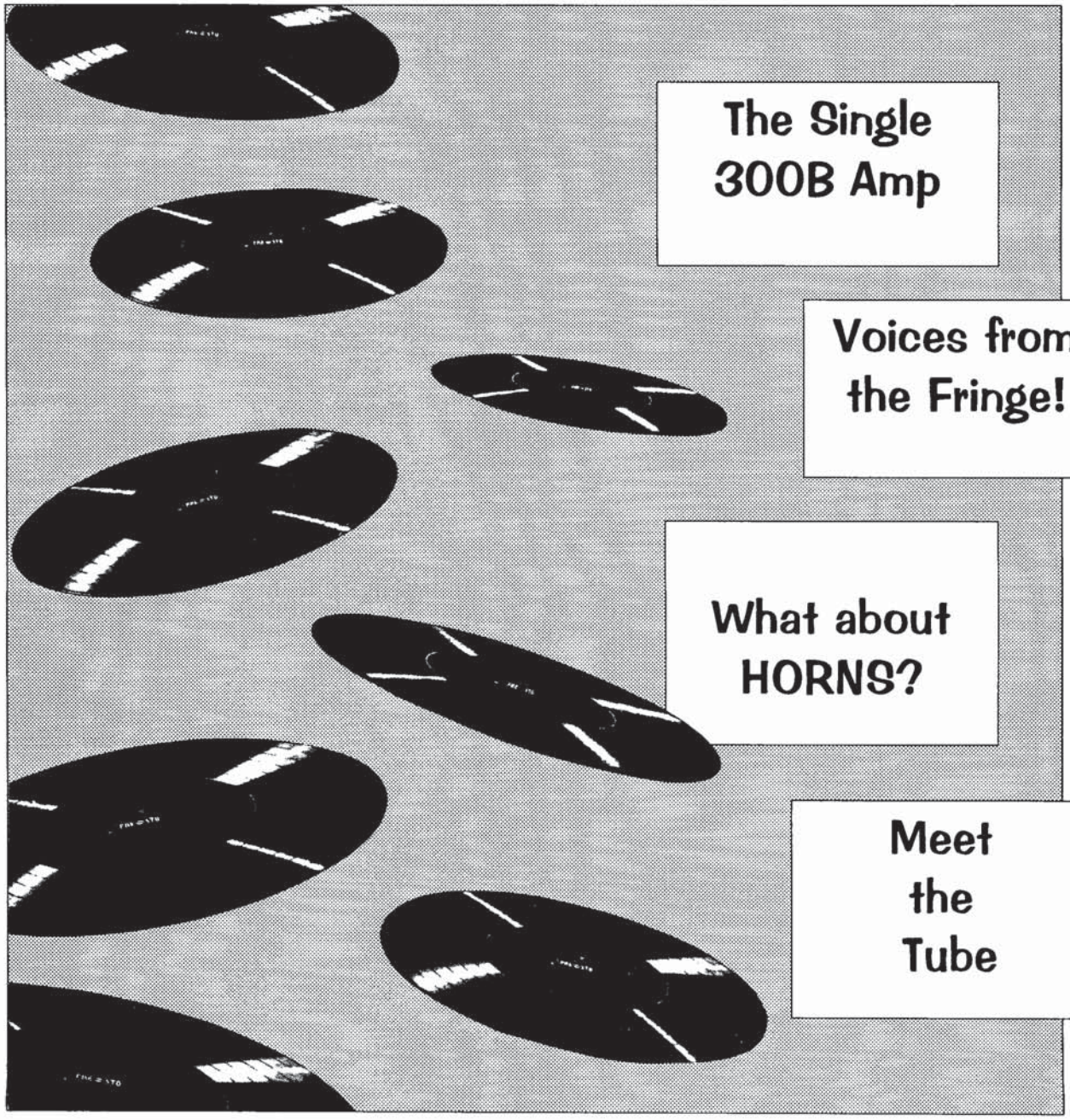
SOUND PRACTICES

A JOURNAL OF AUDIO TECHNOLOGY SUMMER 1992



Variations of Audio Experience Issue #1

Sound Practices

Sound Practices is published 4 times a year at Box 19302, Alexandria VA 22320. This publication exists to encourage audio experimentation and to promote the exchange of related information. Permission is given to reprint all contents freely, except for individually copyrighted articles. Please be sure to mention Sound Practices as the source in any reprints.

Subscriptions are available at the rate of $16 yearly in the US, $20 in Canada, $26 Overseas Airmail.

All subscriptions are on a calendar year basis. Regardless of which month you choose to subscribe, you will receive all four issues published that year.

Sound Practices actively solicits contributions of written material of interest to the readership. Please contact us to discuss your ideas. We are open to articles on all sound practices.

Display advertising rates and deadlines available upon request.

Summer 1992 Contents

Voices from the Fringe?

Audio today consists of a much wider range of practice than you'll find reported in the glossy mags. Some of the most interesting activity in the hobby takes place outside the borders that commercial producers of contemporary equipment accept as their playing field. There are vintage gear enthusiasts, modifiers of old and new gear, and people who build things that the manufacturers are wise to avoid - products with limited popular appeal or which are not economically viable to manufacture. Except for Audio Amateur/Glass Audio, there's no dedicated forum for do-it-yourself audio, one of the most rewarding facets of our hobby. Only a few decades ago DIY was an important part of the hobby for people as committed to it as we are. What happened?

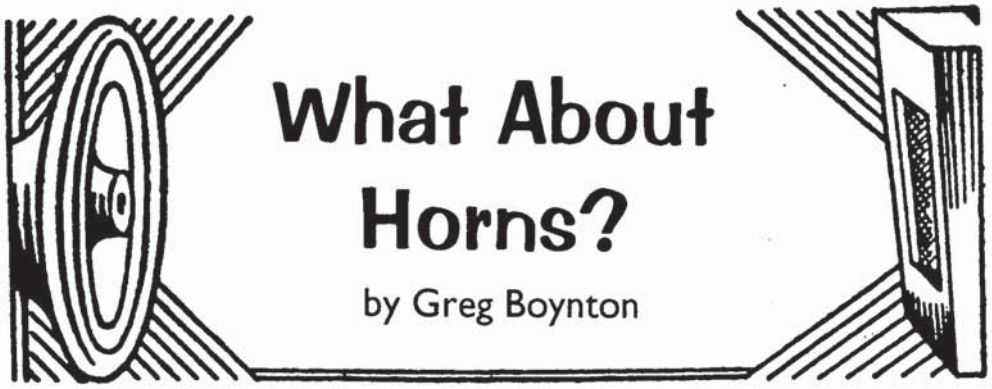
Since most magazines focus on the latest gear and currently fashionable technologies, any sense of the development of audio over the decades is lost. I consider the absence of historical perspective in the literature a very major failing. The development of the technology over the 80 years since the first useable tubes came along is a fascinating and important story which is too seldom told. And we would have a clearer understanding of present trends in audio (and other technology) if we study the past accomplishments of the ancestors and evaluate our practice in light of the technical and institutional factors which give it its present shape. Besides, some obsolete (and otherwise unfashionable) technologies can produce superb 1992 sound! Witness the current triode "revival".

My academic training is in anthropology not engineering. One of the main tenets of anthro is "relativism", the idea that one should keep an open mind about different ways of being. First you must consider what people themselves think they're doing, from *their* insider perspective, if you want to understand their actions. If you enter the worlds of sound engineers of the 1930's, Japanese horn speaker listeners, or contemporary high end designers you will meet some very smart people. The tools, technologies, and values are different, but there is a timelessness in the wisdom (and sometimes foolishness) of all sound practices.

Everyone who contributed to this issue is writing on a subject they get excited about. To get Sound Practices rolling, I wrote an article on one of my favorites, the single 300B amp. Then, I approached a few passionate, perceptive, and particularly adventurous audiophiles and asked them to write about what *they* believe needed to be said. I think you'll agree that there is an atypical group indeed gathered in the pages of our premiere issue. You would never read this stuff in *The Sensible Sound*. Voices from the fringe? Perhaps, but they say it with heart.

Lunatic fringe, DIYers, historians, and experimenters.There is a group of us looking beyond what is available in the glossy magazines. We know who we are and, as the old Spanish *aforismo* puts it, "We are not many but we know how to find each other." Maybe Sound Practices will be a place where we can meet and enjoy the benefits of the gathering.

Joe Roberts



What About Horns?

by Greg Boynton

Over the last 5 years, I have had the pleasure of exploring a branch of home speaker design that has been all but forgotten by the audio mainstream. The title of this article should give you a hint. Yep, that's right, HORNS! Oh my God you say, what is this person babbling about. Obsolete technology. Honky and distorted, right?

Wrong. I once held the opinion that horns were a kind of bad joke. People who used horns for speakers were either deaf or had a major case of tin ear. I now find myself in the somewhat awkward position of being a horn advocate. While bad horn systems are indeed unspeakably bad, a great one can be truly great.

Horn speakers fall into that category of products that includes vacuum tube amplifiers, vinyl records, and analogue tape recorders. These technologies were discarded primarily for reasons of convenience and profit margin. For the serious audiophile, the analogue record-tube electronics-horn speaker combination offers performance that leaves many CD -solid state amp - cone speaker systems in the dust.

Horn systems take up a lot of space but doing it right will also require time. To really get horns set up correctly will require a fair amount of thought and experimentation. You absolutely must get amplifiers which are compatible with the speakers. Biamplification (separate amps for high and low frequency drivers) is necessary to explore their full potential. It will require some effort on the part of the builder to acquire all necessary parts for the system. Finally, most horn system components (even the classy pro stuff) just don't cut it. You will have to choose your parts wisely.

But when you get a horn system set up right, the sound quality is amazing. The most obvious advantage is in the dynamic range and transient response of the horns. For me, the emotional impact of recorded music is in the dynamics. Most speakers just do not produce realistic dynamic contrasts. Horns do, and they do so with ease. They also excel in low distortion. The sound seems unusually clean even at high levels. Imaging quality ranges from adequate to outstanding, depending on the shape of the high frequency horn and the frequency extension of the driver. When I listen to my horn system, I find myself getting lost in the music, rather than in critiques of sound quality and technical arguments. That's the whole point.

SELECTING A HORN SYSTEM

Now that I've talked up horns, let me say that I'm not suggesting that you run out and buy one of the "classic" hi-fi speakers from the 1950's. Most of them make horrible compromises in design and are not worth the trouble. Particularly bad sounding horn speakers for the money include: any Klipsch product, RCA, EV Patricians, Georgians, etc., JBL Hartsfields (HA!), Altec 604s, any folded horn design, and any design in which time alignment of the drivers is impossible.

