther's cone is the predominant factor in sound quality and can make or break the drivers as to their usefulness in high quality audio. At the same time, no other part of these drivers has seen more experimentation by hobbyists and the Lowther factory.

The low point in driver quality was reached during the 1980s when the following three elements were combined to produce the worst drivers Lowther ever made, causing much dismay among enthusiasts.

1. The previously mentioned hard suspension was used causing the drivers to suffer especially in regard to resolution of fine-dynamics.

2. The cones were no longer made using the pre-1980 pale yellow paper (about the color of a manila folder) but instead were then made with a white paper that did not have the same high inner density. This 1980s white paper did not have the ability to control certain cone resonances very well and those cones sounded noticeably more aggressive.

I realize that this may alarm some people who recently bought Lowthers with "white" cones. In regard to that let me say this: to the best of my knowledge, Lowther today uses the good paper on all of the A series units However, some C series drivers have reportedly been shipped with the less desirable white paper in recent memory. It varies with the production run, as do so many other things. All AT Specials, whether A or C type use the better paper or else Dieter wouldn't sell them. Again, it is not the color that matters but the "weight" of the paper. Again, find yourself a knowledgeable dealer...

3. The whizzer cone had been shortened by a whopping 8mm!!! I think Lowther did this in response to recommendations by various publications (one no less by the prestigious *L'Audiophile*) that recommended various forms of "butchery" to the whizzer cone to achieve better measured

frequency response and to attempt to tame a resonance that occurs at about 2.5 kHz. Overall, these attempts failed in subjective listening tests when compared to mid-1970s drivers.

Dieter related an interesting story to me about some friends who tried, during weeks of eager experimentation, every possible modification known to man to the whizzer cone. They tried lengthening it, shortening it, cutting triangular patterns into it, you name it. When they brought the "optimized" drivers to Audio Technik, Dieter quickly pointed out that they had rediscovered the 91 mm whizzer cone of the mid-1970s.

According to Donald Chave there is only one correct set of parameters in regard to cone geometry that works optimally. So whether old or fresh off the line, make sure your whizzers are as close to 91 mm outer diameter as possible (see photo).

When Audio Technik was offered the German distributorship of Lowther products in 1989, Dieter asked for samples of current production units. Upon inspecting the current "State of the Art" he respectfully declined unless Lowther were willing to supply him with drivers based on the design of the 1970s, especially in regard to the cones. So after some research and the sacrifice of some older good drivers, Dieter forwarded the design information to Lowther.

Through the concerted efforts of Dieter and especially Mr. Roy Hopps, chief designer at Lowther (credit where it is due), the year 1990 saw the introduction of Lowther drive units by Audio Technik with the suffix "A.T Special" which are very similar to 1975 units. Many of the findings of this research were also incorporated into standard production models, much to the benefit of the product line.

Early 1970s cones had the very outer edge of the cone bent downward and the surround was attached to this lip instead of the cone directly. This kept the cone nice and round and offered a little more strength. Unfortunately it's been impossible to persuade Lowther to use that method again, apparently because it is rather difficult to manufacture.

As to the patterns impressed into the cones, the older diagonal is preferred. All the Alcomax drivers have the original pattern. Only the "C" series has the newer ring pattern and only on the low frequency cone. The whizzer on "Cs" still has the original pattern.

Cone trivia: Sometime in the early 80s Lowther was experimenting with PLASTIC CONES! I have photos to prove it.

The Feroba Models

The only Feroba driver recommendable is the PM 6. All the others have the large magnet problem in which sound is reflected off the magnet back through the cone. A PM 6C/A.T. Special sounds almost identical to a PM 6A/A.T. Special, the C type sounding a little bit brighter because of the shorter mechanical filter described earlier. Don't even consider the C 45 or the C 55!

The PM 7C and the PM 2C tend to sound a bit shrill and aggressive, partially due to the shorter mechanical filter, than their A type counterparts. Don't be fooled into mistaking brightness for clarity.

The Alcomax Models

The Alcomax series consists of 3 different magnets combined with various "soft" and "hard" iron pole pieces and end plates to produce the different magnet assemblies. The hard iron pole pieces concentrate more energy in the air gap for a given physical size but the soft iron pole piece, in my opinion, produce a more "linear" magnetic field.

PM 6A: Has the smallest magnet and pole piece.

PM 7A: Has the PM 6 type small magnet but has a hard iron pole piece that is able to concentrate more energy in the air gap.

PM 2A: Has a medium size magnet with PM 2 soft iron pole piece.

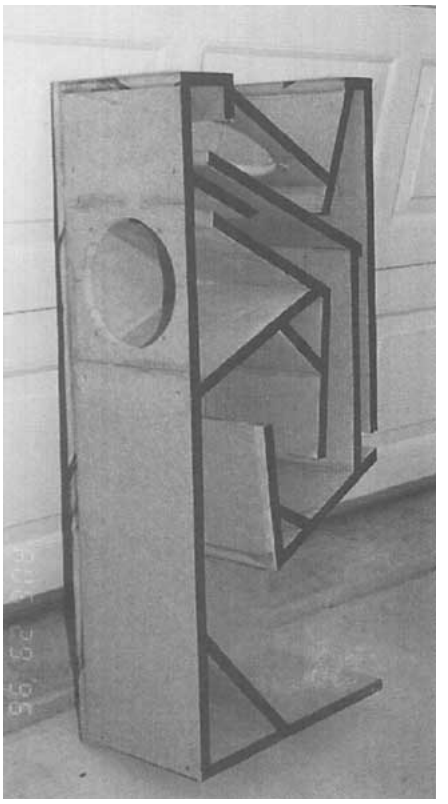
PM 2 MK2: This driver is no longer available. It had the same magnet as the PM 4 A with a soft iron pole piece.

PM 3A: This is a PM 2A with an attached enclosure purpose built for the TP 1 type enclosures.

PM 3/5A: This is a PM 5A with the above mentioned enclosure.

PM 4A: Has the PM 4 magnet with the biggest hard iron pole piece available. This driver was designed to be used as an indirectly radiating speaker in the Audiovector type enclosure which is why it has that "light bulb" like diffuser instead of the standard phase plug. It was never intended to be used as a direct radiator like all the other models.

PM 5A: Has the same magnet as the PM 2 A but has the hard iron pole piece of the PM 4A.

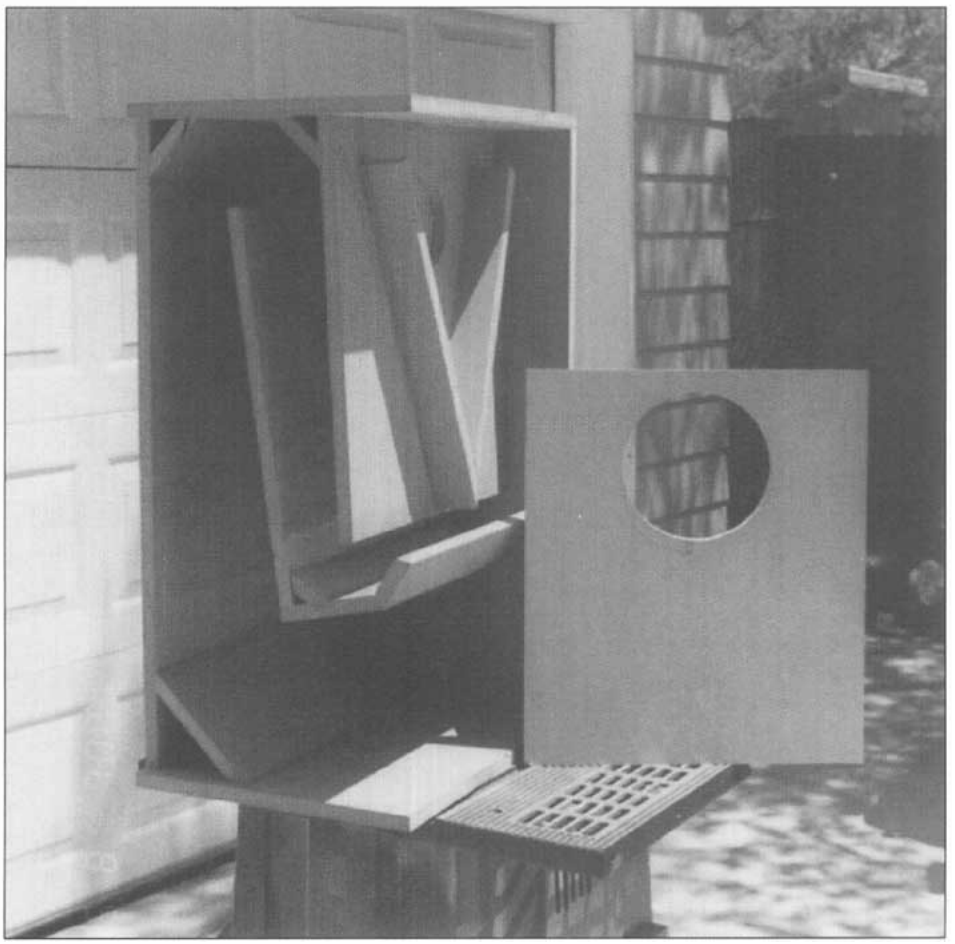


An Academy in the works.

The PM 7A currently enjoys great popularity that I don't quite understand. Dieter points out that the PM 7A is a PM 6A with a different pole piece allowing a little more of the PM 6A type magnets' energy to reach the air gap. Notice the identical weight specification for the PM 6A and PM 7A. Recent spec sheets indicate that the PM 6A has an Alcomax 2 magnet and the PM 7A has an Alcomax 3 magnet? No comment.

If you're considering buying a pair of PM 7s, you may want to invest a few more dollars and get the PM 2A. It's a much better deal. As magnet power increases so do things like high frequency extension, dynamics, voice coil control, and unfortunately a tendency of the speaker to sound aggressive and unbalanced. The PM 2A seems to strike the best compromise in this respect partially, I believe, because it has a soft iron pole piece. Time and time again, I have seen this model chosen by many enthusiasts as the best driver for direct radiating applications because it sounds the most "harmonious."

Note: The use of silver voice coils now available on all units may reduce the aggressive tendencies of some of the more powerful drivers. But this is probably due to the weight factor as pointed out earlier.



A modified Acousta cabinet in progress

It seems wiser to me to put your money into a better magnet assembly versus a "slower" voice coil to achieve this desirable effect.

What to buy used

Of the Feroba type, only the PM 6C and PM 6C MK1

Anything and everything of the Alcomax line you can find cheap but be aware that if it's from the 80s, you're buying it for the magnets. What is cheap? That's hard to say. If you have some used drivers lined up you should check to see what a replacement cone would cost for that particular unit versus the complete unit new. The rest is obvious. Stunning logic, huh?

The good thing about functional used drivers is that they're probably already broken in!

What to buy new

This, of course, depends on the intended application. Get the appropriate driver for the enclosure you plan to build.

As you can tell from what I said earlier I personally would recommend the PM 6C if you're on a budget. If it's Alcomax you want and you can afford it, get the PM 2A, my personal favorite. Other people have different opinions, what can I say?

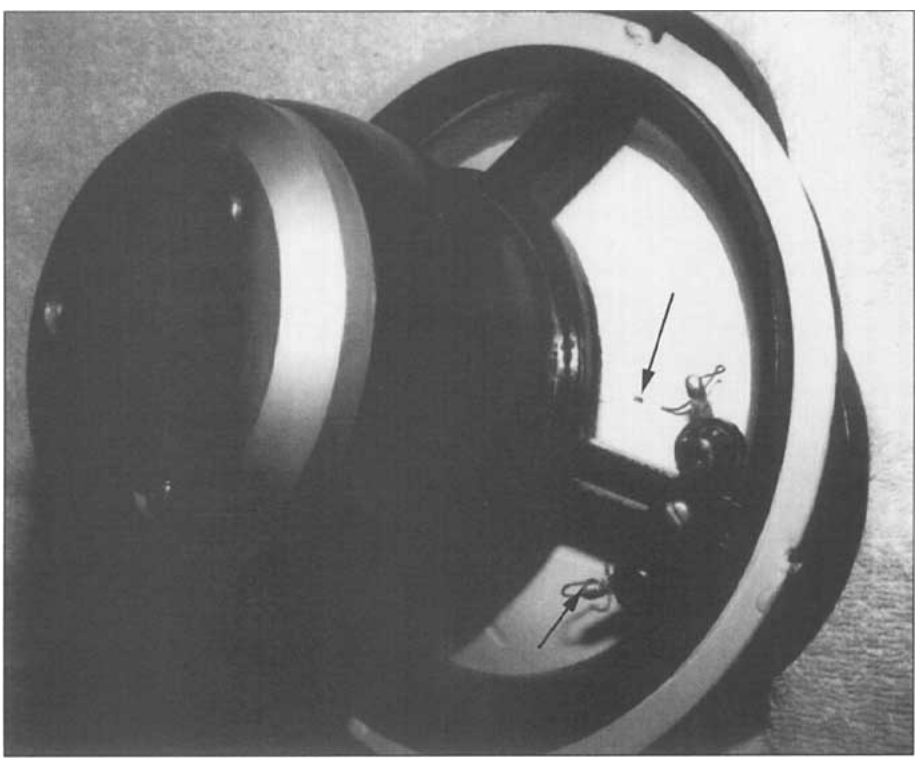
Important: If you are not in a position to hear a set of Lowthers of any type before you buy and don't want to take it on faith, I strongly recommend that you get a pair of PM 6Cs. I am personally absolutely convinced that if you do not like the basic sonic signature and character of Lowther drivers, it won't matter what model driver or what enclosure it is, you ain't gonna like it!!! So if you have to find out through a purchase it may as well be cheap. I assure you the PM 6C has all the qualities that will let you know if Lowther is for you at a reasonable cost.

If you find that you like Lowthers, you can then consider upgrading to one of the Alcomax models. Furthermore, if you want to experiment with one of the dual driver type enclosures, you can get an Alcomax for the front and use your PM 6 Cs for the back.

FIRST AID

The following applies mainly to used drivers, of course. But if you get your drivers directly from Lowther, you should give them a thorough check up, especially with regard to voice coil centering. Lowther is really bad about that.