If you want a horn system, the best bet is to start with industrial equipment made by Altec, JBL, or Western Electric. Altec gear is the easiest to find and to work with. Aside from being reasonably common, Altec components are available at reasonable prices - a great system should cost less than $1000, much less if you're lucky. Also they made about the only workable low frequency cabinet for hi-fi use.

A two-way system is the easiest to build and set up. Also some of the best speaker components ever built were designed specifically for use in two-way systems. My favorites are the components designed by Jim Lansing (of JBL and Altec-Lansing fame) for Altec's famous "Voice of the Theater" systems. All of the VOT systems use similar cabinet designs but the size varies dramatically. Some of these babies weigh thousands of pounds. All VOT systems used the same drivers in various combinations. Typically they use 15" woofers and 1" or 1.4" high frequency compression drivers. The crossover point is typically in the 500 cycle range, giving each driver approximately 5 octaves to reproduce. The high frequency driver is fully horn loaded. The woofer is partially horn loaded with lower frequencies handled by a ported enclosure. The best known examples of this kind of speaker are the venerable Altec A5 and A7 VOT systems.

THE HIGH FREQUENCY HORN

Horn selection is probably the single most important challenge in constructing a high-fidelity horn system. Nearly all of the horns that were available from the major manufacturers sound dreadful. In putting together my system I listened to 12 different pairs of Altec horns, as well as some Electrovoice and JBL pieces. All of the horns were rated for use with a 500 cycle crossover. I can only conclude that sound quality just was not as important a design consideration as small size and dispersion control. Almost all of these horns exhibited large amounts of distortion at the crossover point and significant high frequency rolloff.

Most horns designed for theaters and auditoriums are meant to spread sound over a large area. Wide dispersion is not something which comes easily to horn speakers. Most designs rectify the directivity problem by sacrificing performance in other parameters. Such horns include multicellular, diffraction, and sectoral designs. All of them (well, most of them...) perform as designed. But, when the goal is ultimate fidelity, avoid them. Their sins are too numerous to list.

Instead, look for a horn with the following characteristics: First, you should be able to look straight into the mouth of the horn/driver combination and directly see the phase plug of the driver with no obstructions whatsoever. From the driver, the horn walls should follow a smooth curve as the horn opens out. Straight walls should be avoided if possible. Avoid radical changes in the cross-sectional shape of the horn. From

the driver through the throat, it should smoothly assume the shape of the horn mouth. The shape of the mouth is probably best kept close to a square or circle. Rectangular mouths with radial aspect ratios have the characteristics of diffraction horns and should be avoided.

In order for the horn to sound good through the crossover point it must be very long compared to most commercial designs. I would suggest at least 3 1/2 feet long for a 12 dB per octave crossover at 500 cycles. A somewhat shorter horn will work with an 18 dB or 24 dB per octave crossover. Shorter horns will tend to have severe intermodulation distortion and impedance problems around the crossover region.

Avoid any horns built of non-rigid materials like cardboard (no joke!). If the horn is constructed of a resonant material like cast aluminum or sheet steel, use some sort of deadening material like Mortite or lead sheet to control the resonance. Bolting the horn to a secure mount also helps. That's right, take all of those piles of old stereo magazines out from under it and bolt it down.

THE HIGH FREQUENCY DRIVER

There are several factors to consider in choosing a high frequency driver. The diaphragm material is important if wide frequency response is a goal. Aluminum, beryllium, and titanium are good. Only metal diaphragms are worthy of serious consideration. Phenolic diaphragms are best used in airport paging systems. Apologies to fans of old EV and RCA stuff but they just don't do it for me.

The phase plug is also important. The best system was used in the Western Electric, Altec, and JBL drivers. These units use concentric exponential flared slots through which the sound passes from the diaphragm to the throat. Again, avoid older EV drivers - now that the patent has run out EV uses the Lansing phase plug.

The magnetic system is also significant in its effects on both frequency response and driver distortion. heavy drivers generally sound better than light ones. This is because a large amount of iron is needed to carry the powerful magnetic fields which energize the voice coil gap. Try to get drivers with Alnico V magnets. These have inherently lower distortion than the ferrite crap they make nowadays. Pre WWII drivers often used

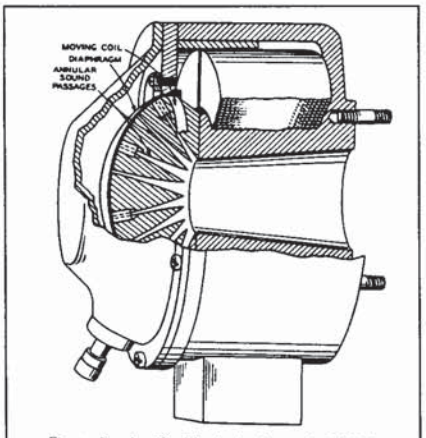


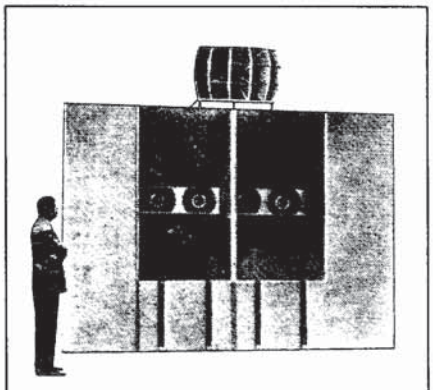
Fig. 3—Sound radiated by the diaphragm of the high-frequency units is conducted through concentric annular passages to prevent interference effects

Cutaway view of typical horn driver

powerful electromagnets and are worth checking out if you can find them.

THE LOW FREQUENCY ENCLOSURE

Low frequency horns require lots of space. To actually get even 50 cycle tones out of a horn it must be *huge*. In some installations people have built straight exponential bass horns. A system of this size would take up my whole house. The best compromise is to partially horn load the bass. This requires an enclosure which is both a short horn and a tuned port. The short horn is not compression driven like the high frequency section. It's really more of a directional baffle. It serves two purposes: the woofer cone is recessed into the enclosure facilitating the alignment of high and low frequency drivers and the dispersion of the woofer at the middle frequencies is narrowed making a more natural transition to the narrow dispersion high frequency horn. Altec used this system almost exclusively in "Voice of the Theater" installations.



The Altec A-2: A large VOT system

For most people, buying the cabinet is a smarter move than building one. Construction of the wooden horn parts is best left to those with serious woodworking experience. I built Altec A7 type cabinets and it was no fun at all. An interesting and convenient alternative is to buy one of the modern public address cabinets. Community Light and Sound makes a cool thing called a VB790 which is a fiberglass version of the Altec vented horn type enclosure. To build it you buy the fiberglass horn from CLS and construct a nice rectangular box. The flare bolts in with no hassle. But, I imagine most of you are hung up on having the original kind of thing. In that case, buy the Altec 3/4" or 5/8" plywood cabinets that were part of the A5 or A7 systems.

The A5 and A7 cabinets are fairly common since they were the mainstays of the VOT line. If you have the space, one of the larger VOT cabinets would provide better low frequency performance. For most of us, practical considerations dictate a smaller system

LOW FREQUENCY DRIVERS

There are a lot of good choices for a low frequency loudspeaker. I have listened to units from Altec, Electrovoice, JBL, Jensen, and Stephens. The quality of bass note tracing some of these units can produce when properly horn loaded is amazing. Woofer design has not really improved for quite a while. Many of the older units are unsurpassed in performance.

Most modern woofers offer reduced efficiency and greater power handling capability. I have seen this trend quite clearly in the sound industry. JBL now makes 15" woofers that handle 800 watts. Compared to the 15" units made even 30 years ago these monsters don't sound as good. Power handling means heat dissipation, which means more weight. The voice coil gets heavier, the coil former gets heavier. The suspension of the driver has to be strengthened to withstand those 800 watt excursions. If you want to know how this makes a speaker sound, just tape a big rock to the cone of your favorite speaker (or listen to some of the leading planar speakers).

When looking for a woofer, try to find one with a big Alnico magnet. Alnico has efficiency and distortion advantages over ferrite and ceramic magnets. Another desirable feature is an edgewound voice coil. This geometry gets more wire into the gap, promoting high efficiency. The voice coil

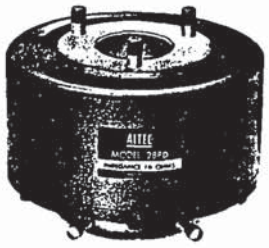
Recommended ALTEC Components

HORNS

Finding a good horn is the key to building a great system. Unfortunately, the good horns are few. Some horns require "throats" or adaptors to mate with your driver. Try to get these when you get your horn if you need them. They can be expensive or hard to find as spare parts. A crossover no lower than 500 cycles is recommended with these nominally 300 cycle horns.

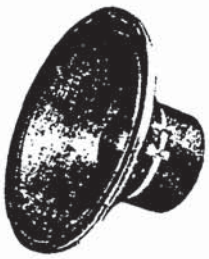
Here are a few horns that worked for me. These are subjective impressions and somewhat surprising in light of Altec's intended applications. Among common and reasonably proportioned Altec units, the 311-60 and the 311-90 are your best bet. Surprisingly good sounding despite their rather cheapo cast construction - apply damping to exterior. A 288 bolts right on. The sheet metal 203 is a nice long two cell horn which avoids many of the problems presented by shorter horns with more cells in the home listening context. Intended as a "long throw" horn but sounds good short range. The Altec horn that works best in my system is the large cast aluminum 329A. It is rather unhandy to install but it sure sounds good.

Perhaps the best option is to build the right kind of horn from scratch. Simple equations for horn design can be found in *Audio* magazine articles fron the '50s and a number of textbooks. Use of Altec hardware and throats can facilitate the mechanical interface with your driver. I'm working on this project myself - results forthcoming in a future installment.



288 Driver

Power	40 Watts (above 500 cycles)
Frequency	500-16,000 cps
SPL	115 dB at 1 W / 131 dB at 40 W
Impedance	16 Ohms
Weight	20 pounds



515 Loudspeaker

Power	35 Watts (50 W. Peak)
Impedance	16 Ohms
Diameter	15 3/16"
Mounting hole	13 1/4"
Weight	26 pounds

LOW FREQUENCY HORNS

These enclosures are direct radiating exponential horns using a modified bass reflex principle and are the proper enclosure for the 515 or 803A loudspeaker in full range two-way public address systems.

	HEIGHT	WIDTH with wings	WIDTH without wings	DEPTH	NET WEIGHT
110 with stand	87"	73¼"	50"	35½"	400 lbs.
210	84"	80½"	32½"	39½"	560 lbs.
410	84"	103"	65"	39½"	890 lbs.
610	84"	135½"	97½"	39½"	1220 lbs.
825	42"		30"	24"	100 lbs.

825 Cabinet

formers on the better speakers are paper. A heavy aluminum former just reduces the quality of the sound. Besides, we're only going to be running maybe 50 watts max on the system, so who cares about 800 watt power handling?

As far as cone material is concerned, paper is *it*. The combination of a light paper cone and a big magnet is difficult to beat. Harder stock usually provides more detailed reproduction through the midbass. The shape of the cone can be important. Straight wall cones have better tone and detail through the mid bass and curved wall cones have better top end extension. With a 500 cycle X-over, straight wall cones are preferable.

Woofer suspensions also have a great effect on sound quality. In high efficiency speakers there is little coil overhang in the gap. The coil must be returned to the exact center of its travel. If this doesn't happen, the sound is muddied because of asymmetry in the magnetic field. I like the old Lansing spiders which are made of Bakelite. They hold the cone in a rigid grip and provide for controlled excursion. In a proper enclosure, total cone travel is only a small fraction of an inch so excursion limiting is no problem.

The most common really great old woofer is the Altec 515 or 515A. It was in production for about 40 years beginning in the mid-40s. The older ones used bakelite spiders and a straight walled cone of hard stock with a half-rolled paper surround. This is how speakers should be built. The later 515 is the B model. During the 1980's this speaker was made with a ferrite magnet which is clearly inferior to the awesome Alnico magnet of its forebearers.

Other woofers worth checking out are the Altec 416 and 803. The 416 is a late 803 with a different part number. The 803 is similar to the 515 but designed for use with an 800 cycle crossover. The 803 woofer with the 825 cabinet, the 803 compression driver, and the 811 horn made up Altec's A7. This was the "baby" VOT.

CROSSOVERS

As is the case with horns, most crossover designs of the early days are not really that good for hi-fi use. One of the biggest problems can be solved by using very long horns. The reason that horn length can affect crossover performance so dramatically is

(continued on p. 21)

HORNS (continued from p.4)

because crossovers are directly affected by impedance changes in the drivers. If a horn is too short for a given frequency to be reproduced the speaker will present a far different load to the crossover than its nominal 16 or whatever ohms. Crossover networks require a flat impedance curve for the high and low frequency drivers to sum properly. Impedance changes result in phase and amplitude anomalies.

Be sure to take pains to phase your speakers correctly. You will have to experiment because drivers are not all phased the same electrically. Go for the connection which produces the most output at the crossover point. Get a friend to switch the connections while you listen. Make sure the drivers are aligned such that the ear-speaker distance is the same for each driver.

Because of the complicated nature of crossover design, I am inclined to gloss over it in this introductory article. In a follow-up piece, I will provide tips for bringing old crossovers in line with modern practice and a design for a high quality line level crossover for a biamp application that will really get those old drivers working. Stay tuned.

One of the major challenges in setting up a horn system is finding an amplifier which will work with the horns. High power solid state amplifiers sound best when mated to ineffjcient speakers. With horn speakers they tend to sound really awful. The efficiency of horns is so high that your average big hog solid state amp never really gets turned on. Likewise, big tube amps using banks of 6550s just don't sound that clean when operated in the milliwatt power range. Horns work best with *low power* tube amps.

I hope this introductory survey will help some experimenters avoid a few of the most tempting wrong turns. Most of the information you really need to know will not be found in any books. Good "pro" sound practice differs from the best strategy for hi-fi horns in the home. Some suggestions you read here would be a mistake in the theater context. But recognize that what excels in the auditorium won't necessarily soar in your listening room and you're on your way.

Greg Boynton is proprietor of Rapid Sound, provider of audiophile quality sound reinforcement and audio consulting for the Grand Rapids, MI area.

THE SINGLE 300B AMPLIFIER: A MODEL 91 FOR 1992

BY JOE ROBERTS

Back in the 1930's, the American public had its first experience of wide range audio in the movie theaters. By then, radios and 78 players were common in the home so the initial amazement at "talking boxes" had worn off somewhat. The '30s radio probably sounded okay for tuning in Will Rogers but the movie palace was the home of the first real audio goosebumps.

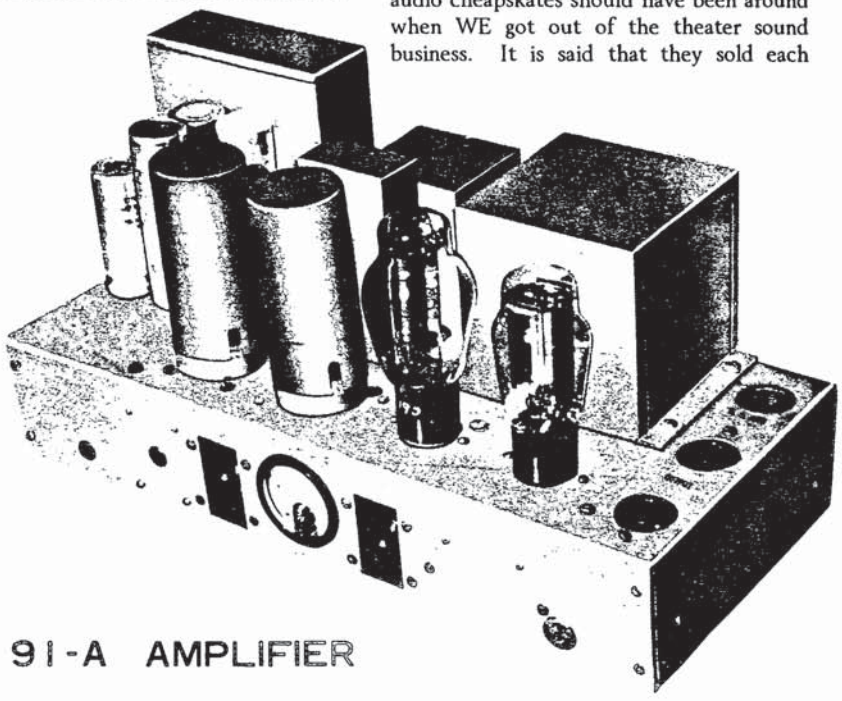
Back then, audio was at the forefront of engineering and major companies invested heavily in research and development of this young and potentially lucrative technology. The movie theater was an arena for heavy competition among major players in the electronics and communications industry. After all, there was big money in outfitting Hollywood and the tens of thousands of sound theaters nationwide and abroad. American industry rose to the task.

A lot of our basic knowledge about sound and perception came out of the institutional research context created by these huge corporations. The insights gained by well-financed "men of science" in audio research enriched lives not only through moving pictures but also by improvements in telecommunication systems and the information industry in general.

RCA (Photophone) and Western Electric (Mirrophonic) were the two dominant forces in the emergent theater sound market back in the 30's. Both developed complete systems for recording and playback of cinema sound, from the microphones on the set to the speakers on the stage. You can do historical research on this topic while watching old movies on TV. Look on the credits for RCA or Western Electric logos. I must admit that I enjoy Popeye cartoons much more knowing they were produced with WECO Mirrophonic equipment.

Today, theater gear of the golden era, particularly Western Electric Mirrophonic equipment, is revered by aficionados of vintage audio worldwide. A complete stereo set of WE amps and speakers would cost as much as a new car - if you could find it. It would cost many hundreds to ship. A large slice of the street price of Mirrophonic gear can be attributed to its status as rare, desirable collectible. Certainly this system has enormous significance in the technical and social history of audio technology. But make no mistake about it, this equipment is capable of stunning sonics and it is highly sought after for this reason as well as its artifact value.

Typical theater systems of the era employed very low power amps by today's measure and enormous super-efficient horn loaded speaker systems. Often these speakers used electrodynamic drivers since field coils provided higher flux for the bucks than permanent magnets in those days. Ten watts was enough to fill a good sized movie house to impressive SPLs. Nowadays the equation is reversed; you need 100 watts to drive a one cubic foot mini monitor to acceptable living room levels. Anyway, it's clear that the efficient old methods were in sync with the laws of physics. Must be nice to have a theater sized listening room to indulge mother nature.



91-A AMPLIFIER

Two WE amplifiers were featured in the Mirrophonic systems, the Model 86 and the Model 91. The 86 is a push pull 15 watt all triode amp using 3 WE 262 tubes as single-ended voltage amplifiers transformer coupled to a pair of WE 300Bs at the output. The 91 is a single ended 300B amplifier, good for 1/2 the output of the 86, which uses two WE 310A pentodes in voltage amplifier stages. Both amps were high gain devices (>95 dB) intended to amplify the low output signal of a photoelectric sound cell in the projector. The 86 and 91 were specialized instruments meant to be used in Mirrophonic theater systems and their industrial strength looks tell the tale.

The 91 can be viewed as the economy model Mirrophonic amp. It uses a lot less iron (no interstage trans. or choke) and surely was less expensive to make. By the way, WE didn't sell this stuff - they *leased* it to theaters the same way Ma Bell used to lease you your phone. By 1992, the prices on the 86 and 92 have evened out somewhat. You audio cheapskates should have been around when WE got out of the theater sound business. It is said that they sold each

installed system to a lucky theater owner for $1 to close out the existing leases!

The published specifications of the 91 are rather unimpressive by today's standards. The data sheet on the 91 claims a useable range of 50 to 8000 cycles at 8 watts with distortion figures in the single numbers. These ratings are conservative but you can do you can do a little better than this with a LM 383 chip for a couple bucks. As is so often the case the specs don't begin to tell the whole story. The 91 plays with incredible authority on appropriate speakers. Liquid, detailed, natural and harmonically right on - rich but not too slow - it is a majestic and utterly involving presentation. The chip provides acceptable AM car radio performance.

If you plan to begin looking for a Mirrophonic system, Tokyo would be a good place to start. The Japanese obsession with Western Electric gear is well known and often satirized by US audiophiles. Based on my listening, I wouldn't be too quick to judge. Not only are *certain* WE amps amazingly good but *some* WE horn drivers and cone speakers are also exceptional. I must applaud the Japanese for recognizing the virtues of Western Electric even if they sometimes get a bit carried away with brand name worship. Audio is one activity in which it's cool to be crazy in Japan.

The fact is that not all WECO gear is audiophile manna from on high. Some of their products are meant for BINGO hall grade applications and they sound it. On the other hand, some "general purpose" WE amps and speakers were used everywhere from radio stations and studios to Woolworth's and school PA systems. At one time, my home system consisted of Model 124 amps (12 watt push-pull 6L6) from a shoe store in Michigan and 755A speakers that came out of the ceiling of a think tank in Cambridge, MA. It was difficult to admit this to my clients at Excalibur Audio (now defunct) while trying to sell $1000 cables. Funny that I thought my system sounded better than a lot of stuff in the store!