First check the voice coil with an Ohm



Voice coils often break at these points. This is a repairable condition.

meter. If it reads open,the coil is either fried or the unit has the following typical Lowther problem: When Lowther attaches the aluminum voice coil wire to the litz wire going to the binding posts, they often put too much tension on the coil wire. Eventually this causes the wire to break at that point. Especially if the drivers are stored in a place with varying temperatures, like a garage. I know this because its happened to me. Although very tricky this is repairable (Dieter does it all the time). First you must find out where the wire is broken and then you will have to use a special solder for the repair. It is best regarded as a job for your Lowther dealer or someone who's done it before.

A case in point: A friend of mine in France had 8 new drivers stored for 8 years. When he unpacked them recently to complete the "temporarily" shelved project ALL EIGHT drivers' coils measured open. Yes he was extremely bummed!!!

As I said earlier any thing from the 80s which has the hard suspension and/or the short whizzer, and/or the white paper cones, the cones should be replaced. If the drivers are functional, certainly you can go ahead and use them, just know this is not how it was intended to be.

If you found some drivers that appear to be in O.K. shape, and not from the crap vintage, inspect the whizzer cone for any evidence of butchery which unfortunately is quite common. It should have a measured outer diameter of about 91 mm (see Photo).

Next check to see that the voice coil is centered properly. Press down carefully and evenly onto the whizzer cone with thumb and index finger of both hands. Listen and feel for any resistance or scratching. If any resistance or scratching is present, proceed as follows. Loosen the bolts attaching the frame assembly to the magnet just enough so you can move the frame independently from the magnet. If you have a function generator set it to 20 Hz and give it enough voltage to get the cone to move a few mm. If you get a lot of scratching, use common sense and back off!

Carefully move the frame relative to the magnet until you can turn the generator voltage up far enough to get a good 2 to 3mm of excursion in either direction without any interference to the voice coil. But this is only a starting point. If left here, there is a good chance that the voice coil may be very close to a side of the air gap. When the driver is installed the weight of the magnet can produce enough distortion of the frame to again cause interference.

The careful pushing on the cone method introduces enough "slop" to reduce the chance of this happening. So now go back and do the pushing test again. If the voice coil scratches, do the re-adjust again and check by hand until it runs free. This takes time and practice. Re-tighten the bolts carefully and evenly.

If you can't get the voice coil to run free after several attempts, there's probably something in the air gap that will have to be removed. This is especially likely if you have a Hi Ferric driver.

In this case the frame/cone assembly will have to be removed and the air gap cleaned with tape. As always, use extreme caution during this procedure. Completely remove all bolts before carefully lifting the frame from the magnet.

Should you decide you need a new cone for any reason, it would be wise to remove it from the driver and measure the distance from the edge of the voice coil to the cone assembly. This information may help you or your dealer in getting the best possible replacement unit. If you can't get an exact duplicate, at least you'll know if shimming for proper voice coil alignment is an option. This, by the way, is a common practice.

Repairing minor foam surround damage is possible. I like window silicone the best because I can paint it on very thin with a small paint brush and it has very little effect on the suspension's compliance. Of course, you have to thinly coat the complete surround and spider on both sides. The spider on Lowthers is also made of foam and siliconing it properly will require disassembly of the driver.

Is it really worth fixing an old driver? Well yes, if it's one from the 70s. And furthermore its going to be about as broken in as it will ever get! Besides what have you got to lose?

ENCLOSURES AND WHAT TO EXPECT

This chapter really requires a separate article because there's so much that could be said. But here are a few brief thoughts. The powerful magnets needed to overcome inertia for high frequency reproduction tend to reduce low frequency response. It is also necessary to keep cone excursion down as low as possible to prevent doppler distortion. For these reasons, Lowthers are generally fitted to some type of rear loading bass horn that augments the frequencies below 300 Hz or so.

In my opinion, these horns are a blessing as much as they are a curse. I've been doing quite a bit of work on alternate horn designs for Lowthers as well a some non-horn designs. Assuming there is any interest and I don't get shot by some "Lowther Cultist" for saying some of the things I have so far, I might publish some of my findings in a future issue of *Sound Practices. [Heck, send in the manuscript even if you do get shot. We'll do posthumous articles--ed.]*

I separate the enclosures into 3 basic types:

1) The *Acousta-type* free-standing horns. These are front-firing and are somewhat less critical in room placement than the Bicor type. These are the Mini Acousta 109, the standard Acousta 115 the "new" Acousta 115 and the Super Acousta 124 which uses 2 drivers.

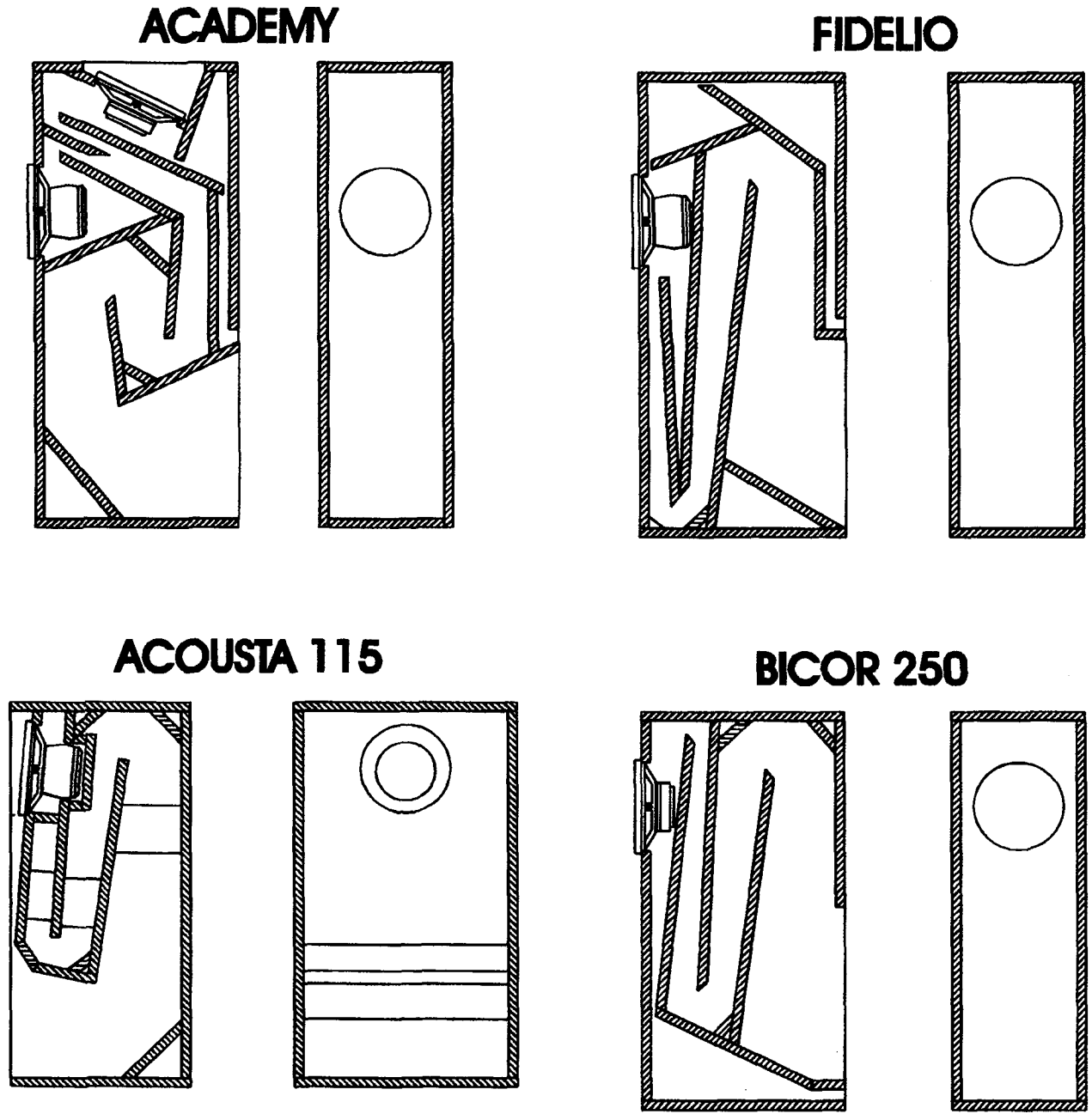
2) The *Bicor-type* enclosures which are rear firing and must be placed to some degree close to the back wall of the listening room. This family of enclosures includes the Bicor 200, the Bicor 250, the Fidelio, and the Belcanto. The models that use 2 drivers are the Bicor 2000, the Academy, the Delphic and the Delphic 500. (The Delphic 500 is not really a bicor, since it does not have a "bicor column.")

3) The *large corner horns* like the Opus I and the TP1 which don't always sound as well as may be expected. Let's stuff Ricky Lee Jones tightly into a corner and see what she sounds like, shall we?

And then there's the Audiovector, Dieter's favorite, which is sort of in a category of its own. This is a VERY large semi free standing horn that uses the PM 4A driver firing upward onto a reflector. Some versions (there are 4 types) also use a PM 2A firing directly. There are probably a lot more enclosures than those mentioned above, but these I know and have the plans for.

So lets have a look at the beloved Acousta 115. This is truly the classic Lowther folded horn. And its got that "Vintage Appeal". The interesting thing is that this enclosure according to Donald Chave is not one of their originals at all!!! Lowther at some time back in the dark ages took the plans from some other speaker and adapted them for use with the PM 6 driver.

There are two things that support this theory. First of all the throat area of this horn



Acousta 115 shown with some newer Lowther "Bicor" designs. Note the narrower baffle width on the new designs

is about 110 cm^2. Just about all other Lowther designs I have seen provide the driver with about 50 to 60 cm^2 of throat area. Which is more appropriate for a driver of this size. In fact if you take a close look at the throat area you can see that it really looks like a hack job with a very uneven transition from compression chamber to throat. This is not Lowthers' style because in spite of many of their faults Lowther does an incredible job of folding their horns. The Super Acousta 124 with two drivers in the same horn provides a better loading.

Secondly, there's that funky magnet box. Look at any other Lowther horn, including the Mini Acousta 109 and you'll see that they generally do a much better job of accommodating the driver's magnet than with a magnet box!

The Acoustas I just built for myself eliminate both problems. They have no magnet box and the throat is 20 cm longer and tapers down to an area of 60 cm^2 (see photo). This horn was built to accommodate the PM 2A/A.T. Specials that I have. Not having an original for comparison I can't say whether it works any better though.

The Acousta's major drawback is its large baffle size. There are a lot of reflections and secondary radiation coming off the baffle that cause some problems and because of this it sounds best at a listening distance of 4 meters or more. Notice that almost all current Lowther speakers have cabinet widths not much greater than the driver itself. The Acousta's big plus is that with minor adjustments to the magnet box it will take any of the Alcomax drivers up to a PM 2A.

The Bicor line are very narrow enclosures. This eliminates many of the problems associated with the large baffle of the

Acousta. They consist of a small folded horn that fires out toward the back. There is also a second "air column" basically in parallel with the horn that terminates in a small vent next to the horn mouth. Lowther claims it eliminates standing waves. Most of the Bicor horns will only take Feroba-type drivers which they were designed for. The single driver Fidelio will take a PM 2A and the two driver Academy will take a PM 2A in the front position and a PM 6C in the rear.

Dieter says that with this driver combination, the Academy is one of the best sounding cabinets going and he sells a lot of them. He also says that where the Acousta has a tendency to "scream" at you the Academy will "sing" to you.

In spite of being a little suspect of the twin driver concept, I built a pair of Academys with a PM 2A/A.T. Special up front and a PM 6C/A.T. Special as the rear driver and compared them to my Acoustas. In my opinion there is NO comparison. The improvements offered by the Academy in every respect, including far better bass in my listening room, are so staggering that thoughts I had of correcting some of the Acousta's shortcomings no longer seem that interesting.

The Fidelio is more or less the single driver version of the Academy and I would build this enclosure before I build another Acousta. It is very popular in Europe right now.

Of the large horns, Dieter considers the Audiovector to be the sonic flagship. It uses the PM 4A rear-loaded into a long bass horn and front-loaded into a midrange horn which fires up against a reflector. This virtually eliminates the unpleasant effects normally associated with the extreme directivity of Lowthers. It can use an additional PM 2A firing directly forward. This driver is attenuated quite a bit in relationship to the PM 4A and it should be run from a separate amplifier with proper attenuation.

I think the large horns should not be considered by Lowther neophytes. They're very ambitious and expensive projects that are difficult to build. It would be wise to start small and graduate to something like an Audiovector.

Unless you're going to get a super high grade (and super expensive) plywood like the Europeans like to use, such as Finland Birch or Multiplex, I would generally recommend MDF for cabinet construction.

Audiovector

There's no substitute for mass. Think about it, if you build an Acousta from some of that super strong and light alloy stuff they recovered from the Roswell U.F.O. crash and it weighed only 5 lbs what would it sound like?[*That Roswell stuff is good for tonearms too- ed.*] Standard plywood may have reasonable strength, but it doesn't have enough mass.

Contrary to what you may have heard the compression chambers of ALL cabinets should have some damping material in them to absorb higher frequencies so they don't reflect back through the cone. Hold a piece of Manila folder (similar to Lowther cones) tightly up to your speakers and see how much sound makes it through. Enough said.

As to the sound you can expect, let me quote my friend Peter Clark who stopped by while I was writing this article to hear my altered Acoustas with the PM 2A/A.T. Specials. After a few minutes of Rare Silk, on vinyl of course, he said:

"They really don't have a lot of bass but man that's the fastest darn thing I've ever heard"!!! And he hasn't even heard my Academys yet!

And fast they are indeed, extremely so. The response to the attack as well as the decay of transient information is absolutely phenomenal. In my opinion, this is Lowthers' greatest strength. These drivers produce a level of midrange clarity, detail, dynamic contrast and liveliness that is just incredible.

The PM 6C does sound a bit rolled off but not enough to be bothersome to me. Years of riding loud motorcycles has reduced my ears "top end response" to about 14.7 KHz. On the other hand the PM 2A plays with a clarity in the top registers that makes any thought of a super tweeter fade quickly. At the same time the sound can take on a somewhat aggressive quality depending on the specific driver and enclosure used and the listening distance. This is due partially to the 2.5 kHz cone resonance described earlier and the extreme beaming at higher frequencies. But you will find that you don't need to turn Lowthers up as far to get the message. All the fine dynamics and detail are there even at relatively low listening levels.

Lowthers can play LOUD. One slip of the volume control and your ear drums will meet in the center of your head!!! And they'll do it with just a few single ended watts.

In his must read book, *The Tube Preamp Cookbook*, Allen Wright makes a statement that I find profound and agree with wholeheartedly. He says, "The ability to accurately reproduce low level information in the presence of other stronger signals is one of, if not *the* most vital property of really good audio gear!" And Lowthers do this sooo well.

So what about the bass you ask? Well J. C. Morrison wrote in one of his articles that no amplifier plays perfectly over 10 octaves. And Lowthers don't either. Lowthers are undoubtedly bass challenged regardless of driver model or enclosure type. The bass they have is bone dry, swift and punchy. But there's just not very much of it and it really doesn't go all that low. Things really start slacking off in the lower mid-bass area and if you're used to the grunt of 15" cobalt powered Tannoys like me, its the only thing you're going to miss.

Of course it depends very much on the listening room. None of the enclosures couple well to a large room. Measurements of a well placed Acousta indicate response down to 50 Hz. Subjectively speaking, I feel that things start getting a bit thin at about 100 Hz or so. The Lowthers bass shyness has sparked many designs in which these drivers were liberated from frequencies below 200 Hz to 300 Hz or so by using a 12" or 15" woofer for the low end. One design as I recall even suggested a Karlson coupler!

I know Lowther fans don't want to hear this but if you want bass extension to complement the Lowthers' spectacular midrange and top, there's simply no getting around using some kind of subwoofer. The problem is finding one that can match the speed of a Lowther. In applications where a subwoofer is desired, Dieter uses nothing less than a Klipschorn actively coupled at 70 Hz. He thinks that it is the only bass speaker that can keep up with Lowthers' speed.

So there you have it. I could have said twice as much and still not have finished my say but all things must come to an end.

Lowthers (good ones) have a unique quality which is entirely their own. They don't appeal to everyone but after reading this you may be closer to knowing if they're for you. If you've been contemplating using Lowthers in your system I hope that you'll now be a little better equipped to make the best choice for yourself. If you get good examples of these drivers, break them in, and use them properly I'm sure you'll derive a great amount of listening pleasure out of them just as I have.

For questions, comments (I have a feeling I'll get a lot of those) corrections or just basic exchange of ideas I can be reached at E-mail : darmah@ goodnet.com Phone: 520-776-5996 Arizona time please! Fax : 520-776-5994

If you want to talk to real Lowther expert, Mr. Dieter Kirchhoff at Audio Technik in Germany, can be reached at 011-49-5222-3096 (voice phone) Make appropriate allowances for local time difference.

Editors note:

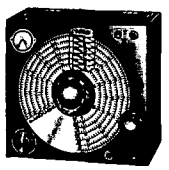
When I first got hip to Lowthers some years ago, I thought that something like a PM6A in an Acousta box would be a great sensible system for tube lovers. And my PM6As in Medallion-style Acoustas are just that for me. Natural sound, simple, reasonable size, medium cost, play loud on low power, intriguing whizzer cone design, I'm quite satisfied with the PM6A Medallion combo. Even though it doesn't have the presence and scale of a 300 lb. horn system, it's no slouch for the size and price.

Little did I appreciate early on that Lowther attracts a wildly diverse, ultra-hardcore crowd beyond anything else in audio. Five articles like Mark's fine essay above would only scratch the surface of what has been done and could be done with Voigt's twin-cone loudspeaker design.

One thing to mention counter to much cult lore about Lowthers is that these things work great with big tube amps too. They seem to come alive with the added power. Somehow it got implanted in many minds that you *have to use a small amp* with Lowthers because they are so efficient. I say try 'em with a pair of 6550s.

Feedback amps really help control the low end, although they *will* play on flea-powered NFB amps. I did find that some otherwise fine amps, like my 45 SE 2 watter, just didn't cut it on the Lowthers. You got to try it out to know for sure, as usual.

Measure Audio Harmonics the Easy Way



by Larry Lisle

Designing, building and tweaking audio amplifiers can be a lot of fun. It can also be very frustrating unless you measure the effect of design changes or parts substitutions. In this article I'll show you an easy way to measure one of the most importantcharacteristics of an amplifier, distortion caused by harmonics in the second, third, fourth and higher orders in the middle frequency range.

Every audio amplifier adds some distortion to the signal it amplifies. One type of distortion that's especially important is harmonic distortion. For example, if the input signal is 500 Hz, the output may also contain signals at multiples of 500 Hz, such as 1000, 1500, 2000, 2500 Hz and so on in addition to the fundamental frequency of 500 Hz. The relative strength of these harmonics to the fundamental and to each other can completely change the sound of the music amplified by the system.

There are many ways of measuring harmonics. One popular method cancels the fundamental with a null circuit and gives a value for what's left as total harmonic distortion or THD. This is useful but doesn't tell anything about the individual harmonics.

Other methods employ tunable filters and are tuned from harmonic to harmonic with the value of each being recorded. These devices are popularly called wave analyzers and tend to be very expensive.

My solution is to use a single, very sharp audio filter intended for ham radio operators for code reception. The better ones will give selectivity of 60 dB down at an octave away from the fundamental. Set the filter to a particular frequency such as 1000 Hz and tune the signal generator to submultiples of that frequency. The voltage passing through the filter will therefore be a harmonic of the input.

This method will measure distortion very accurately in the middle frequency range and give a good picture of the 'sound' of the amplifier. Of course the signal generator has to be relatively free of harmonics and its output and the voltage gain of the amp under test have to be uniform over the middle of the audio spectrum, but these are easily checked.

The equipment needed can often be found used at electronic flea markets. Older tube type gear is often dirt cheap. The signal generator shown cost $25 and the audio voltmeter cost $5. These two items are basic if you're going to do much work with audio. The prices are not unusual. The Autek audio filter cost $25. Some audio filters are tunable over a limited range but since the gain isn't constant they should be set at one frequency as described in the procedure outlined below. The only home-built item needed is the 50,000-ohm potentiometer on a board which is used to set the meter to a convenient value, such as 1.00 volt, and keep the audio filter from running out of head room.

To measure harmonics I use the following procedures, which will take longer to read than it will to make the actual measurements:

1. Measure the input voltage to the amplifier when used in its normal way.

2. Connect a dummy load with non-inductive resistors to the output of the amplifier.

3. Connect the outside contacts of the potentiometer across thedummy load.

4. Connect the input of the audio filter to the wiper contact and one end contact of the potentiometer.

5. Connect the voltmeter to the output of the audio filter.

6. Connect the signal generator to the input of the amplifier. Set the output voltage of the generator to a value determined in 1 above.

7. Set the frequency of the generator to the frequency of the audio filter, for example 1000 Hz. Rock the frequency back and forth slightly to make sure it's at the peak of the filter response curve.

8. Use the potentiometer to set the output of the filter to exactly 1.00-volt or some other convenient value.

9. Without touching the audio filter or potentiometer tune the signal generator to 500 Hz and again rock the frequency slightly to be sure you're on the peak. The output voltage will give the amount of second harmonic distortion. For example, if the reading is .003-volt, .003 divided by 1.00 equals 3/10 of one-percent.

10. Now tune the generator to 333 Hz and take a reading. This is the third harmonic and may be greater or less than the second, depending on the design of the amplifier.

11. Other readings may be taken at 250 Hz for the fourth harmonic, 200 Hz for the fifth and so on, but the values for the second and third are the most significant.

Notice that the calibration of the signal generator and voltmeter doesn't need to be highly accurate in absolute terms, which makes this an ideal method for used or even home-built equipment.

With this method you'll really be able to see and hear the effects as you tweak your amp toward your ideal sound.

An audio signal generator, audio filter, and audio voltmeter can tell you a lot about how your amplifier is working. The potentiometer is used to set the meter scale.

Meet The Tube

The elusive TYPE 50

Until its purchase of Victor Talking machine factory in 1929, RCA was only a sales organization for General Electric and Westinghouse radio products made to its specifications. The two manufacturing companies could engineer and propose new designs, but RCA had final say on marketing any new tubes or equipment. Because of patent cross-licensing among GE, RCA, Westinghouse, and (for commercial use only, no sales to the general public) Western Electric, RCA had a virtual monopoly on tube designs. As a rule, the smaller independent tube manufacturers would only produce what RCA standardized. Most radio makers would use nothing else anyway.

During the late 1920s, more and more radios incorporated electrodynamic speakers in order to satisfy the public demand for boom-boom bass power. However, only one tube was suitable to drive these new speakers, the GE designed 10 which was limited to 1.5 watts output. The 10 used a thoriated tungsten filament as was common in tubes of the day.

Westinghouse engineers substituted a more efficient oxide cathode and managed to get 10 Watts from a tube of roughly the same dimensions and heater power. RCA began offering the 50 in early 1928.

The 50 enjoyed a short vogue until the advent of the 45 tube in 1929. A push pull pair of 45s would deliver the same power as a 50, enough for any radio in the average home, plus it required a far cheaper rectifier and filter system since it ran on 250 Volts instead of 450 and a smaller output transformer was required. In an internal company report in March 1929, GE engineers snickered at the 50 and distanced themselves from it. The 50 lingered in commercial service for a while but by 1930 it was gone from home radios. Not surprisingly then, 50s have never been easy to find – modern claims of wonderous performance are based on a scarcity of samples and abundance of wishful thinking.

Alan Douglas

RCA Cunningham Radiotron RADIO TUBES

50

RCA-50

POWER AMPLIFIER

Filament		Coated			
Voltage		7.5			a-c or d-c volts
Current		1.25			amp.
Direct Interelectrode Capacitances:					
Grid to Plate		7.1			µµf
Grid to Filament		4.2			µµf
Plate to Filament		3.4			µµf
Maximum Overall Length					6-1/4"
Maximum Diameter					2-7/16"
Bulb					ST-19
Base					Med. 4-Pin Bay.

Pin 1-Filament, Pin 2-Plate, Pin 3-Grid, Pin 4-Filament

BOTTOM VIEW

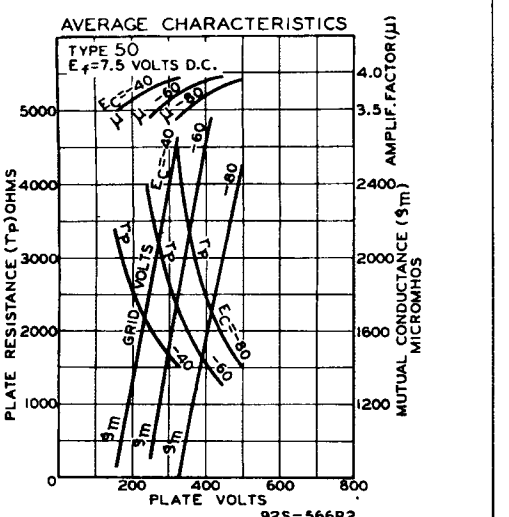
AMPLIFIER (Class A)

Operating Conditions and Characteristics:

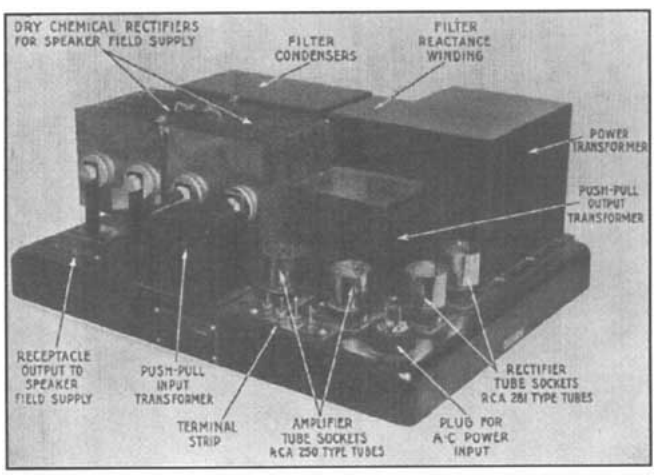
Filament	7.5	7.5	7.5	7.5	a-c volts
Plate	300	350	400	450 max.	volts
Grid *	-54	-63	-70	-84	volts
Amp. Fact.	3.8	3.8	3.8	3.8	
Plate Res.	2000	1900	1800	1800	ohms
Mut. Cond.	1900	2000	2100	2100	µmhos
Plate Cur.	35	45	55	55	ma.
Load Res.	4600	4100	3670	4350	ohms
U.P.O.	1.6	2.4	3.4	4.6	watts

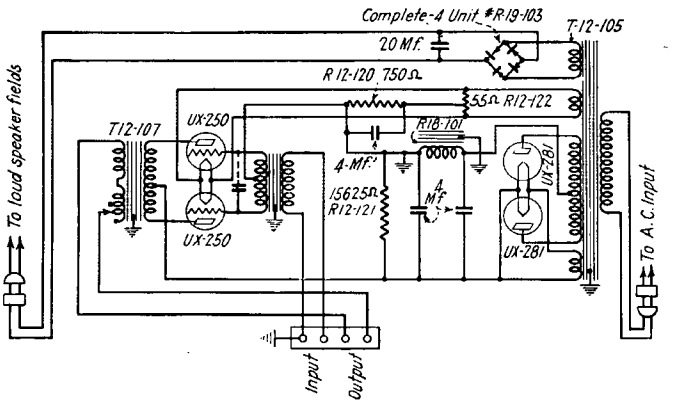
Self-bias is advisable in all cases. The resistance in the grid-coupling circuit should not exceed 10000 ohms.

* Grid volts measured from mid-point of a-c operated filament.



JULY 1, 1935 RCA RADIOTRON DIVISION RCA MANUFACTURING COMPANY, INC. DATA





RCA PK-1 Photophone theater amplifier from the early 1930s. The PK-1 features a step-up transformer at the input and one stage of push-pull amplification employing a pair of UX-250s

An Excerpt from

Tube Lore

A Reference for Users and Collectors

by Ludwell Sibley

Tube User's Guide

Electronics restorer-collectors and audio enthusiasts are rather intimately involved with tubes. The following ideas may prove helpful in preserving and enjoying classic equipment.