I first heard about WE from local audiophiles who were active in the early 50's. When anti-trust proceedings forced WE out of the sound equipment trade in the late 40's, surplus permanent magnet WE speakers dumped on the market were snatched up by "golden ear" types at bargain rates; you can see 'em in Harvey Radio ads from the early 50's. Electrodynamic WECO theater speakers were also highly revered by early Hi-Fi experimenters. The first Klipschhorns in 1948/9 used WE compression drivers, possibly obtained through surplus channels. Avery Fisher used electrodynamic WE theater speakers at home. Surely, Mr. Fisher could afford to choose the best.

As a student of Western Electric, Walt Bender of *Audiomart*, wrote in TAS 54, perhaps it is a limitation of the American ethos that the latest is often unthinkingly considered the greatest. Some very experienced listeners solemnly contend that WE gear blows just about everything else away. Naturally, any such pronouncement should be recognized as a strong statement of taste rather than "truth" in any empirically verifiable sense. Even those "true believers" usually admit to shock when they discovered that this industrial looking stuff outperforms Mac, Marantz, and most other products since!

Western Electric ranks high among the giants of audio. And the Model 91 is one of WECOs most intriguing and best sounding designs. If you are at all intrigued with single triode amplifiers, as historical artifact or as contemporary strategy for good sound, study the Model 91 because it defines the genre.

THE SINGLE 300B AMP

In many areas of the world, the allure of the single triode amp lives on. It is certainly not a mainstream audio phenomenon anywhere but numerous single 300B amps are available as kits and off-the-shelf product in Japan and Europe. If you read (or look at the pictures) in Revue du Son, L'Audiophile, or any of the Japanese audio mags, you will see ads for the single 300B.

The 300B has attracted quite an aura of mystique over the years. It was first announced in Bell Laboratories Record in 1935 in the form of the 300A. The difference between the A and B was that the guide pin on the side of the base was rotated a few degrees. The 300A/B was designed as a replacement for large transmitting triodes in audio service, offering higher output at lower plate and filament voltages.

There is no direct substitute for this filimentary cathode tube. It is generally similar to the earlier RCA 50 in characteristics, with the exception of filament voltage, but it is considerably improved in terms of mechanical construction and life characteristics. It is a real workhorse.

The 300B was primarily intended for audio use but they you occasionally find them in regulated power supplies (what a waste). Only a few WE amps used 300Bs - the 86, 91, 92, and some versions of the 46. .As far as I am aware, the only classic consumer amp that could be set up for 300Bs was the Brook 10C, which had a filament transformer with 2.5 V taps for 2A3s and 5V for the 300B.

Since original WECO 91's are in short supply everywhere and tough to get running in a home system, the single 300B amp is an international favorite with audio constructors. Transformers for the single 300B application are produced by Partridge, Tango, Tamura, and various other companies in Japan. A small niche industry has developed behind this amp in pockets around the globe.

Finally, nearly almost 60 years after its debut, it seems that the single 300B amplifier is coming home. Cary Audio is producing a single 300B amp and Mike LaFevre at MagneQuest/Peerless is reproducing old designs and developing new iron for this legendary tube in his Philadelphia workshop. Suddenly, the concept of running an amp with a single digit power rating is an exciting proposition for some adventurous audiophiles.

Perhaps, it's an extension of the "rebirth of the triode" we have been experiencing in contemporary US high end with manufacturers like VTL, ARC, et.al. venturing into triode amp products. As we go to press, *The Absolute Sound (Issue 79)* features the $67,000 Onagku single 211 amp ! What next?

Fact is that until recently triode amps haven't been a real option for audiophiles since the early '50s when the Brook amps, Fisher 50A, and Craftsmen 500 were among leading contenders. Even at that early date, triode output stages were specialist items for extremists. Brook amps were among the few that used real (three element) triode tubes, i.e. 2A3 or 300B. Others included the Bell 2145, Sun Radio CR-10, and the Goodall ATB-3 which could use either triodes or 6L6s - all of which were based on the 6B4-G, a 6.3V octal version of the venerable 2A3.

Most "triode" amps, then as now, used triode wired KT66, EL37s, or similar beefy beam power tubes to get the extra watts which such tubes provide in triode operation. As you Marantz groupies will be quick to note, the 8B offered the option of triode configuration by tying the screen to the plate through a 100 ohm resistor.

The hard fact is that despite their technical and sonic virtues, triodes just don't deliver high power for the buck and power is easy to sell. You can get double the power from a pentode for the same manufacturing dollar. Just as manufacturing economics drove the market toward transistors around 1960, the triode was pushed out back in the mid-thirties by the pentode. Single-ended amps were an early casualty in the specs and power war, except in the most uncritical applications - TV sets, table radios, etc. - and in pentode powered guitar amps designed to distort.

Better specs (or more power) per dollar is the death sentence of last year's technology. Manufacturing economics drives the market. Subjective concerns, which matter only to "freaks" like us, have little influence on the big picture.

Contemporary high end audio moves outside the usual strict economic constraints to some extent, but it must operate within a larger supply and support context which is very susceptible to changes in mass market practice. In 1960, you could buy 6550s at the local drugstore. Output transformers, no problem. Probably a few places in town that sold 'em. Who would argue that tubes and related parts are better today than back when billions were spent annually on tube equipment? It's a challenge to pursue state of the art in an obsolescent technology and the quality of the support apparatus may set the limits of what is possible with tubes today.

Parts for the single 300B amp are available all over the world from specialist suppliers, but since it won't support "economies of scale", nowhere is the 300B amplifier an "audio cheapskate" pursuit. New WE 300Bs go for upwards of $200 in this country. A set of worthy transformers of modern manufacture will cost several hundred more. Looking on the bright side, you can build a pair of single 300B amps to a high standard for a bit over a thousand dollars and still save thousands over a pair of genuine WE 91s. Be thankful that the amp only uses one tube per side!

Forget the price tag - moderate by high end standards anyway - unless you're shopping for watts per dollar. The 300B is hard to beat in terms of midrange glory and it gives you a fair power output for a single tube. For the price of a decent "upper mid-fi" setup, you can have the best 8W amps in town.

The single 300B amp is a great beginner project for several reasons - simple design with low parts population, no need to match parts and tubes, no balancing or adjustment necessary - just check the voltages and fire it up. Of course the usual challenge of parts procurement applies but most of the components are standard stuff. I know several hobbyists who never built before who have constructed single 300B amps with success. The lure of the 300B is a powerful force, transforming passive "Recommended Component List" zombies into intrepid experimenters.

Basically, if you want to hear a single 300B amp, you almost have to build it yourself-that's why I built mine. There's a motivational factor lacking for push pull pentode projects! I would be sure be less enthusiastic about spending three weeks in the basement working on a scratch built Stereo 70.

THE WECO 91

The original Model 91 is built with reliability and serviceability in mind. You don't want the system going down in the middle of "Gone with the Wind" with a full house. The amp is built on a heavy welded chassis and all wiring is cleanly bundled and laced. Electrolytic caps are screw base types for easy field replacement. Coupling caps are hermetically sealed oil types of WE manufacture. All signal resistors are 2 watt Allen Bradley composition type and power resistors are hefty ceramic wirewounds. Plate current in the driver and output tubes is metered. Western Electric, the manufacturing arm of the Bell System, understood reliability and maintainability. Remember those bomb-proof black WE dial phones?

Setting up a WE 91 in your home audio system is not straightforward. Inputs and outputs use unusual 5 and 6 pin tube socket like connectors. The field coil of a monitor speaker in the projection booth served as a power supply choke (see schematic) in Mirrophonic installations. Since you're not using this speaker, you'll have to outboard a choke (it won't fit underneath) and you need a high DC resistance inductor (maybe 1K ohms) to get the voltages right. Nowhere to put it. A real hassle.

The standard input is 30 ohms balanced, but this isn't an obstacle since for home use the first stage can be disconnected and the signal fed to the grid of the second 310A. One voltage amp stage is all you need with a line level source. In the 91s I set up for home systems, I just disconnect the feedback resistor and let the amp run open loop. Another method is to replace the input trans with a volume pot and strap out one of the feedback resistors to decrease closed loop gain. In this configuration both 310A stages are used.

As you might expect, a 50+ year old amp usually requires a bit of restoration to get it back in the game. Resistors drift, cloth insulated wire disintegrates, impossible to find 500V screwbase caps give up, etc. Breaks. your heart to conduct major surgery on such a classic.

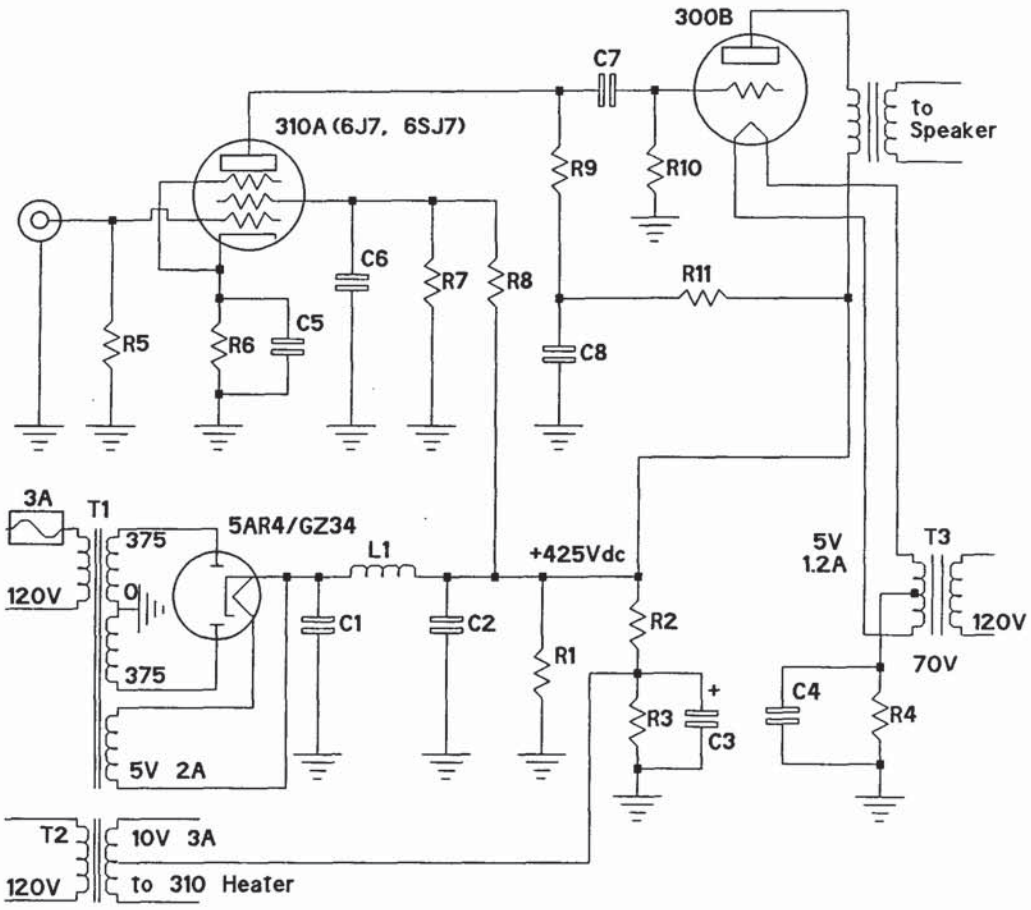
The heck with it I say. Let's just build one from scratch. Actually it is possible to recreate the 91 circuit in a more appropriate form with real RCA jacks and speaker terminals, using fresh parts, and including only the required voltage amp stage. The aural magic will still be there. In fact, in a side by side comparison, I preferred my homebrew to the original after I tweaked my creation to taste. Since you're flying the soldering iron, you can customize the look and sound of your "mock 91" to suit your eye and ear.