THINK TWICE BEFORE REPLACING

It's surprising how rarely trouble in a piece of old gear derives from a bad tube. Even though tube makers in the old days promoted routine replacements of tubes, and even though radio repairmen got a major part of their profits from sales of tubes, the tubes in an old set are quite likely to be usable.(The main exceptions are audio power tubes, which have often at the ends of their lives, and 35Z5s, which commonly have the heater section between Pins 2 and 3 burned out.) Corroded-open inductors, leaky or dried-out capacitors, partly open resistors, and similar troubles are far more likely to be present - and it's a rare set that has only one trouble. Before replacing a tube, consider the following factors.

Loose Base. A tube may be loose from its base. This has no effect on performance, but there is some risk of the bulb twisting around enough for the wires to short-circuit in the base. Recementing (see below) is all that's needed.

Rattles. Bits of loose cement in the base have no effect on the operation of the tube. Likewise with glass particles inside the tube: as long as the vacuum is OK, bits of glass from the "press" are harmless.

Loose metal parts like getters, are more serious: there is a risk of their falling into other elements and causing a short circuit.

Occasionally a large filament-type tube like a 5U4 or 2A3 has rectangular white flakes of filament coating loose in the bulb. This is suspicious, and calls for a test of emission.

Blue Glow. Tubes filled with gas (0C3, 0Z4G, 2A4G, etc.) or mercury vapor (82, 83, etc.) glow in vivid colors in normal use; lack of glow indicates failure. Some healthy power tubes (6CA7/EL34, etc.) show a small area of blue inside the glass at the top, the result of stray electrons striking the glass. However, blue glow inside the elements of a vacuum-type tube indicates a gassy tube which had better be replaced.

One Side Bad. Duodiode-triodes (75, 6Q7, 12AT6, etc.) often show weak emission on one or both diodes. This diode is only a detector; it's not worked hard, and most radios have the two diodes wired in parallel anyway.

Here is a fine case not to replace unless a new tube produces improved volume. The same goes for pentagrid converters (6A7, 6A8, 12BE6, etc.), in which the oscillator section commonly tests weak. If the oscillator works on all bands, at both ends of the dial, it's OK. (For a more refined test, reduce the line voltage 10% with a Variac.)

Full-wave rectifiers often show imbalance between the sides, in a radio which performs satisfactorily.

TESTERS AND TESTING

People naturally like to delegate hard "go - no go" decisions to a machine, but a tube tester is simply a guide to the usefulness of a tube. In earlier times it it was a handy sales tool, a scientific-appearing device helping convince the customer that a new tube was required. The "emission" type of tester checks for gross defects like failed emission - the usual problem with old-time tubes - and for interelectrode leakage. The "transconductance" type of tester is more refined, and usually tests for gas as well. Regardless of type, a tester may "fail" a usable tube or pass a defective one. Any tester in use today is at least 20 years old, and its components have aged appreciably - "5%" composition resistors, for example, have almost universally aged upward, out of tolerance. The tester may not really simulate reality - a TV sweep tube may test "OK" for emission, yet fail miserably in a linear amplifier that works the tube harder than the tester. Because individual tester designs apply different test parameters, a given tube routinely yields different readings from one tester to another.

The message: use one tester consistently, rely on it to catch the gross defects (leakage, gas, burnouts), but expect it to give no more than relative ratings of tube quality. There is no other place in electronics where keep-or-replace decisions were commonly made, based on a drift-prone analog instrument lacking even a calibration control!

Certain expensive 2.5-volt tubes (the 45 and 2A3) draw multiple amps of filament current from the tester. Before placing too much faith in the meter reading, it is wise to be sure the filament voltage is close to 2.5 volts under load - just put the probes of a digital meter on pins 1 and 4 of any of the unused sockets. The voltage often sags to 2.1 or so, guaranteeing a low reading. This is partly a fault, the result of using an inexpensive transformer. It is also partly a virtue, answering the need for current-limiting at times when the user sets up the tester to apply heater voltage to an internal jumper in the tube! Bottom-of-the-line testers may supply "2.5" volts, but don't even give setup data to test 2A3s - and test 5U4s at 4.6 volts.

The test instructions can be screwy, too. Example: on the Heathkit IT-17 and -21 testers (the best of the kit emission checkers), the test instructions for a 199 tube call for a filament voltage of 2.5 (vs. a proper 3.3). This lets only unusually good tubes read "OK." Turn the voltage up to 3.15, and the tube perks up considerably. The use of 2.5 V is probably a carryover from earlier models that lacked the 3.15-V setting.

FURTHER TUBE SCOOP

Multiple-Numbered Types. Far too many tubes carry multiple numbers, as the result of prototypes that were only triflingly different. Early examples were the 35/51, 39/44, and 47/PZ. Toward the end of the tube era this effect mushroomed. Thus, the owner of a 6BS8 automatically has a 6BQ7A and a 6BZ7. The best defense against this confusion is a tube-substitution book.

Improved Versions of Tubes. An "A" or "B" version of a tube is improved over the basic model, and will replace it (except for some Western Electric tubes which are incompatible from "A" to "B"). However, many "A" versions of the mid-'50s are improved only in that they warm up in a controlled length of time. This is important in series-string TV sets but meaningless in parallel-wired equipment. Some such types are:

6AM8A 6AU6A 6BK7B 6CL8A
6U8A 6AN8A 6AU8A 6BR8A
6CG8A 12AZ7A 6AQ5A 6S4A
6AW8A 6SN7GTB 6CB6A 6T8A
12BH7A 6AT8A 6BA8A 12BY7A

Improvements in other types may or may not matter, depending on the use: The 6AF4A is simply shortened physically; the 12AU7A is a low-microphonics type; the 12AX7A is a low-noise-low-hum variant.

Interchangeability Between Makers. In North America, the land of interchangable parts, the tube industry was blessed with uniform standards. Makers produced tube parts and complete tubes for branding and sale by their competitors. An 80 made by RCA can be replaced confidently by one from Arcturus, GE, Sylvania, etc. This seems obvious, but the writer has seen an old-timer insisting that the only feasible replacement for his blackened National Union ripply-plate 80 was another NU.

Military Tubes. There are numerous ex-military tubes around. These lack prestige to some degree, having once been sold off as "war surplus" at low prices. However, they had to meet rigid requirements (at the time, the MIL-1-A series of specifications) and are a higher-quality product than ordinary civilian tubes. They are thus perfectly good for radio-electronic restoration, and carry some cachet in the tube-audio world. The military departments are still selling excess tubes in lots of thousands, so this source has not dried up.

Early Metal Tubes. Plain black metal tubes carrying steel-stamped brands and type numbers date from the first production in 1934-35. Looking like engraving, the stamping appears mainly on RCA-Cunningham and Raytheon tubes: the "original nine" (5W4, 6A8, 6C5, 6F5, 6F6, 6H6, 6J7, 6K7, 6L7) and the 6X5. Tubes in this style are "correct" replacements for 1935-season radios like the Atwater Kent 317 or GE A-81; by contrast,they are not really right in a later set.

Metal tubes with a protruding "getter bump" on the shell just above the header are early, dating pre-1936-38. Grid-cap types (6K7, etc.) having brown insulation under the grid cap are of pre-war vintage. Those with the type number steel-stamped into the bottom of the shell are from 1945 or later.

"MR" Tubes. Many old tubes are stamped "MR." These came from a 1943-45 program of manufacturing a few popular types for "maintenance and repair" of civilian radios, thus reducing a crippling shortage caused by WW II military needs.

"T9" Oldies. Interesting tubular replacement tubes appeared in the '50s: T9-bulbed versions of the 27, 37, 41, 80, 84, and 25Z5. They were a useful simplification to makers: put a 6K6GT bulb on a six-pin base, and a 41 results; put a 5Y3GT bulb on a four-pin base, and get an 80. It is easy to overlook these today because of their GT-sized cartons.

Substitutions. The beginning tube substituter can get good guidance from the wartime booklets produced by the tube manufacturers, or any edition of the Howard W. Sams substitution guide (still in print). There has been some wild substitution advice in the tube-audio world ("replace a 47 with an 814"), but the old-time sources are reliable. Speaking of substitutions: the little known industrial 5R4GY is a dandy plug-and-play replacement for the 5Y3G; it draws no more filament current, but has bigger plates and runs cooler.

Making Your Own. Many otherwise uninteresting tubes can be made into useful types by making an adapter. Equipment restorers are unnecessarily reluctant to make adapters, perhaps out of simple unfamiliarity, yet this was routine stuff in the tube shortage of WW II. For example, the 7591A audio tube is now scarce and pricey. The 7868 is common and the 6GM5 is more or less an orphan. Yet these are electrically the same - quite fit for use with adapters.

Changing or rewiring the base can work fine. As an example, consider the 6A4/LA: a 6.3-V filament-type five-pin power tetrode used in 1931 Motorola car radios. A lot of these have survived as new-old-stock, being useless anywhere else. The 6A4 becomes a good replacement for the 201A by changing from a five-pin to a four-pin base, triode-connecting the tube. At five volts, it draws the 201A's 250 mA and has ample emission. An Atwater Kent 35 plays nicely with six rebaseed 6A4s.

Rectifiers, which usually involve only four leads, are particularly easy to re-base. Some handy conversions among electrically identical (or better) types:

5R4GY to 80
5U4G to 5Z3
5Y3GT to 5Y4GT
5U4G to 5X4G
5V4G to 83-V
5Y3GT to 80

What You See Is (?) What You Get. In inspecting flea-market tubes, it is helpful to verify that the tube in the box matches the brand and type on the carton. However, RCA tubes are a special case: new-old-stock with the "new" (1969) logo often appears in cartons with the "old" logo. RCA must have had a large stock of obsolete boxes when the corporate symbol was redesigned. A variant tube should match the box - a "12AU7A" box should contain a 12AU7A - but the writer has seen a group of distributor-stock 6GT5s in 6GT5A cartons.

BUILDING A REPAIR STOCK

Restoring old equipment goes a lot easier with a good supply of "tubeware" on hand. The hints that follow will be helpful in assembling a stock for general repair use. The assumed starting point is, say, a bag of loose tubes fresh from a flea market or auction: begrimed and unknown as to condition. The rate of recovery is not bad, usually running 80-90%.

Clean-up. Inspection comes first, with filtering-out of the hopeless color-TV types. Then a wash under running water with dish detergent is effective on the grime, with a little steel-wool help on the power tubes where the dirt is baked on. Tubes should be generally be held upside down to keep water from running into the bases. Cardboard beer flats with paper towels on the bottom organize the finished product and aid drying. Tubes needing repairs get set aside for the Tube Hospital. The exception to washing is miniatures and loctals, most of which are identified with water-soluble ink. Either the brand name disappears or the tube becomes wholly anonymous. Washing should be limited to the non-inked part of the tube. The ink even smudges when handled with moist hands.

Miniatures and compactrons need a check for bent pins. A pin straightener or fingernails are the preferred tools to correct any bending. The use of pliers is likely to crack

the glass.

An important hint applies to big-pin (4-5-6-7-pin) tubes: if they've been stored outside a radio through humid summers, the heater pins may have corroded enough to give poor contact in the tester. This applies particularly to the 2.5-V types. These draw an amp or more, so a contact resistance of even 1/10 ohm will keep them from heating fully. Hand wire-brushing is insufficient. It usually is necessary to scrape the heater (big) pins vigorously with a single-edged razor blade. The same goes for loktals with their small pins: the heater pins (1 and 8) may look clean, yet be covered with an insulating film.

Testing. The game now is to speed up a basically slow task. The affordable luxury in this area is two testers of the same type. For multiple single-section tubes of the same type - 50L6s, say - the test goes left-right-left-right, warming up in one tester while reading on the other. For multiple-section tubes, each tester handles one-half of the tube.

Many testers require the user to cruise up and down the roll chart to get test instructions, and then to set up all pin connections before the heater voltage is applied. It is easy to make up a simplified card showing the setups for the most common audio and antique tubes. The setup sequence also can be changed so that the first thing set up is the heater; the tube is then warming up while the other settings are in process. This is a safe process because no known tester applies high voltage until the "test" button is pushed.

Regardless of the hardware, the idea is to group the octals together, the 7-pin miniatures, the loctals, and so on; then to bunch up tubes of the same or similar types. With the tester set up for a particular type, one can breeze through all units of that type. This idea leads immediately to grouping all types having the same pinouts, for example the 6SG7-6SH7-6SJ7-6SK7-6SS7 family or the 12AU7-12AV7-12AX7-12AY7-12AZ7 group. Here it is possible to go between types by changing only the potentiometer(s) on the tester, not the pin switches. Or one can group by heater voltage: test the 6BA6s, then do the 12BA6s by simply turning up the heater voltage. Wisdom requires testing the lowest-voltage types first, to avoid the bitterness of blowing a tube with excessive voltage. With practice, one can do a hundred mixed tubes an hour.

In the '50s, the counterman in a parts store who spent the day testing whole TV-sets-ful of tubes had a preheater: a chassis with multiple sockets wired to apply six volts to all heater pins. This shaved a few minutes off the time to check a load of tubes - not a bad idea for anyone expecting to test a lot of tubes.

Further Tests. Supplemental tests are sometimes necessary. 35Z5s and 35W4s may test "good" even when the pilot-lamp section of the heater is open. An extra check with an ohmmeter is needed on these. Big rectifiers like 5U4s that test OK may arc-over when used at full voltage; only set-testing finds these.

Mystery Tubes. Tubes of the two-digit variety may be numbered almost anywhere: on the crown, the side of the bulb, or the base. The numbers are often faint, especially on Sylvania and Philco tubes of the early '30s. Here the old repairman's trick of rubbing the tube on one's hair comes into play. The tube collects a light coat of oil, which one strokes with a finger into a microscopically thin layer. Holding the glass up to the light then reveals the number by contrast. The best test is to do this in bright sunlight, observing slowly and patiently.

With practice it becomes possible to guess the type pretty closely by inspection. (If it has a cylindrical structure with a zillion visible grids, a cap, and a seven-pin base, it's either a 2A7 or a 6A7. If it then tests OK as a 2A7, that's it.)