BUILDING YOUR CUSTOM 91

Figure 2 shows a circuit which you can use to build an amplifier patterned after the WE 91. This "abbreviated 91" is a very popular design in Japan and France. It is *the* classic single 300B circuit. There is an undeniable synergy in the 310 + 300B recipe, a perennial favorite among triode amp enthusiasts.

Basically, this circuit recreates the modifications necessary to civilize a WE 91 for home use. The first 310 stage and the feedback loop are left out. A choke is included in the power supply as standard equipment and RCA jacks and manageable speaker terminals are furnished.

I chose to build my amp using classic parts for both philosophical and sonic reasons. Resistors are 2 watt Allen Bradley composition or wirewound ceramic power types of



12/93 corrected version

R1 - 50K 25W wirewound	R8 - 75K 5W wirewound	C1-C2 - 15 mf 1000V oil cap (or 2 X 8 uf in parallel). Use 500V electrolytics if you insist on being conventional.	C6 - film or oil cap 8 mf 200V
R2 - 270K 2W	R9 - 91K 2W	C3 - 50mf 100V electrolytic	C7 - .1mf 600V Vitamin Q
R3 - 20K 2W	R10 - 390K 2W	C4 -C5 - 16 mf oil cap or film bypass cap of your choice @ 75VDC or greater.	C8 - 15 mf 1000V oil cap
R4 - 880 ohm 50 W. wire wound	R11 - 27K 10W wirewound		T1 - 375-0-375 V @ 125 ma; 5V@ 2A
R5 - 220K 2W	All 2W resistors Allen Bradley composition type 5% tol. or "tweak" resistor of your choice.		T2 - 10V @ 500ma CT
R6 - 1.2K 2W			T3 - 5V @ 1.2A CT
R7 - 30K 5W wirewound			L1 - 10 henry 125 ma choke

appropriate wattage. PCB caps made before OSHA regulations improved worker's lives at the expense of capacitor technology are employed liberally throughout. Power components are mil-spec surplus iron or commercial units of high quality. I usually build my amps on heavy Bud box style chassis for that timeless "made in the garage" look - a surefire spouse pleaser.

I heartily recommend auditioning various components in your homebrew projects. After all you're building it so look for a sound that makes your ears happy. You will find that this amplifier is highly sensitive to parts swapping and it's a low parts count design so it's a good test bench for experimentation. The beauty of "rolling your own" is that you can optimize the aural character of your creation to fit your tastes and system balance.

You might feel inclined to go with the times and use the standard metal film resistors but I would recommend giving those forgotten ultramusical AB carbon composition resistors a second listen in this circuit. Like most triode designs, this amp is so subjectively quiet that the added noise of a high quality composition resistor, minimal in any case, still results in a lower junk level than most listeners are used to. I personally don't care much for the icy and sharp sound of metal film resistors but if you like it, go for it. At least make sure that's what you actually like by trying other kinds.

After auditioning various film caps and electrolytics at various points of the circuit, I

chose to use a Vitamin Q 196P oil impregnated paper cap for coupling and Sprague Clorinol oil caps shunted with .1 mf polystyrenes for cathode bypass. If you never listened to a good oil cap in your audio chain you might be really surprised when you do. They produce an extremely liquid and grainless sound which might be just what you've been looking for. All the detail is there but it is integrated in a different, what I perceive as a more natural, way than with film caps. They are also historically correct in a circuit of '30's vintage. Other constructors report good results using Teflon caps, Vishay resistors, and other modern "tweak" parts. The best cap for your application will depend on your output transformer, speakers, and individual taste. Try as many as possible.

I chose to use bypass cap values close to those specified in the original WE design. I was unconcerned about low end rolloff since my system bandwidth is limited by my speakers and the -3db @ 12 Hz rolloff provided by 15uf cathode bypass caps exceed the capabilities of the output transformers at my disposal by >20 Hz. Besides, a good sounding 100mf cap is hard to find.

POWER SUPPLY

The power supply is a standard full wave rectifier, cap input circuit with no surprises. It is a good idea to use a slow turn on rectifier like the WE274B or a 5AR4/GZ34 so you don't blast your priceless 300Bs with B+ before the filaments warm up. Based on my listening, I would say that the GZ34 gets the nod on sonics. Very smooth and musical. The 274B provides a bit leaner tonal balance but I find both Sylvania and WE 274B to impart a slight glassy effect to the musical presentation. I have no theoretical explanation for "rectifier sound" so I look forward to hearing from you if you do. Not just a question of voltage drop, scope jockeys. Be aware that rectifiers do sound different so audition several types as part of the general process of parts selection.

I used 15 mf @ 1000V oil caps in the power supply for reliability as well as sonic considerations. You could also use electrolytic caps but I like the smooth sound of oil caps. If you opt for electrolytics try a single 4-10 mf oil cap across the second cap in the pi network(C2) and listen to the grain disappear.

This is a pure class A design so the power supply doesn't have to cope with large peaks in current demand. Thus here is an opportunity to go with quality over quantity in filter caps in good conscience. With two 15 mf caps and a10 Henry choke, ripple is reduced to .03% or thereabouts. Use a bleeder resistor to improve regulation, prevent overvoltage at turn on, and provide a discharge path for the filter caps as a safety measure. A good oil cap will hold a dangerous charge for a long time!

You don't see too many oil caps in audio gear, especially at the consumer level. Marantz used them as the input filter cap in the Model 2. Some Altec pro amps also used them for filter caps. The problem is not performance but price. Back in 1952, when a three section 40 mf @450V electrolytic cost $4.90, 10mf 600V oil caps ran $15.85 each. All manufacturers have to be concerned with runaway costs. When you build your own you can use better parts than would be found in anything you can buy off the rack.

THE 310A/B STAGE

The 310A is a 10 V filament, six pin base pentode which has a grid connection via a cap on the top of the tube. It is a general purpose pentode, akin to the later octal 6J7 or 6SJ7 which will work just fine in this circuit The octal WE version of the 310 is the WE 348A. There was also a 310B which was controlled for low hum and microphonics, targeted for low level preamp applications. A standard 310A is quiet enough for this application. The 310A was designed for critical carrier amplifier service in the telephone system. The phone company ran 310s on DC filament supplies and a DC supply for the tube would be a nice touch. Noise should not be a problem with an AC supply.

There are some parts required to install the 310A. The grid cap is the same size as that on an 807. If you don't want to bother with finding or installing a 10V filament transformer or if your power trans has a 6.3V winding, you can substitute a WE 328A which is essentially the same tube with a 6.3 V filament. A 6J7 (or 348A) will require a smaller grid connector which is often a bare metal spring clip. The exposed terminal is a grid so there is no problem with dangerous voltages.

You will want to use a shielded cable running up to the grid cap with the braid grounded to the chassis. A piece of interconnect will fit the bill. I put +40 volts on the filament line through a voltage divider from B+ to avoid potential hum problems.

I would recommend using a poly or oil cap to bypass the cathode resistor. If you choose to use electrolytic caps here, try paralleling them with a cap of high sonic integrity. I found that the screen bypass cap had a strong effect on bass quality and I recommend experimentation to find the one you like. An electrolytic will work, I guess, but why skimp in such a classic design. I ultimately chose a Aerovox 12mf glass seal metal case paper cap. Maybe a large poly cap like a Solen will do the job for you. Use what you can get but don't settle for junk.

THE 300B STAGE

You'll need a 5 volt filament transformer for the 300B. Try to find one with a center tapped secondary. You can then run the 880 ohm cathode resistor from center tap to ground like WE did and apply the bias voltage through the filament transformer winding. In this arrangement, the signal doesn't have to go through a big ugly wirewound pot. In the amps I built there was no need for a hum balancing pot at the filament.

If you can't find a center tapped xfmr or if you discover that you need hum balance capability connect the bias resistor to the wiper of a 25 ohm 50 watt pot and connect the remaining terminals to the filament connections of the 300B. If you twist all filament leads, and locate the 310A away from power supply iron there should be no hum problems. In a single ended amp you don't get the common mode rejection provided by a push pull configuration so take all applicable precautions.

880 ohms is not a standard value but I found Ohmite Brown Devils in this value so they were made. MCM Electronics has 870 ohm 25 W rectangular cement resistors - they will work fine but you'll need to wire four in series parallel to get adequate power handling capability, i.e. connect four leads then connect the remaining leads in sets of two. Maintain our usual high standards in cathode bypass cap selection.

Be sure to check the filament voltage and add dropping resistors if it is too high - you don't want to roast this tube! High filament voltage is one of the leading cause of early demise in vacuum tubes. I would shoot for 4.8-5 V RMS measured with the tube plugged in.

Speaking of 300Bs, there are several brands on the market these days. Genuine Western Electrics seem to be the most desirable and are priced accordingly. The last genuine WE 300B tube rolled off the assembly line in 1988. It was the last tube that WE made and it had been in constant production for 53 years! The quality control and life expectancy of the original Western Electric tube is exceptional. At 10000 hours lifespan, figure on paying 2 cents per tube per hour of musical bliss. I have not tried any of the Cetron or Golden Dragon tubes. Ask around for opinions on these if you're tempted. You can't go wrong with the WE version. Take note that the WE version sells for considerably more than the others, possibly with good reason.

OUTPUT TRANSFORMERS

The other challenge in building a 91 lies in procuring a quality single ended output transformer. They sure don't sell em at K Mart. Luckily, the situation for American audiophiles is improving. Peerless is recreating the Altec TFA-204 which was a replacement part for the Altec version of the 91 [Altec started as a service division of WECO-All Technical Services]. There is also a new design single 300B transformer in the works from Peerless. The Partridge is an old standby among European and Japanese constructors but it is not available stateside. Tango of Japan makes some iron suitable for the single 300B and these are trickling in.

What is special about single ended transformers is that they employ an air gap so that the core will not saturate in the presence of a heavy DC Magnetizing current, i.e. the plate current of the 300B, flowing through the primary. I'm no transformer design whiz but the concept is similar to the air gap between the winding and the core of a filter choke which forestall saturation of the core. According to those who would know, designing a good wide bandwidth single ended trans is an order of magnitude more difficult than developing a good push pull transformer due to the issue of unbalanced DC.

I am fortunate to have had the opportunity to hear several transformers on my single 300B amps. Most of my listening was done using WE 755s (8" full range 70-13,000 hz. response) in a slant front 2 cubic ft. cabinet, Thorens TD-124/SME3009/Grado MCZ, homebrew preamp playing Dinah Washington, Patsy Cline, 50's Jazz and other stuff I play for musical enjoyment. I realize that this is a non standard reference system, but this ain't Sea Cliff, fellas.

Anyway, I'll try to provide a subjective & unscientific survey of the iron to shed some illumination on the field. Take it for what it's worth. There are various other transformers available in the Japanese market from Lux, Tamura, and others. Never had the opportunity to hear them. Let us all know what you think if you have.

Original WE 171A- Great midrange texture, slightly soft on the top end. Romantic, luscious and involving. Very forward soundstage. Speaker really seemed to couple to the room with this transformer. Impossible to find, unfortunately. I wouldn't even bother trying.

Peerless TFA-204 - This trans was designed by Altec as a 91 replacement part. They probably didn't want low bass in theater sound to avoid low frequency flutter. Good choice to drive the mids/highs in a multi-amp system if you want a modern 'neutral' sound but not the best bet for systems capable of impressive bass. Clean, fast, high definition sound. Accurate but musical. Unfortunately, limited bandwidth rules it out for full range use.

MagneQuest FS 030 - Still a prototype when I heard it but it holds great promise for the stateside experimenter. Great bass definition and a grainless, colorful midrange -great on sax & trumpet portrayal. Highs were gentle but detailed. My amps vaguely reminded me of a Marantz 8B with more speed and higher resolution behind this hefty piece of iron. Provided a bit more distant perspective on the stage than the other transformers in this survey. More soulful than the TK4519 or XE-60 described below but not quite as "neutral" in character. Might even be better when it hits the street.

Kenyon T-108 - Relatively low grade universal transformer from the 40's. H'mm, better than I expected. Good bass slam, nice full semi-sweet mids but no highs. Your tweeter will sleep right through it. After prolonged listening, I began to detect a slight glare. Okay, it's not great but it's encouraging that there are sleepers out there. Not really worth crawling around in basements looking for it though.

Partridge TK4519 - The classic in the Japanese and Euro markets. Pricey to import and real difficult to find stateside since Partridge didn't want to export to the states because of liability concerns - WARNING: not UL approved. Too bad because this piece lives up to its reputation. Delicate and detailed highs, smooth accurate midrange and fast extended lows. A bit drier sounding than the Peerless FS 030 and *slightly* grainy in comparison, if you want to get real picky. But the tonal balance was right on the mark. Maybe the best full range sound I heard from a single 300B to date.

Tango U808 - Low end of the Tango line. A universal transformer, designed to work in either push pull or single ended applications between a wide range of impedances. Might sound better in a push pull amp or in a lower current single end project but forget it for this demanding application. Wiry, hard, and somewhat fatiguing to listen to for long stretches with the single 300B.

Tango XE-60-3,5S - *Much* better than the U808. Lean and clean, "well damped" sound. Should appeal to those who like what the audio press calls "neutral" and "accurate. Bass is more conrolled and leaner than the low end of FS 030 or TK 4519. Nice gray hammertone case. There are a few even better Tangos which I never got to hear. These might be better yet.

I might change my mind on some of these impressions if I optimized the amp for each transformer by auditioning various caps in combination, blah blah blah. But I was more interested in the overall musical experience while I had each of these transformers on hand. Maybe if I had, say, the FS 030 when I first built my amp, I would have chosen other parts. I assume most constructors will buy a set of transformers and optimize around them rather than running a xfmr test lab. Most listeners will be happy with either the Tango XE-60-3.5S or the Peerless FS 030. Auditioning transformers is like auditioning wire; at some point it pays to give up and just listen to music.

GENERAL CONCLUSIONS

Why single ended instead of push pull, you rightfully ask? As in most things in life, there are good arguments on both sides and it all comes down to 'what you like' in the final analysis. Single ended amps might not provide impressive specs but there are a few points in its favor. So check your handgun at the door and let's look at some of the traditional positions in this long forgotten debate --

Pro push pull
- More power
- Less total harmonic distortion by cancel ling 2nd order distortion
- Never heard of single ended
- Common mode (hum, noise) rejection
- No unbalanced DC in output trans
- Commonly available
- Wide bandwidth
- Deep trust of familiar technology

Anti push pull
- Phase inverters are problematic
- Balanced tubes and other parts necessary to achieve optimum performance. Balance changes over time even if you can get truly balanced tubes to begin with. Component values drift with time and heat..
- Skews natural proportion of even and odd harmonics toward the wicked sound ing odd order kind.

Pro single ended
- Ultra simple signal path
- PURE Class A
- Avoids phase inverter probs.
- Only need $400 worth of 300Bs for stereo
- No need to match parts
- Extra second order distortion sounds good
- Maintains natural harmonic relationships
- Who cares about bandwidth, 99% of the music is there. Some noise missing however.
- Sounds amazing

Anti Single ended
- Low power
- Mediocre specs
- Obsolete, long abandoned technology
- Never heard of single ended
- Can't buy transformer at K-Mart
- Limited bandwidth

Well, I don't think I settled the debate with that discussion. At any rate, single ended triodes sure do sound different in a way that you pick up on a visceral level. The music "feels" different. I would say that typical pentode/beam tube amps have a somewhat "mechanical" or "strained" presentation while the single triode is easy, supple, very natural. As one audio burnout friend remarked, "It's an amp you can fall asleep listening to" - he meant it as a compliment. If you ever got that tightness in your jaw muscles listening to a reference grade "painfully accurate" high end system, you know what we're talking about.

Like many music lovers, I listen to a lot of records that aren't exactly Shaded Dogs. Triodes render scratched, noisy, and plain old poor recordings a lot more palatable than does the contemporary audiophile amp. This is a benefit of the well behaved overload characteristics and tempered third order response of the three element tube. You'll sure appreciate it the next time you decide to listen to some Reggae 45s pressed on stuff that looks like melted-down combs instead of Thelma Houston direct-to-disc.

The organization of musical information is different with a single triode. Detail abounds but is integrated within the music rather than being "etched on" or peaky as with some modern pentode amps. Perhaps this is a result of the presence of third order distortion unbalanced by its even order counterpart in the p-p pentode amp. I haven't heard anything that portrays subtle microdynamics like the single triode. This dynamic agility contributes to the overall wealth of inner detail.

The single 300B really communicates the "groove" of the music, if the music you're listening to has one. In complex ensemble music, the rhythmic integrity and drive of individual instrumental lines is maintained. Still, given its power rating, its an amp for chamber music rather than "The Power of the Orchestra". It simply runs out of steam on all but the most efficient transducers when confronted with Sheffield Drum Record class booming. On most *music*, the dynamic performance of these amps will be a revelation. The exceptional tunefulness of the low end makes up for the limited power and extension on the bottom.

Incredible timbral accuracy is what really makes this amp special. Maybe its the even order distortion that the push pull pentode amp cancels out but it seems that the tonal palette of the single triode is more diverse. You get the woodier wood winds and cymbals and other metallic sounds are more harmonically rich, e.g. cymbals sound like brass not aluminum. Conga drum slaps have a lot more character, music, and veracity. Piano and guitar sound like they are made of steel *and* wood, not *either* steel *or* wood. The textural rendition of this amp is sometimes disarmingly real. Listening to your favorite Miles discs will be a thrill.

Another way in which the single triode differs from a good pentode amp is in the character of the image.There's a "sourcelessness" with good speakers that pentodes don't approach- lots of air without any bleaching out of musicality. It's like you're *in* the soundspace rather than looking *at* it - more *it is here* than *you are there*. Again it's a difference of kind rather than one of degree.

Regardless of the sonic splendor they provide, single ended amps are clearly not for the "spec freak". You simply can't argue for these amps using the standard quantitative measures - you'll lose. The single triode just doesn't rate on paper. I can't imagine what Consumer Reports or Hirsch-Houck labs would say about a Model 91, but it definitely wouldn't be rated as highly as a YORX rack system. Face it, this amp is *rolled off*. Magic between about 50-15K but, in a phrase often reproduced by Mirrophonic gear, "...that's all, folks". *Maybe* that's all the bandwidth you really need anyway.

The power output of this amp is not as limiting as I thought back when I was brainwashed by specs but it does constrain speaker options to some degree. Class A triodes with their low output impedance and high damping factor can really control a cone. A 300B will adequately drive many an efficient (>90dB) box speaker. If you're interested in vintage speakers like old JBLs, Altec 604 or 755, or you have a set of nice horns, you'll never think about the power rating. This amp is a natural for driving the mids/highs in a multi-amp setup. If you refuse to listen to anything but SL600s or Apogees, forget single ended amps.

If you're looking to put together a single triode system, it's wise to recognize that the small amp/efficient speaker and the big amp/inefficient speaker paradigms don't mix well. If you stay within either tradition and exercise good judgement, you can get high quality reproduction. There are always questions of compatibility to be addressed in putting together a system and this is just a special case of that general principle. It's a mighty 8 Watts, but it is just 8 Watts.

This amp makes sense in several contexts: a mini monitor type system with some efficient bookshelf speakers, a multiamp system, or a big super efficient horn type setup. In either case, vintage speakers are more likely to fill your speaker requirements than current high end fare. Stick with high quality speakers made back when

(continued p.27)

SINGLE 300B (Cont. from p. 11)

25 watts was considered a substantial capability and you improve your chances of coming up with a synergistic match. Finding a really good speaker is probably the toughest challenge in audio regardless of which amp you use.

Be forewarned...some may argue that you listen to a single ended amp because it's "exotic". Understand that the knowledge base and deeply held beliefs of people who take progress and the forward march of engineering science seriously are threatened by the astonishing musical performance of single triodes. Can't be that a technology which was thrown out as inefficient and distortion prone before WWII sounds sooo good. You will find that most vocal critics of single ended amps never heard a serious audiophile grade single ended amp. They sure don't like the idea though.