Storage. Boxing-up comes next. New white boxes are available from sources like Antique Electronic Supply. They sometimes appear in collector markets. Old boxes can be reused nicely by covering the type-number stamping with typist's correction tape of the 2/6" width, giving a fresh writing surface. (New-old-stock TV tubes often are auctioned off for much less than the value of their cartons.)

For storage, a cardboard box of the 11" x 17" size used for xerocopy paper can be cut down to tube-box height. It then takes 96 octals or 192 miniatures, with a convenient slip-on lid. With 3" x 10" spacers cut from old file folders to keep the rows straight, a tidy package for storage results.

To store tubes without individual boxes, cardboard beer flats can be cut down in height (to 1-" for T9s, etc.) and the tubes laid out. The flats will stack in xerocopy paper cartons. This is not as elegant as individual cartons but definitely beats jumbling the tubes in a box.

After sorting out the first few hundred items, tubes resolve themselves into three classes: the Prized Repair Supply, the Flea-Market Sale Stock, and the Embarrassing Glut. One quickly learns the low value of most TV-set "pulls." (The 6SN7 is an "audio" type today, but how many 17D4s can you use in a lifetime?) The flea-market stock can be sold off, if the tube boxes are labeled clearly and displayed in order. Miniatures have only minor value in the collector market, but have some draw with comm-gear restorers. Six volt Compactrons have some (small) value for use in '60s amateur and audio gear.

TUBE HOSPITAL: REPAIR & REACTIVATION

In principle, tubes are not repairable, other than the rebuilding operations that are applied to big transmitting types. Still, there are numerous ways to salvage a troubled tube.

Loose Bases. To re-cement the tube, use clear nail polish - paint a ring around the base, let the polish soak into the old cement, recoat, and let dry overnight. Polystyrene "coil dope" works as well, and can be used to refill the nail-polish bottle. Solvents (acetone, etc.) are ineffective in softening the old base cement - the cement was baked hard in manufacture, and "nothing" dissolves it.

Broken Keys on Octals. These have no effect on performance but are unesthetic. Inspection will usually show where the locating rib on the key was located. If not, an ohmmeter check for the heater will reveal which pins are 2 & 7 or 7 & 8.

Key breakage is most common on big metal tubes (6L6, 5T4), whose weight stresses the key if the equipment is dropped. Fortunately, these are the easiest to repair, simply by replacing the base wafer. To do so, flex each pin carefully with pliers until the brass breaks, then unsolder the pin. Uncrimp the shell from the base wafer. Swap the wafer with a good one from a dud. With practice, this takes less than 15 minutes.

It is possible to cement new keys onto bases, but holding the key aligned until the cement (epoxy, etc.) cures is a problem. A wafer-style tube socket, pushed onto the pins upside down, makes a holding jig. Still, the key often comes out tilted.

Rebasing. Old tubes have sometimes been stored in wet locations where a pin has corroded to the point of breaking - the brass was cold-worked heavily in fabrica-

tion, and is sensitive to chemical contamination.

High-value tubes like 201As or 45s are well worth rebasing. To get the old base off without worrying about the base cement, break the remaining pins and unsolder then. Cut a slit across the bottom of the base with a hacksaw. Insert a screwdriver and twist; this cracks the base off in two halves. Then solder on a new base and recement.

Missing Grid/Plate Caps. The artful restorer keeps a supply of caps from dud tubes. Cap replacement is straightforward if the leadout wire is intact and long enough - just scrape the wire with a razor blade before soldering. If the wire is a bit short, put the new cap on the bench right-side-up and place the tip of a Phillips screwdriver in its center. Tapping the screwdriver will dish-in the cap enough to meet the wire.

If the leadout wire is broken off at the glass, there is still hope. On tubes where the glass seal is long and tapered (e. g., RCA), it is feasible to crush the very end of the seal with pliers to expose a tiny amount of wire. On tubes with a "blob" or rounded seal (e. g. Arcturus), the trick is to use a vibrating engraver (Burgess Vibrograver, etc.) to chip away just a bit of glass, say, 0.020". Then take a few inches of hair-fine copper wire from a piece of zip cord. Loop the center of the wire around the exposed leadout - only a single turn is needed - and solder. This gives two pigtails that will reach up into the new cap.

"Open" Filaments. Oldies like 201As routinely have "open" filaments from corrosion inside the base pins. The best repair is to make a tight hairpin from a short piece of #20 tinned wire. This fills space inside the pin, and gives lots of surface for new solder to grip. Melt the old solder, insert the hairpin, and apply new solder liberally. This also applies to 2.5-volt tubes, which cannot take even small amounts of joint resistance. Resoldering was a standard trick of TV technicians in the days of soldered-base picture tubes.

Resoldering is a slow way to troubleshoot tubes. To determine quickly whether the "open" is real, connect a current-limited high-voltage transformer to the filament pins. If there is an arc visible inside the glass, the tube is hopeless. If not, the current has probably broken down the solder joint and is flowing harmlessly. Resoldering is then justified. A typical high-voltage transformer is the oil-burner type, putting out 10 kV but self-limiting to 23 mA. This current poses no danger to a 250-mA 201A. Neon-sign or bug-zapper transformers would probably work as well.

Just use well insulated leads and a three-wire power cord, and stay clear of the high voltage.

Leaky Tubes. Old tubes often show inter-electrode leakage. This is generally harmful to circuit operation, but a 201A with, say, a one-megohm leak from grid to filament will work fine in a '20s battery radio.

Many such leaks (other than temporary ones from water getting in the base during washing) result from cathode material evaporating onto insulators inside the tube. These can often be cleared by a brief spritz from the oil-burner transformer - half a second will do. A leaky miniature tube can often be fixed with a vigorous rap on the bench. And there are special cases: a pair of EL34s with leakage from plate to heater (Pin 2 to 3) turned out to have arc tracks burnt into the base. (Someone must have turned the volume up with the speakers disconnected.) Scraping away the burnt material fixed them.

One nice "S"-bulbed UX-280 that had arcing between plate leads inside the base was saved by drilling a hole into the bottom of the base and pushing the wires apart. An old-time tipped BH cold-cathode rectifier that arced-over internally was cured by putting a pair of 1N4007 diodes in its base. This is one of the few cases where silicon diodes are unlikely to stress the rest of the circuit from overvoltage.

Gas. The word among old-time radio operators was that a gassy tube could be saved by applying normal voltages and heating the flashed getter deposit with a small flame. A couple of recent tries on gassy CX-245s failed to confirm this, but it may be worth trying.

Rejuvenation. Reactivating tubes was a well known practice in the '20s but not common later. There are three techniques involved, depending on the type of tube.

For pure-tungsten filaments (in the original 200, 201, and early transmitting types), the goal is simply to evaporate contaminants. Operate the tube at 110% of rated filament voltage for up to half an hour, then retest.

For thoriated-tungsten filaments (in the 10, 22, 71 - not 71A - , 120, 199, 200A, 201A, 216B, 240, and later transmitting types), the trace of thorium on the surface of the filament that provides most of the emission needs to be restored. The starter technique is to operate the filament at 135% of rating for 30 minutes. This makes fresh thorium diffuse to the surface. Test, and repeat once if necessary. If that doesn't succeed, take a deep breath and give the tube 350% of rated voltage for 30 seconds. (This usually wipes out whatever emission there was.) Then let the tube idle at normal voltage for a while - two hours, four hours, overnight - and the emission is usually normal.

For oxide-coated filaments or cathodes, it may be successful to run the tube for an hour before testing. Then go to 120% of rated voltage and monitor the emission for an hour or so. It should slowly increase, peak, and gradually decline. The trick is to go back to normal voltage just after the emission peaks, and let the tube run for at least four hours.

For cathode-type tubes, direct action in nothing-to-lose cases is to apply triple voltage for 30 seconds, let the tube cool, and retest. Tubes with 6.3-volt heaters rarely burn out at 19.6 volts. One or two cycles of this will improve - or impair - a lot of '30s and even "modern" types.

"Eye" Tubes. These are usually dim as-found; being nonessential to the operation of the radio, they were rarely replaced during normal servicing. Despite a couple of hopeful-sounding articles in the collector press, they rarely can be reactivated (this is the result of a test run on 25 "dims"). The villain is not low emission; it appears to be contamination of the willemite (green-glowing) target coating. The contamination is visible on the metal targets of really bad 6E5s and the like; it is easily visible on used 6AL7s, which use a coated mica target and readily show the blackening. Two partial fixes: (1) make sure the 1-meg resistor in the socket is good - an open resistor will dim the display; (2) rewire the plate lead directly to the rectifier output, thus giving it extra voltage. A small increase in voltage gives a disproportionate increase in brightness.

IDENTIFICATION AND DATING MANUFACTURER CODES

Tubes are often marked with private brands. A set-maker (Du Mont, Emerson, Philco, Zenith, etc.) usually equipped its products with tubes made by the tube companies but marked with its own brand then warned the owner to use only its brand for replacements. RMA-EIA codes on the following list may be found on tubes in addition to the private brand. They show the real origin of the product, like "Emerson" tubes made by GE (Code 188), or "Philco" branded items from

National Union (Code 247). The codes do not distinguish between manufacturers and distributors; they appear on, say, imported tubes for which GE was the U.S. distribution agent.

This list can also be used on military codes. The letter codes in parentheses are military identifiers that often give the maker of an unidentified tube - for example, a JAN-CIM-2C39 would be an Eimac product. The services did not put up with third-party manufacture: the code on the tube represents the actual maker.

MANUFACTURER CODES

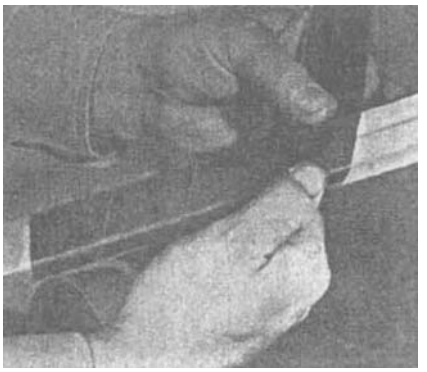
111: Amperex (CEP)
117: Arpin Mfg. Co. (CAPQ)
158: Du Mont (CDU)
162: Eimac (CIM)
170: Electronic Tube Corp./General Atronics (CVG)
177: Farnsworth Tel. & Radio Corp. (CFN)
179: Federal T. & R. Co. (CFT)
188: GE (Ken-Rad) (CG, CKR)
189: General Electronics (CDR)
210: Hytron/CBS-Hytron (CHY)
212: Ind'l & Comm'l Elect. (CIZ)
226: Kuthe Labs (CADK)
231: Machlett Labs (CAGD)
247: National Union/Lansdale Tube Co. (CNU)
260: Philco
274: RCA (CRC)
280: Raytheon (CRP)
301: Sperry Gyroscope Co. (CS)
308: Stromberg-Carlson
312: Sylvania (CHS)
322: Tung-Sol (CTL)
323: United Electronics (CUE)
336: Western Electric (CW)
337: Westinghouse (CWL)
354: Lewis Electronics (CYN)
423: North Am. Philips (CNY)
431: Waterman Prod. Co. (CAGX)
557: Electronic Products Co.
562: Polarad Electronics
636: Sheldon Electric Co.
653: American Telev. Inc. (CAGE)
672: Thomas Electronics (CBUP)
677: Rogers Elect. Corp. (CQ)
713: Taylor Tubes, Inc. (CTY)
738: Lewis & Kaufman, Ltd.
744: Hughes Aircraft Co.
749: National Electronics (C)
771: Penta Labs
781: Vacuum Tube Products
787: Sonotone Corp. (COZ)
803: Microwave Associates
806: Gordos Corp.
809: Varian Associates
818: Tel-O-Tube Corp.
879: Litton Industries
884: C. R. T. Electronics Corp.
886: Calvideo Tube Corp.
935: Electrons, Inc. (CEL)
940: Bomac Labs. (CBNQ)
964: Huggins Labs
1012: Bendix Red Bank (CJEA)
1101: Rauland (CIY, CBQZ)
1120: General Electrodyn. Corp.
- Arcturus (CAA)
- Cable (Speed) (CRS)
- Canadian Westinghouse (CK)
- Champion (CRS)
- Chatham Electronics (CAHG)
- Daven (CDN)
- Duovac (CBW)
- Electronic Enterprises (CDZ)
- Heintz & Kaufman (CKH)
- Johnsonburg (CJR)
- Majestic (CMW)
- Northern Electric (CT)
- Victoreen (CBBM)

Classic Reprints

"Roll Your Own Output Transformer"

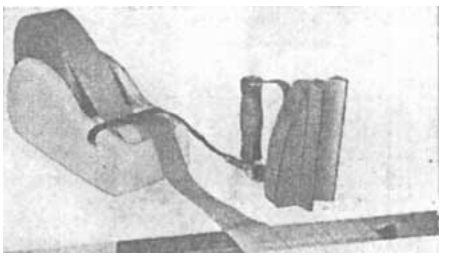
by J.R. Langham

Good old J.R. definitely gets our vote for Homebrewer of the Month, December 1948



All photos courtesy U.S. Navy

This is one of several ways to make the form ·



Finishing the form. Forms may also be made of electrical fiber scored and folded square

The first time I ever wound an output transformer was way back when. I was just getting interested in radio, and the XYL was just a YL. I wasn't even in the radio business. I was just an amateur. Money being very scarce those days, I could not afford to buy a decent output transformer for my amplifier. I had a little open-frame 39 cent special and blamed it for the distortion and the short frequency range. I ached to be able to spend ten or twelve bucks for a hi-fi job, but I just didn't have the long green stuff.

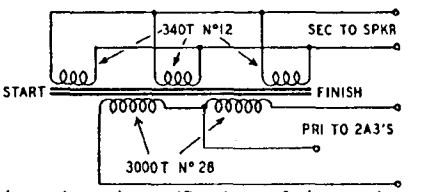
It was the YL who put this particular bug into my head. "Why don't you make your own?" she suggested.