It *is* very interesting that this amp excels according to audiophile performance criteria that were only defined long after its topology was abandoned as obsolete. Shows what an unimportant influence subjective experience had in the development of the technology.

One of the best arguments for this amp is that it cures cases of high end burnout. It's a simple project that you can build yourself regardless of prior experience, a form of deep satisfaction you can't get at your local high end saloon. Since I started rolling my own a couple years back, audio has assumed a much more thought provoking and rewarding role in my life. In other words, it's fun again.

If you're totally non-technical now, try a few projects like this and soon, through osmosis and trial and error, you'll find you understand more than you ever thought you could. If you already know the techie stuff, you may well discover something new in the ancient wisdom of WECO.

Power Cord PLUS

The good stuff for your AC interface

by Gordon Rankin, Wavelength Audio

Over the last several years, many manufacturers of high end equipment have adopted IEC type power connectors. This move toward a standard AC mains connector led to experimentation with aftermarket power cord designs. It is now widely recognized that important shielding advantages and impressive sonic improvements are available through the use of high quality AC wires.

These advantages became apparent to me about two years ago while I was demonstrating a pre-production discrete FET preamplifier at a local dealer. Initially, the result was pleasing. Then we installed the preamp just above an ARC Classic 60 amplifier. This time the preamp sounded terrible - there was considerable noise even without any sources attached. The unit does have high impedance areas which were susceptible to noise pickup. We changed the power cord to a Belden shielded unit. The noise disappeared suddenly and the unit sounded good again.

After this experience, I investigated what was available on the market. I was surprised to find a number of power cords ranging from $100 to over $300 for a six foot length. I bought several of these entries and tested them in the configuration that caused problems with the stock cord I had been using. I couldn't believe the improvement over the Belden shielded cord. The noise radiation problem was eliminated, but there was also substantial sonic improvement in a number of areas. This was starting to get interesting.

I polled several equipment makers and learned that most were using standard grade high gauge wire or off-the-shelf IEC cords for their units. Clearly, one could do better.

In my first attempt at building power cords, I used Romex wire, inspired by a write up in IAR suggesting that since it is what is running in the walls it should suffice. The result was good but not as good as some of the store bought cords. I am against tearing open cables and devices and copying them so I went back to the drawing board. I tried some average grade 12 gauge solid core wire with a copper braid shield and the result was better than expected.

One day, I got some Cardas wire for a prototype amplifier we were building and I tried this as a power cord conductor. In this attempt, I adopted a few aspects of construction and aesthetics from the Cogan-Hall Intermezzo speaker wire kit. The copper braid shield was aplus in the abovementioned effort so I retained it in the prototype of this design.

I braided the three Cardas conductors to cancel any radiation and I used a Wonder Wire™ drain wire for the ground connection. Stretching and taping the braid down every few inches helps the drain wire maintain contact with the braid and keeps the signal wires wrapped tightly. At this point the cable was functional but not very pretty. A nylon braid sheath *a la* Cogan Hall over the copper braid gave the unit a finished and "professional" appearance.

Compared with the other cables I had been auditioning, this cable provided a more spatial sound with enhanced definition. On track 5 of Ricki Lee Jones *Flying Cowboys*, the oscillation of the vibrato contoller was cleanly articulated. The other cables were somewhat smeared in the vibe passages in comparison. Overall, there were surprising differences for such a simple change.

On extended listening, I liked this cord so much that I now include it with my Wavelength Audio products. The cord is not available separately but here are plans for you to build your own or provide inspiration for your experiments.

DESCRIPTION

The *Power Cord Plus* uses Cardas 14.5 ga. wire for hot and neutral leads and 18ga Wonder Wire™ as a drain, a tinned copper braid shield, and a nylon braid covering. The wall end is terminated with a hospital grade mains plug and the female end is terminated in a high grade IEC connector. This configuration will work with all equipment using male IEC connectors.

PARTS FOR AN X FOOT CORD

1- Three lengths of 14.5ga Cardas Golden Stranded Chassis wire at (X+0.75") each
2- X feet of tubular copper braid 0.375" dia.
3- X feet of nylon braid 0.5" dia.
4- X feet of Wonder Wire™ or other tinned solid 18ga. conductor
5- Hospital Grade three prong power plug
6- IEC female connector (15A-25A) with as large an opening as possible
7- Electrical tape precut in 1.5" lengths (approx. 10-15 pieces)
8- Heat shrink tubing: One 1.5" piece of 0.75" dia., two pieces of 0.25" dia.

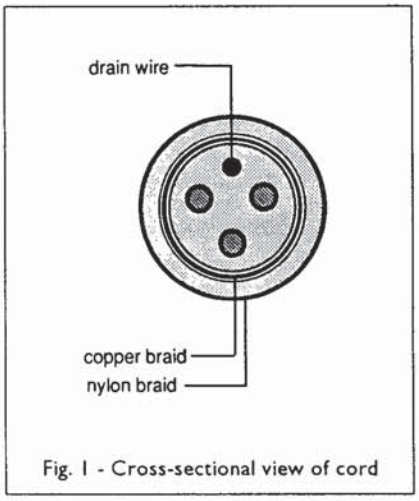


Fig. 1 - Cross-sectional view of cord

EQUIPMENT REQUIRED

1- Solder pot or high wattage iron
2- Needle nose pliers, cutters, and scissors
3- Ruler or tape measure
4- Heat source for the heat shrink tubing

CONSTRUCTION

Dimensions are given in terms of offsets so that the user can create any length of cord.

Prepare the three 14 ga. conductors in the following manner: Cut lengths about 3/4" longer than the proposed length of the cable. Strip about 0.25" from each end of the wires. Using a solder pot or a high wattage soldering gun, tin both ends of all three conductors. Mark two of the three wires with a marker or heat shrink, unless you have two or more colors of Cardas wire. I use red and yellow heat shrink to mark hot and neutral conductors.

Line up the ends of the three wires and tape them together about 1" from one end in a tight bundle. This will be the wall end. Braid the three conductors up to the other end and tape them together about 1.25" from the end. This will be the equipment (IEC) end.

Line up the 18 ga. drain wire with the unmarked (ground) 14 ga. wire. Tape it in place about 1" from the wall end, then spiral it around the braided wires. Tape it in place about 1" from the other end and clip off any excess.

Temporarily tape over the ends of all conductors at the wall end. This will facilitate threading these wires through the copper braid.

Trim the copper braid to 1" less than the proposed length of the cable. Start at the end you just taped over and feed the cable through the braid. Tape the braid tightly around the wires about 1" in from the equipment end then, while pulling the braid tight, tape every six inches or so. This will ensure good contact between the braid and the drain wire. Trim any excess braid off at the wall end and tape it down about 1" from the end. *Make absolutely sure that the braid can not come into contact with any power leads.* The copper braid will get your hands really dirty, so go wash them after this section of the operation.

Trim the nylon braid to 1" less than the proposed cable length. Starting at the wall end, inch the nylon over the copper braid. Make sure that the copper braid does not bunch up while doing so. Pull the end of the nylon just over the end of the copper braid and tape it off *very* tightly. Be sure that the tape does not show beyond the rubber sleeve of the female IEC connector. Smooth out the nylon braid over the length of the cable, tape it down 1" from the wall end and trim any excess.

Remove the temporary tape from the wall ends of the wires. Place the heat shrink tubing over then end of the wires and adjust so that about 3/4" of the conductors is showing. Shrink the tubing until the nylon pattern begins to show through the tubing.

At this point, take apart the female IEC connector. Take the rubber sleeve out and position it on the equipment end of the cable. There should be about 1/2" of conductor showing. Insert the conductors into

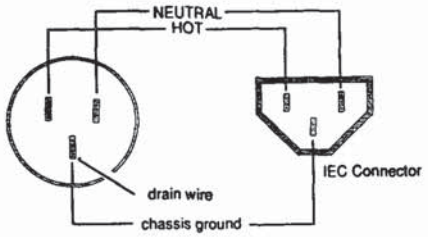


Fig. 2 - Connector diagrams

the channels of the IEC connector and bolt them down. I find it useful to square the ends of the connectors using a pair of pliers for better fit and greater surface area for the screw down contact. Close the IEC connector and bolt it together. The connector should close completely, though I have had battles with my needle nose pliers getting everything squeezed in when using large gauge wire.

Take apart the wall plug and place the strain relief portion over the cable. Make connections per Figure 2. Make sure that the drain and chassis ground conductor are fed into the center position. Use an ohmmeter to make certain that all connections are correct and that no shorts between conductors exist. It is easier to change connections on the wall end of the power cord if necessary. This completes construction of the cable. Plug it in. Enjoy.

The Power Cord Plus can be used with any source, preamplifier, or amp up to 100W. For amps bigger than 100W, heavier wire is indicated because of increased current. Be prepared to get frustrated over the limited working area of the female IEC connector when using wire heavier than 14 gauge.

FOR FURTHER EXPERIMENTATION

Here are a few suggestions worth trying which I have not yet implemented:

1- Put IRON cores around the signal leads to filter out HF noise components. Fix placement with heat shrink.

2- Put a low value resistor in series with the chassis ground connection to filter out digital noise in CD and DSP units. Some digital AC cords omit the chassis ground connection entirely.

3 - Run multiple thinner conductors in parallel for each conductor. Tightly twist or braid these together.

4- Michael Percy reports excellent results using a pair of .1 caps from chassis ground to neutral and hot leads. Be sure to use AC rated caps or units rated *at least* 600 VDC for a 120 V line.

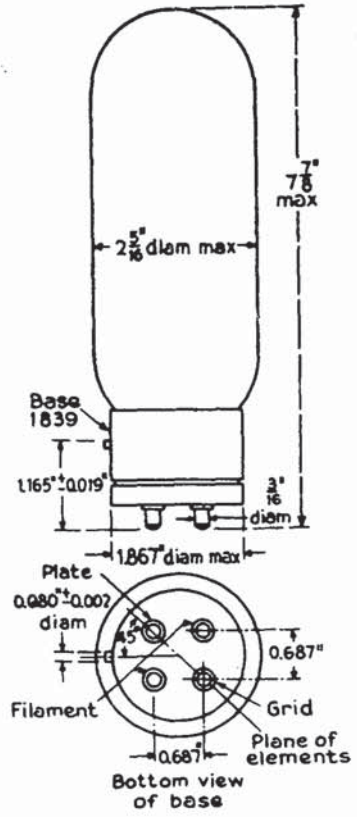
PARTS SOURCES

Parts for Power Cord Plus are available from Michael Percy, Triode Electronics, and many other audiophile suppliers. If you have any problems sourcing parts feel free to contact me at Wavelength Audio.