"Me? Wind a transformer myself?" It was absurd. Transformer winding was an esoteric art reserved for the mysterious high-priests of electronics. It was unthinkable,but I thought of it just the same. I heard of a guy who wound transformers, and I made a pilgrimage to see him. He talked, I listened. I bought some beer and was respectful, and he gave me an old burned-out 300-ma power transformer and some insulating paper.

"Here," he said. "This'll make you a honey of an output transformer."

I gulped. "How do I go about it?"

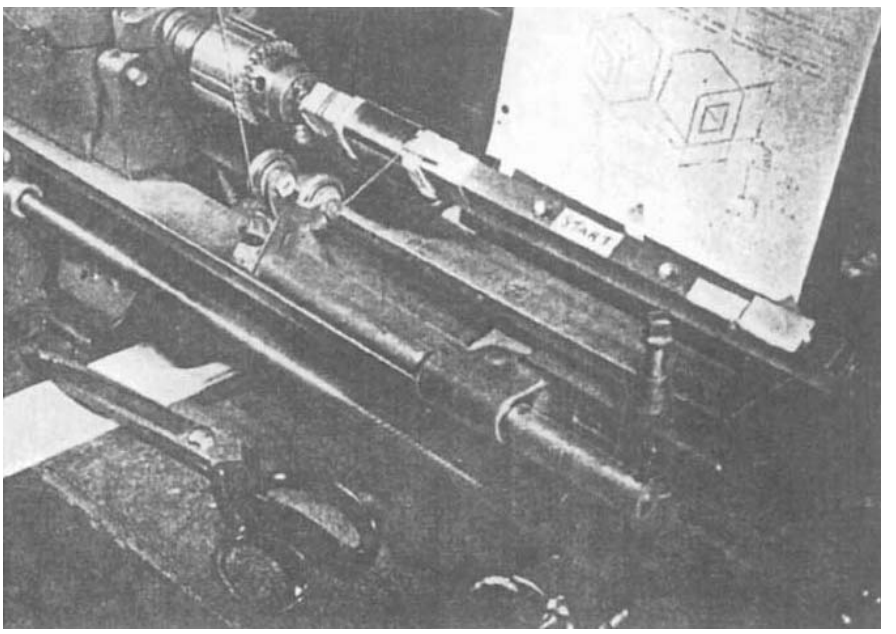
"First un-pot it and knock the laminations apart. Heat them up and then let them cool slowly so they'll get soft. Measure your window carefully and decide how many turns you want of what size wire. You know your impedance ratio, so you know the turns ratio. Get a wire table. Make the primary about half the space available. Put in at least three secondaries and parallel 'em. That's to give good highs. Design it."

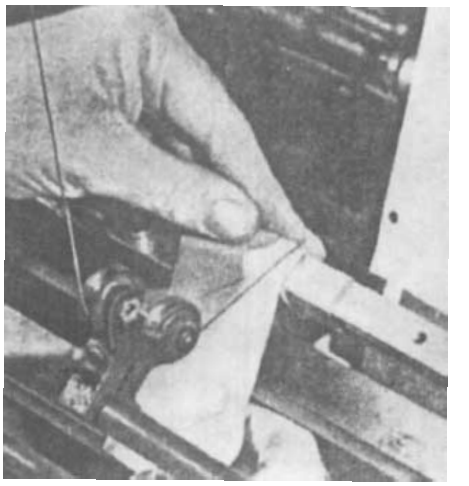


Schematic and specifications of the windings.

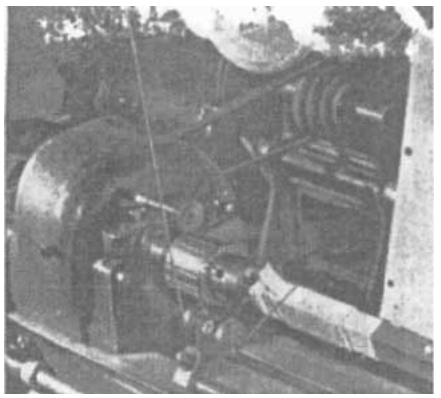
I gulped and went home with my booty. I melted the tar out and pulled the ugly thing out of the case. I hammered the laminations apart and cooked them in an electric oven over at the technical school. That was to anneal the iron and soften it. It had to cool slowly to do it. I spend a morning easing the temperature up slowly, and then I just shut the oven off and left the laminations in there with the door closed. That was on a Saturday, and I came back on Monday to take them out.

Well, the textbooks gave me most of the dope: the efficiency varies with the amount of copper in the window; bass response is determined by the primary inductance; treble response depends on the leakage inductance (mostly). I knew I wouldn't have to worry about capacitance because it was to be used from tube to speaker and therefore was a low-impedance affair. My impedance ratio was from a pair of 2A3's to a 16-ohm voice coil and amounted to 5000:16, or 312.5. I

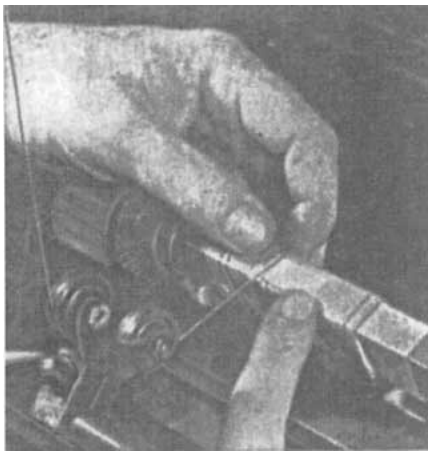




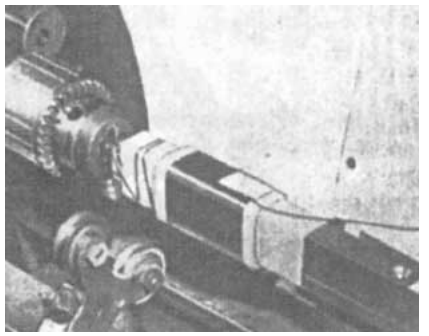
Above, left– First layer wound in place. To start second layer, insert glassine paper under wire so that wire is at least one-eighth inch from paper's edge, and roll it on with the next turn of wire (photo right). Paper secures and stiffens ends of windings.



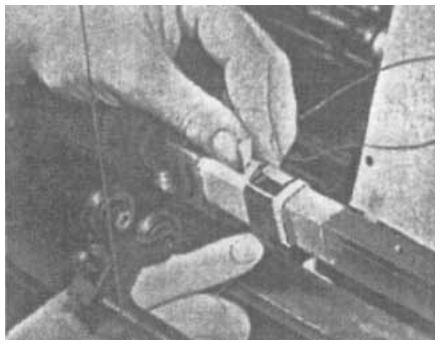
If an end turn cuts through the glassine, lay a strip of paper under it as shown above



and loop it back, winding other turns over it. Pull the loop up snug after a few turns.



Finishing winding. Place paper loop as shown, wind a few turns over it, pull up loop ends and continue. On last layer pull end turn through and pull loop ends tight. If winding ends midway, use loop as above, wind a few turns over it and slip the end turn through.



knew the turns ratio had to be the square root of that: 17.7 approximately. Plain arithmetic gave that and it meant there had to be 17.7 primary turns for each secondary turn.

I forget now just what the dimensions of my window were, but I remember deciding that 6,000 turns of No. 28 wire would come very close to filling the bill for the primary. The figure of 6000/17.7 meant 340 on my secondary would get the needed impedance ratio.

My friend had told me to make at least three secondaries. That didn't really mean much so I called him on the phone. "Why, its simple," he answered. "To get good high-note response you have to have good coupling. So make three secondaries: one next to the core, another between the two halves of the primary, and the third on the outside. That way you get better coupling between the primary and the secondary. Just tie all three of the secondaries in parallel."

"But I figured 340 turns for my secondary and ..."

"That's fine," he said. "Make three of them and tie 'em together. Just use a smaller-size wire so you can accommodate three 340-turn windings."

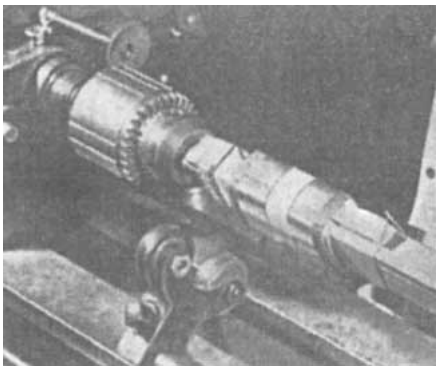
"But about this high response business," I said. "The books say it's a matter of leakage inductance and ..."

"That's just a measure of the coupling. With low-impedance stuff the coupling is all that limits your high notes. Forget the capacitance."

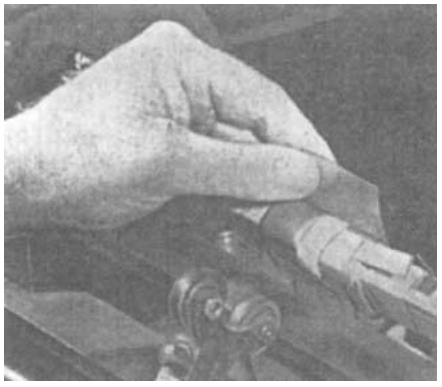
I sat down again with my wire tables and figured. 3 X 340 meant 1,020 turns had to go into that space and, what with the thickness of the insulation–hmmmm. No. 12 wire ought to be about right. A trifle light, but No. 11 would be too big. I drew up my winding sketch. (See diagram.)

Now came the big problem: how to do the actual winding. There were several lathes over at the technical school, and the management said I was welcome to use them if I'd clean up after myself. I provided a counter that could be attached to the end of the spindle to keep track of the number of turns. I still had the old cardboard winding form and I stripped all the old wire off it. Then I sawed a piece of wood that fitted nicely into the form and bought my wire.

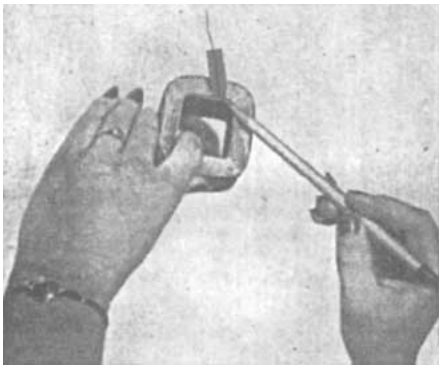
One more visit to my transformer friend showed me how to tape the ends of each winding layer, and then I started. It went much easier than I had expected. Actually it wasn't hard at all. Tedious, but not at all difficult. It took the better part of the day, what with attaching the counter and setting up a roller for the spool of wire to feed from. I wore heavy gloves and fed it by hand.



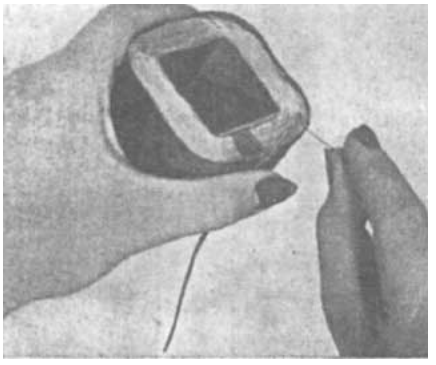
Winding finished with final paper wrapping and a strip of adhesive to hold it secure



Putting insulating fiber between windings evens up the surface and provides insulation



Finished job, showing method of attaching lead wires. These connections are usually



made in the interior, between windings, and are held securely by the windings over them

Cutting the insulation carefully with a pair of shears, I taped it as neatly as possible.

The YL and I had a date that night, and we spent it fitting the laminations into and around the winding and then re-potting the transformer. Her mother still resents the fact that we used a saucepan to heat the tar and pour it into the case. We cleaned it, but I guess we didn't get it as clean as she thought we should have. Tar wouldn't hurt her anyhow. We used to chew it when we were kids.

The transformer was still warm when we bolted it onto the chassis and soldered the leads in. We hadn't checked it for shorts or opens or anything, just hitched it up and tried it out. It worked fine. I swore I could hear lows and highs that hadn't been there before. The old 39 cent open-frame job was given to the YL's kid brother who was building a set at that time.

But that transformer had faults. Several of them. The two halves of the primary weren't balanced properly, and the whole unit was too big and clumsy. My finances improved, and the YL became my XYL, and before long I could buy a big, fancy output transformer and build a new audio amplifier. That old wreck was kicked around the house for a couple of years before it was given, traded really, to a chap I knew. I had never run a test on it at all while I had it.

The new owner did run a test. I was amazed when he gave me the results. He used it in a class-B 6L6 PA amplifier and ran loads of current out one time, and he put an audio oscillator into the circuit as a sort of signal-tracer deal. He found the trouble and then idly twisted the dial on the thing. It went right down to 20 cycles on the bottom and (he said) up to 16 kc on the top.

I frowned when he told me, so he unshipped the big brute from the chassis and made a bench test. The half-power points on the curve were 11 cycles and 23 kc. Those were where the level dropped 3 db. The efficiency was 87% and there was no sign of distortion at 30 watts, which was as much as he had available. All this too, was without feedback, mind you.

It sounded as though it were better than the transformer I had bought. The curve on that was supposed to be 1 db from 20 cycles to 20 kc but it conked out at 12 kc on the top.

I got a new job around then in a laboratory and was put to running bench tests on a whole series of standard transformers. I found an amazing thing: None of the "high-fidelity" transformers tested would meet their published curves. In fact, most of them didn't come near them. There were only two brands among all those I tested whose transformers all came up to their own specifications. Since our work involved Sonar listening gear we had to have the highest possible fidelity in transformers for faithful transmission of submarine sounds. We soon found we could not get enough really good transformers from the busy companies and so we had to wind a lot of our own.

The winding was done much as I had done it. I managed to get those photographs from the U.S. Navy. They show the work done in that laboratory in making up a transformer– and we made a great many of them.

I have since wound up more output transformers for my own outfit and for those of some friends. I use essentially the same techniques as with that first hoary old model. I try to find a big old power transformer that someone has burned out and rip the old windings off it. I anneal the laminations and then design a new winding. This is really very simple and takes just a little figuring. You have to remember these things:

1. Fill up the window with copper. Fill it as full as you can. This governs the efficiency.

2. As a rule of thumb, allot half your space to the primary and half to the secondary. It works fine.

3. Have plenty of turns for the primary to get good low-frequency response. I never use wire larger than No. 30 anymore. Even with 6L6's the transformer still runs plenty cool. For 2A3's you can use even smaller wire if you wish. Lots of turns.

4. Have several secondaries in parallel for your coupling. At least three. Five is even better. Put them here and there and all over and then just tie them together–but watch your polarity.

5. If it's to be for a push-pull amplifier, wind both your primaries at the same time from two spools of wire. That way you can get good balance and keep down the intermodulation distortion. Make them in two sections or three, interleaved with the secondaries, but if you wind both primaries together you'll have a good balance.

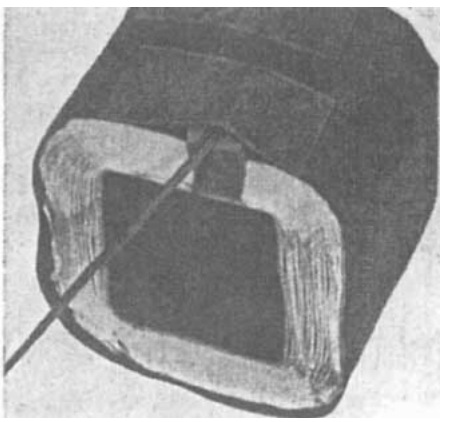
6. Lay the turns in closely and don't let any overlaps stay in. Go back and remove them.

7. Don't use transparent sticky tape if you live near water. Get thin cambric tape and regular thin paper insulation from your supply house.

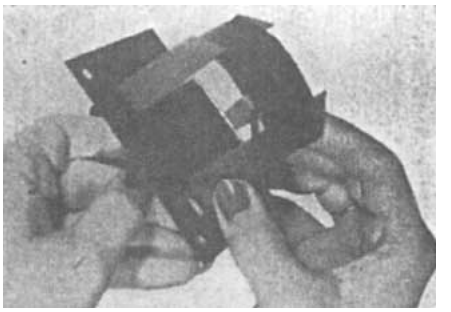
As to what kind of power transformer is best–that's up to you. The bigger it is, the easier it is to get enough primary turns for good bass response. Just get yourself a wire table and study the turns-per-inch of the different sizes. Don't squeeze it. A thousandth of an inch too little means a slight loss in your efficiency, but a thousandth too much means you can't get the laminations back together and you'll have done your work for nothing. Measure your insulation thickness and plan the whole thing carefully.

You might be arguing to yourself now, "Well, if it's so easy, why don't the companies make transformers that are as good?" I'll tell you why. The economics are against it. You're worry is about one transformer –your own. They have to think in terms of a thousand or more. Extra wire, extra insulation, and larger cores run up the cost considerably and then they couldn't compete with the other's prices.

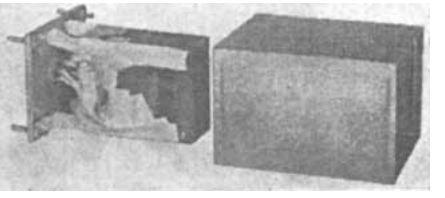
You can have any coil-winding firm make you up a special transformer to your own specifications, and it will cost you plenty. Or, if you're a working stiff without much lettuce, you can look around for an old, burned-out 300 mA power transformer and, with a little work, make yourself a really fine output transformer. It's really easy and, what's more, a lot of fun. Try it!



Adhesive strips make external connections stronger. Whole winding may be taped also.



Last job of all is inserting laminations. This is not hard if all the dimensions are correct



Transformer is now ready for repotting. Don't forget to give it a test run first!

Casual Reactions

by Herb Reichert, Audio Note NYC

The Ressurection of Dead Man Tate

Unbelievable! I'm sitting at this guy's house listening to Buddy Tate play "Darn That Dream" when one of the fellows says, "Hey, stop the music! Let's put my amp in and see how it sounds" – so they put his amp in. Immediately, when the music resumes, I feel like Wegee at a crime scene. I am talking serious necromancy, Folks!

The same record is playing. There is sound coming out of the speakers...but Buddys' a corpse! No tempo, no color, no texture, no movement, no heartbeat, no excitement...Buddys' cold dead folks! His features are clearer than ever and his widow says, "Yep, that's him"— but he sure ain't dancing.

A few minutes into Buddy's wake, the owner of the amp turns to me and asks, "Do you think the soundstage shrunk a little?" My eyes bugged out and I felt like I just took both barrels, right in the chest. "Lord, get me out of audio!"

This kind of missing the musical point entirely is why I had to write this article. Audio today is in the '*looks* like Buddy but it ain't him' era. I doubt that one of my little essays is going to shift the momentum of the present audio/critical encumbrance but, if we do not begin to develop new music-based and user-based criteria for evaluating audio components, if we stick with the mostly irrelevant, non-musical critical devices absorbed from the mainstream audio press, music listening in the home will become as dead as Ron and Nicole.

The current audio critical format is worse than useless. Music unfolds on a different level from computer-generated measurements and holographic tricks. What we need is a simple, user based, musically relevant, and aesthetically valid format for evaluating the quality of audio components. We can't let the imaging weenies, bench testers, and dandruff head ABXers define the culture. That would be like letting the plumbers design the house, wouldn't it?

Harry Pearson actually once said to me, "If a system cannot get the stereo soundstage right, nothing else matters!" Is this true? Am I missing something obvious here? What about dead man Tate? What about when my speakers are not broken in and the music is so lifeless I can't bear to listen? What about all the systems with spectacular imaging that I have heard that forced me to go outside and smoke my pipe for relief? What about whether a system makes me really want to listen? What about whether a system makes it easy for me to pay attention to the music and forget the sound?

This whole soundstage business reminds me of the 16th century Dutch art scene. The emerging merchant bourgeoisie used their new found wealth to acquire the trappings of the aristocracy. They wanted to rise up on the social ladder, using fancy possessions as tools for this purpose. They bought paintings, fine furniture and clothing. Unfortunately, despite their money, they were semi-literate and had not developed a very high level of connoisseurship in the field of great art.

So instead, they commissioned artworks that they could understand and that would be easy to show off to their equally unsophisticated friends. Their peer group, who were also successful business men, understood the value of hard work, long hours and attention to detail. This is how they become wealthy. Makes sense, yes?

Only trouble is, this is not enough for high art. It is enough for high craft though, and this is exactly what they commissioned. Paintings bought by merchant class collectors needed to show 1) Depth and perspective 2) Large vistas 3) Lots of detail and precision workmanship; the results of obviously long hours by the artist and most importantly, easy to recognize and understand subject matter. Sounds like mainstream audio, doesn't it?

Impressive craftsmanship perhaps, but where is the inspiration? Successive generations of avant-garde artists have sneered at these lifeless, boring exercises in excessive detail. Historians call this type of art "academic machines" - overblown objects made only to impress the uninitiated.

Why do we listen to records?

When I walk over to the record stacks to pick out a record, I have one of several motives in mind. Generally, I am in a mood, not one I can define or sometimes even notice, but I am clearly looking for a record to play that will enhance the mood I'm in.

Next time I go, I hate the mood I'm in and want to change it, so I go looking to create a new mood. Sometimes, I say to myself, "I can't remember what the Brahms violin concerto sounds like" or "I can't remember why I don't like it — maybe I should listen again?"

In other words, I pick a record to learn or experience something new. Maybe I am having company and I want to enhance the atmosphere of my home. Sometimes I just listen for a general pick-me-up to generate a little excitement while I work on a painting. I am sure you can think of others but, these are a few of my own familiar reasons for playing recorded music in the home.

I judge the quality of my own hi-fi by how well it succeeds at helping me do these mood and atmosphere things. Clearly, every audio system has varying abilities with regard to generating emotional responses from music, inspiring mood changes and creating atmosphere. Shouldn't home audio's abilities in these areas therefore be *at least part* of the criteria used when assessing "quality"?

One cold grey Tuesday morning, I got into the limo to leave the cemetery after burying my mother, I *needed* to change my mood so I asked the driver to turn on the radio. You won't believe this but, when the radio came on, the first song out of the silence was the Staple Singers doing "Will the Circle be Unbroken". That was the most momentous experience I've had with recorded music. Every time I think of my mother, I am reminded what powerful emotional effects recorded music can have.

My most poignant memories of recorded musical performances were all in very intimate, emotionally charged, social situations and closely tied to the 'who-what-

where' of the emotional stage. The surroundings and memories are probably more important than the equipment used with regards to how we feel about the records we play.

My personal criteria for evaluating any musical experience are: What kind of feelings did it inspire while I was listening and how do I feel remembering it the next day, the next week and the next year? I ask myself, "Did the performance/composition seem exceptional in any way? Does the music stick in my head? Can I bring back the mood or the melody?" The most important question I ask myself is, "Did it fire up my emotions? Did I get all the pleasure and stimulation I was looking for?"

So what do these experiences suggest about evaluating audio components? Is it even possible to sit down with our audio buddies, pull out *Casino Royale*, and attempt to make realistic determinations about system quality? Only if tonight is the night you are all in a James Bond state of mind. Even then you can only ask yourselves, "Did we get that 007 kind of feeling?"

It might be easier if we use really outstanding musical performances by great artists that we enjoy and then only if we listen, suspending our audiophile/critical minds, trying to give ourselves over to the musical flow, and then when the music finishes, we reflect on what we felt. We ask, "Did I get all the fun and excitement this disc has to offer? Could I have had a stronger reaction? Will I have a vivid memory? Does the system seem fundamentally truthful?" When you begin to feel that the disc has offered up most of it's pleasures, then you are getting somewhere audio wise.

Pretend you are a reviewer. You listen to music at home using two different amplifiers and ask yourself, "Which one focused my attention on the performance?" or "Which one gave me the most passionate reaction?" or "Which one picked me up and changed my mood?" or "Which one made me forget about audio sound?" or even more to the point, "Which one just feels right?" Is this kind of critical thinking too abstract? Can anyone legitimately say that the amp that does the above things best is not the best amp?

The reasons we listen to music in the home should provide the foundation for a mutually agreeable set of criteria for evaluating our audio creations. What we intend for our listening sessions to accomplish is exactly the same as what we should hope our playback systems do well. We simply compare audio products based on the degree to which they fulfill our hopes for music in the home. This method is simple and works fine for me.

Unfortunately, not all of our listening intentions will yield the quality evaluation criteria that we need. There are non-musical reasons for selecting a record from the stack, such as: "My friends are coming over and I want some records that will demonstrate how good my system is." Then we have the audiophile classics: "I need to find a Kenneth Wilkenson recording to see if I can hear the second train running under Kingsway Hall" or "I want to see if I can hear the separate voices in the choir".

It's OK to listen to records for reasons like these but keep it in perspective. They are non-musical reasons (I would call them "entertainment reasons"). If we employ them towards evaluating equipment we could end up with non-musical results. Musical reasons are about mood, drama, inspiration and enlightenment, not *detail*. Hi-Fi is about bringing strong feelings and exotic atmospheres into your home.

What about low distortion?

Audio people have been complaining about the lack of correlation between audio measurements and what they hear for as long as I can remember. However, when magazines measure amplifiers they always 1) use sine or square (steady state) waveforms instead of music signal. and 2) use resistors or hypothetical "simulated loads".

Think about this for a second. These measurement techniques *eliminate* the music signal. I thought amps were designed to amplify music signals from preamps (which by the way, are all electrically different)? Bench tests also *eliminate* the loudspeaker and cable. Nobody I know ever listened to records without some sort of transducer connected to the amplifier. And they have *eliminated* the room!

How surprising is it then that correlation between these kind of measurements and what we hear is hard to find. Hell, if you take away the music signal and operate the amplifier in a completely alien environment, what do you expect?

Unfortunately, the test bench is the environment most amps are designed to operate in. Certainly, instruments and bench testing are fine for checking that the amp works in a basic way and they are useful for investigating select electrical phenomena as part of the design/development process and sometimes they can even give us clues about speaker compatibility, but as a final arbiter of quality, I fail to see the value of the usual tests.

In a very recent review, in a most influential audio magazine, by a very influential reviewer, of a highly praised amplifier from one of the biggest and best known audio manufacturers, the reviewer's conclusions made reference to only three things. 1) the "detailed soundstage", 2) the size of the soundstage and 3) the (lack of) "profound bass slam". Oh yes, I forgot, the amplifier had a "respectable set of measurements". What do you think Bo Diddley or Cab Callaway would say if you told them about this jive? I know you won't be surprised to hear this, but I never, ever consider any of these three 'issues' – not at Carnegie hall, not at the Knitting Factory and certainly not while listening to Buckwheat Zydeco on my home hi-fi.

Let's face it, even after forty years of trying, the present format for subjective reviews coupled with standardized bench testing still leaves us clueless as to how to choose or design a better amp or speaker.

What about the obvious?

Before going any further, let's define what we are trying to evaluate. All objects man creates are categorized by their use; clothes to wear, calculators to calculate, cars and buses for transportation, etc.

The present system of audio analyasis starts off wrong by looking at the home hi-fi as a machine designed to recover stored sound information. Then it goes one step further and breaks this machine down into its smallest possible parts; head amp, phono amp, line stage, etc. Next, the critics break the music down into lows, mids, and highs, and so on.

This approach looks good on paper and it is fundamentally-science based, but in practice it results in focusing our complete attention on SONICS! Reviewers listen for sonic details, not performance details. Today, we ask a hi-fi to sound a certain, predetermined way. Instead we should ask if artistic expression is rendered more or less tangible.

We should not assume that if we have flat in-room response from 20-20,000 Hz coupled with a clean 20K square wave and low measured distortion that *any*, let alone *all*, of the musical expression will still be

there. There is no evidence whatsoever to support this notion.

We must begin to look at the *whole hi-fi* as a tool that we use to discover and enjoy music. Like all other tools, we can evaluate it based on its usefulness and dependability; how convincingly does it help us understand and enjoy music from discs?

The best systems retain enough of the original music's proportions that their presentation seems "just right". As with cars, houses, or shoes, *anyone* can tell the basically good from the basically bad *easily* by how it feels when they are using it.

The audio establishment maintains that if a system is "neutral, transparent, dynamic and focused, with bass slam, if it has a wide and deep soundstage and excellent imaging" it will automatically do the emotional stuff. Not true! Go to almost any audio salon and listen and you will experience this lie.

Clearly, mainstream audio has been of two minds about these issues of purpose since the advent of hi-fi in the early 1950s. Mono-era combovers listened to trains, pipe organs, and bombastic big bands. Early stereo shifted the scene clearly towards the 3-D sonic spectacular and when the big solid-state amps arrived, the 'how-does-it-feel' concept had to be canned, in order to advance the cause. This, by the way, is when the wives and kids stopped listening to "Dad's" hi-fi.

By the late '70s, Harry Pearson was defining the soundstage and publishing his *Super Disc List*. The era of the 'Stereo Spectacular' had fully arrived. Foils and wires and cylinders and lacquers and mono vinyl officially became unable to tell us anything really important about the musical performances they stored.

The Absolute Sound provided the hip agenda for critical thought in the late 70s and early 80s. HP's main scheme was a critical program based on the concept of *recording as photograph* that only applied to recorded music in stereo, What started out as an intriguing sideline fetish of far-gone audiophiles was elevated to the last word on reproduction. Soon, the audiophile weenie larvae were hatching everywhere.

The imaging and soundstaging act really caught on with the enthusiast public. It was a simple language but it sounded knowing, perceptive, and sophisticated. I'll admit that it sure was fun to have a common ground to hang out with fellow audiophiles, act like a bunch of reviewers, and talk about our experiences with "high end" equipment. A lot of folks out there still like doing it the same exact way, using the same old lingo, and listening to the same damn awful "audiophile" recordings.

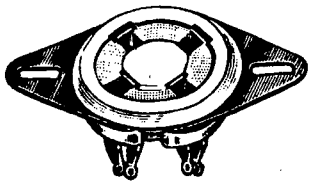
Once the concept of imaging took hold it pretty much defined the agenda for "serious" audio journalism ever after. For a while, the high end critical perspective did more good than harm because it did foster a community of serious, thoughtful folks in the beginning. Eventually, the whole scheme became too literal and inflexible, too focused on the details, and too mechanical and routine.

Look at what happened to the used record stores. Previously, the value of used records was determined primarily by the quality of the performance and the scarcity of the disc. HP's *Super Disc List* and *Mark's Barks* changed all that. Sound and soundstage considerations rather than performance quality, became the driver of record prices.

A new era of record collecting had begun. People pay high prices for records whose *only* recommendation is good stereo sonics. Mono discs of the same performances have no value. The quality of musical performances almost doesn't matter anymore.

A similar movement occurred in the equipment market during the High-End years. Side issues took over the entire stage. Sure today's systems image like crazy, but in 20 years "High-End" made no pronounced advances in the areas of presence, wholeness, completeness, color, texture, tempo, scale, weight, body, drama, contrast or sheer listenability. One could even argue that the hi-fi gear of 1976 or 1956 was superior in most of these dimensions. These are all aspects of reproduction that profoundly affect how reproduced music *feels* while we listen and isn't that the most important thing?

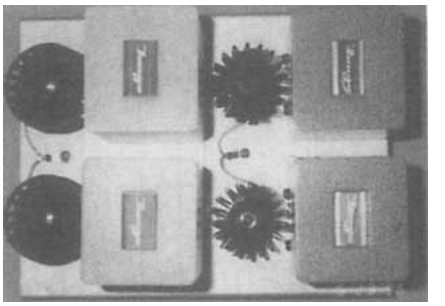
That is why I am calling for a new set of audio evaluation criteria based not on technical stereo sonics but on a system's abilities to evoke, persuade and create strong musical memories. How well an audio system serves these purposes is far more important than any purely sonic consideration should be.



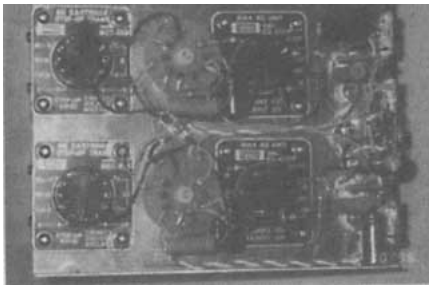
Tube Circuit News

from around the world

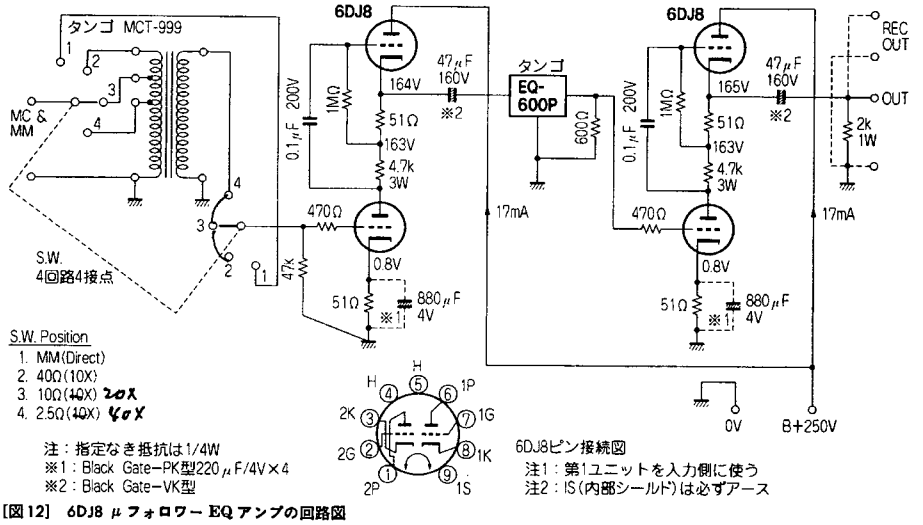
LCR Phono Preamp by Nobu Shishido
from MJ Audio Technology 1996/11 (Japan)



[写真1] 実験のため仮組みしたEQアンプの配置



[写真2] 仮組みEQアンプ部の配線



[図12] 6DJ8 μフォロワーEQアンプの回路図

"Simplest is best" phono amplifier using 600 Ω Tango EQ-600P RIAA network. Although the EQ-600P is an expensive part at $300 ea., usually modest Shishido says the preamp sounds great and is worth the parts investment. The LCR EQ preamp was designed to be used with a high-quality passive atttenuator between it and a power amplifier.

Alesa Vaic AUDIO NOTE

Exclusive Worldwide Cooperation

An agreement has been made between Audio Note, UK Ltd. and Mr. Alesa Vaic (formerly of Vaic Valve) to set up a manufacturing and distribution arrangement, whereby Mr. Vaic in conjunction with the Audio Note design team, will develop, design, and manufacture a range of AV high-gain small signal directly heated triodes, together with a range of AV Super Linear™ driver and power triodes, financed by Audio Note and distributed under the Audio Note brand name.

Alesa Vaic is no longer associated in any way with KR Enterprises (formerly known as Vaic Valve AG). We are enthusiastic that our cooperative agreement will provide a fertile environment for Mr. Vaic's patented innovations in valve technology and ensure reliable manufacture and distribution of Mr. Vaic's new generation designs.

Production will start on a highly linear version of the 300B, dubbed the AV300B S. It will be available from late December 1996 in limited quantities of numbered units, backed by Audio Note's worldwide distribution network and carrying a 12 month or 2,000 hour absolutely undisputed warranty. At a worldwide retail price of $425 each, the AV300B SL will substantially improve on the sound of any equivalent types, including the WE 300B.

Within 6 months of the launch of the AV300B SL, we intend to introduce a higher power triode with a dissipation of 120 W (35-40 W Class A) dubbed the Audio Note AV62B SL at an estimated cost of $750 each.

The Audio Note AV32B SL and AV52B SL

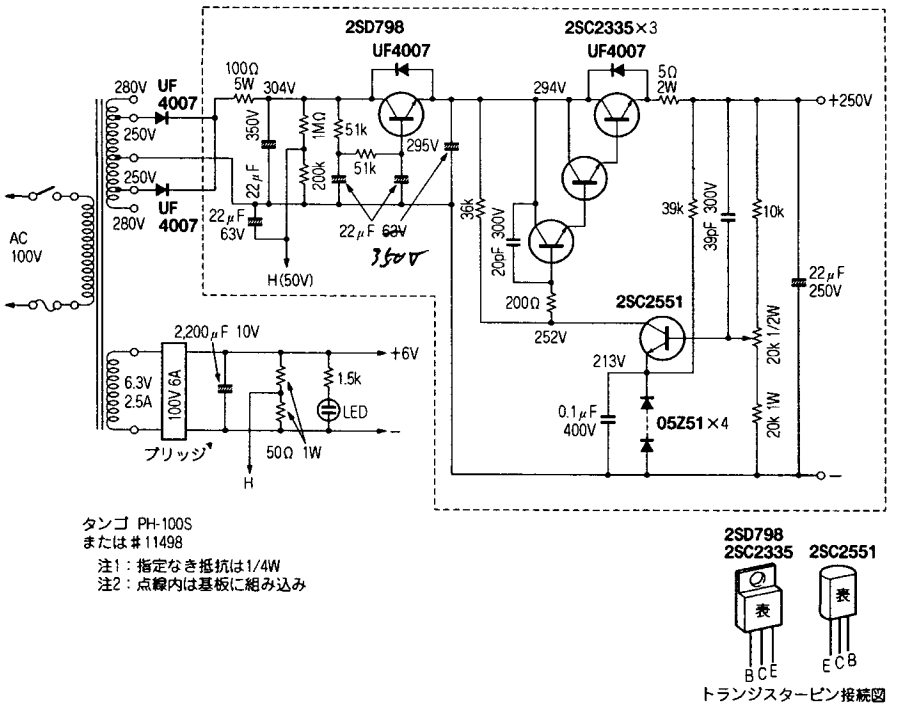
Audio Note and Alesa Vaic Vacuum Technology have introduced substantial improvements in cathode chemistry for enhanced reliability and performance over previous efforts. The two replacement types The Audio Note AV32VB SL at $550 ea. and The Audio Note AV52B SL at $650 will be launched sometime in 1997.

Suitable Audio Note amplifiers and circuits are being developed to derive the best possible results from the unique properties of these triodes and support the advancement of the art and debate on single-ended audio amplifiers.

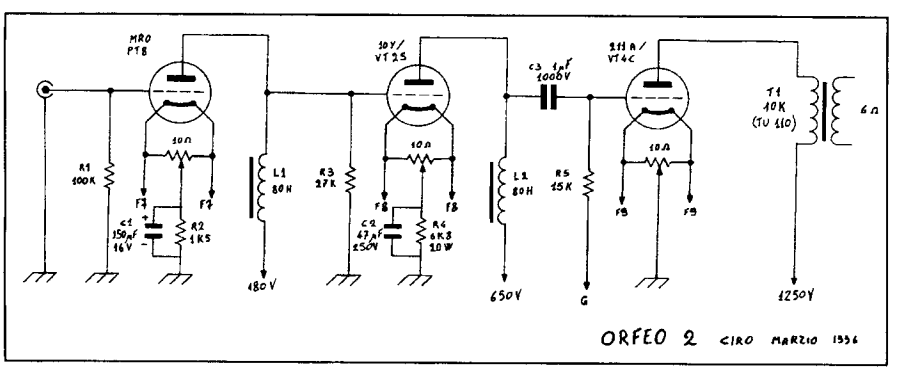
Outside the Audio Note distribution network, Audio Note UK Ltd will license the use of the AN triodes to a strictly limited number of amplifier manufacturers to ensure that the quality of the end products are consistent with the quality of the amplifying devices. Please fax applications for registration of interest to Mr. Paul Masson +44 1273 731498

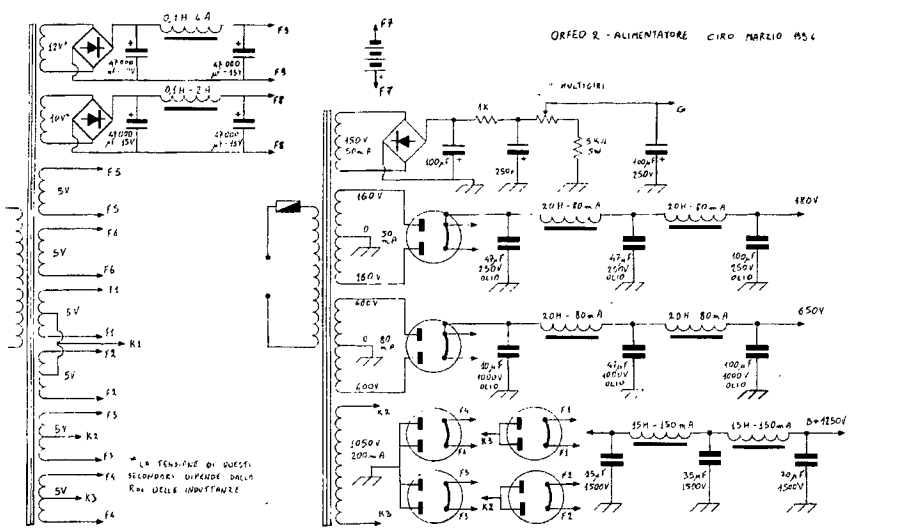
Peter Qvortrup
Audio Note UK Ltd

AVVT Inc Alesa VAIC
Alesa Vaic
Alesa Vaic Vacuum Technology



Regulated Power Supply for Shishido's LCR EQ phono amplifier





Orfeo II Power Supply

(Over)

Orfeo Update by Ciro Marzio from Costruire Hi-fi #23(Italy)

Two choke loaded stages, 8 power supply chokes, six oil caps, a couple of power transformers, eight filament supplies plus a battery filament supply for the PT8 input tube makes for a hefty amplifier indeed!

All in all, the Orfeo II appears to be even heavier and more expensive to build than the original *Orfeo 211 SE* amplifer described by Marzio and Jelasi in SP #6, even though that may be hard to imagine.

Unfortunately, no picture of the Orfeo II accompanied the CHF article, but surely each channel must be at least the size of a small dining table. An amplifier with three choke or transformer loaded stages and individual tube rectfied, choke-smoothed, oil-capped power supplies worthy of the job has to be a real monster. According to the author, the extra measures taken in the Orfeo II yield sonic results that are simply extraordinary.