Gordon Rankin
Wavelength Audio
4539 Plainville Road
Cincinnati, OH 45227
513-271-4186 phone/fax/voice mail

Michael Percy
Box 526
Inverness, CA 94937
415-669-7181
415-669-7558 fax

Meet the Tube
... the mighty 845



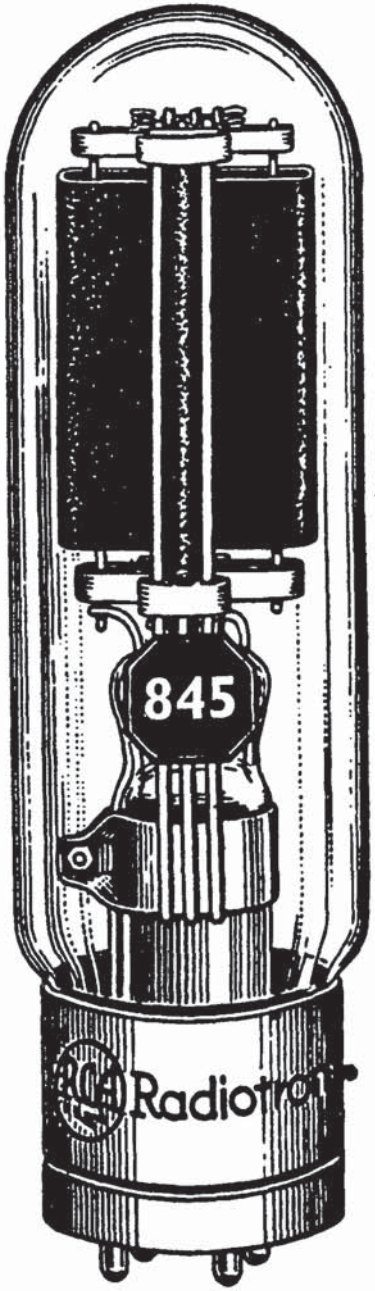
Wow! No tube inspires more fascination, respect, and desire than the large glass triode.

You can just imagine them cooking away in the transmitter room of an all night blues AM station in Chicago back in 1952. Or 1942, or 1972 . . . like all classics, it's beyond time and place. It's been there.

Seldom seen in the home, the 845 is an undomesticated animal, requiring death-defying voltages to make it sing.

Its tungsten filaments give off a bright, white hot glow.

It is a commanding presence; the big triode doesn't bow to miniaturization. It is never an afterthought.



TRANSMITTING TRIODE 845

CLASS A MODULATOR

100 WATTS INPUT

List Price **$10.00**

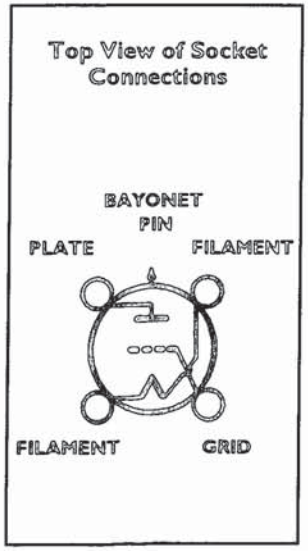
RCA-845 is a low-mu transmitting triode of the thoriated-tungsten filament type designed specifically for use as a class A audio-frequency amplifier and modulator. It may also be used in class AB_1 audio service. Two 845's in this application are capable of delivering approximately 115 watts of power with very low distortion.

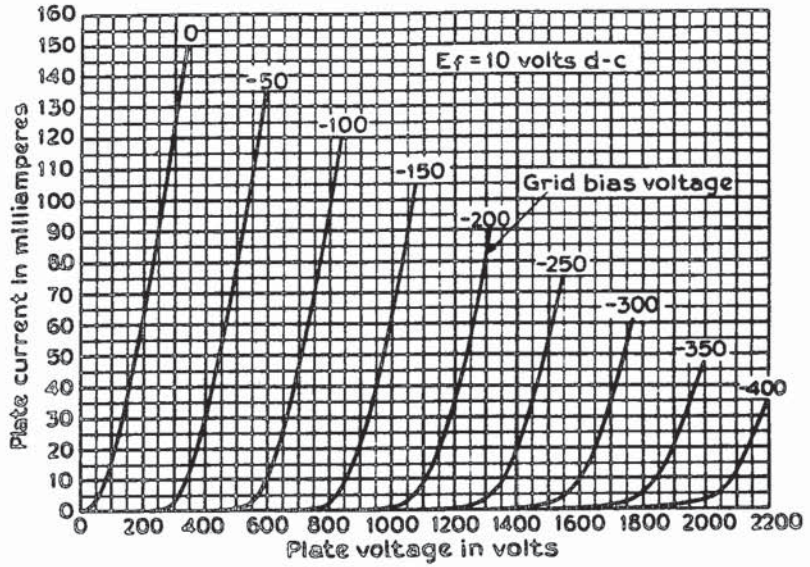
Typical operating conditions for a single 845 in class A service are: D-c plate voltage, 1250 volts; grid bias, -195 volts; d-c plate current, 80 ma; and undistorted power output, 30 watts. Typical operating conditions for two 845's in class AB_1 service are: D-c plate voltage, 1250 volts; grid bias, -225 volts; zero-signal d-c plate current, 40 ma; maximum-signal d-c plate current, 240 ma; effective load resistance (plate-to-plate), 6600 ohms; and maximum-signal power output, 115 watts.

The 845 is one of RCA's three famous "50-watters". It has maintained its reputation for long, reliable service through the years of radio communication. For real audio power with low distortion, RCA-845 is the answer.

RCA Guide for Transmitting Tubes, 1941.

The 845 was already a classic by 1941 -- designed for AUDIO, pure and simple.





845

MODULATOR, A-F POWER AMPLIFIER

Filament	Thoriated Tungsten			
Voltage	10			a-c or d-c volts
Current	3.25			amp.
Amplification Factor	5.3			
Direct Interelectrode Capacitances:				
Grid to Plate	13.5			μμf
Grid to Filament	6			μμf
Plate to Filament	6.5			μμf
Maximum Overall Length				7-7/8"
Maximum Diameter				2-5/16"
Bulb				T-18
Base				Jumbo 4-Large Pin
RCA Socket				Type UT-541

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

A-F POWER AMPLIFIER & MODULATOR - Class A_1

D-C Plate Voltage			1250 max.	volts
Plate Dissipation			100 max.	watts
Typical Operation:				
D-C Plate Voltage	750	1000	1250	volts
D-C Grid Voltage°	-98	-145	-195	volts
Peak A-F Grid Voltage	93	140	190	volts
D-C Plate Current	95	90	80	ma.
Transconductance	3100	3100	3100	μmhos
Plate Resistance	1700	1700	1700	ohms
Load Resistance	3400	6000	11000	ohms
U.P.O. (5% second harmonic)	15	24	30	watts

NOTE: In cases where the input circuit to the 845 is resistance coupled, the resistance in the grid circuit should not exceed 0.5 megohm when cathode bias is used. Without cathode bias, the d-c resistance in the grid-coupling circuit should not exceed 0.1 megohm.

A-F POWER AMPLIFIER & MODULATOR - Class AB_1

D-C Plate Voltage			1250 max.	volts
D-C Grid Voltage			-400 max.	volts
D-C Plate Current			120 max.	ma.
Plate Input			150 max.	watts
Plate Dissipation			100 max.	watts
Typical Operation:				
Unless otherwise specified, values are for 2 tubes				
D-C Plate Voltage	1000	1250		volts
D-C Grid Voltage°	-175	-225		volts
Peak A-F Grid-to-Grid Voltage	340	440		volts
Zero-Signal D-C Plate Current	40	40		ma.
Max.-Signal D-C Plate Current	230	240		ma.
Load Resistance (per tube)	1150	1650		ohms
Effective Load Res. (plate to plate)	4600	6600		ohms
Max.-Signal Power Output	75	115		approx. watts

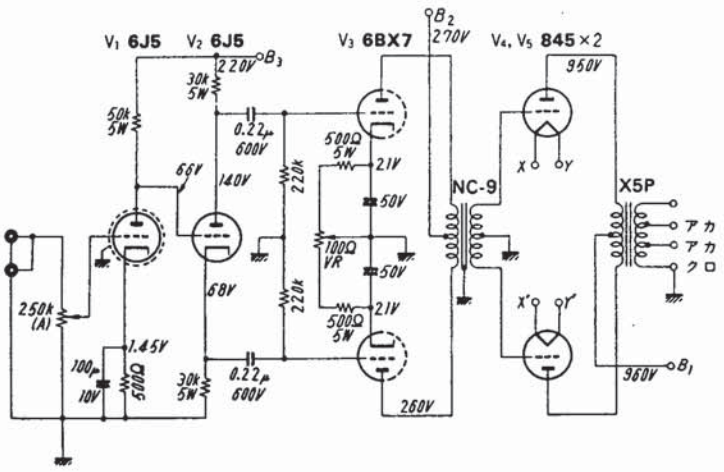
° With a-c filament supply.

OUTLINE DIMENSIONS, TUBE SYMBOL, and SOCKET CONNECTIONS for the 845 are the same as for the 211.

◇ indicates a change.

April 15, 1940 — RCA RADIOTRON DIVISION, RCA MANUFACTURING COMPANY, INC. — DATA

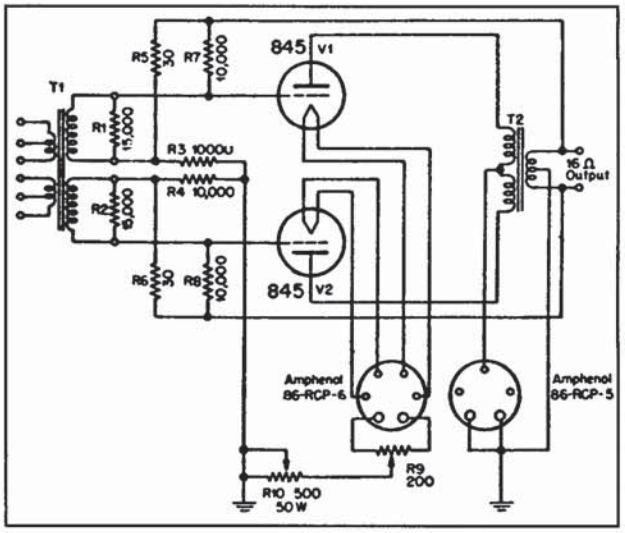
As these plate curves indicate, the 845 is a tube of impressive linearity.



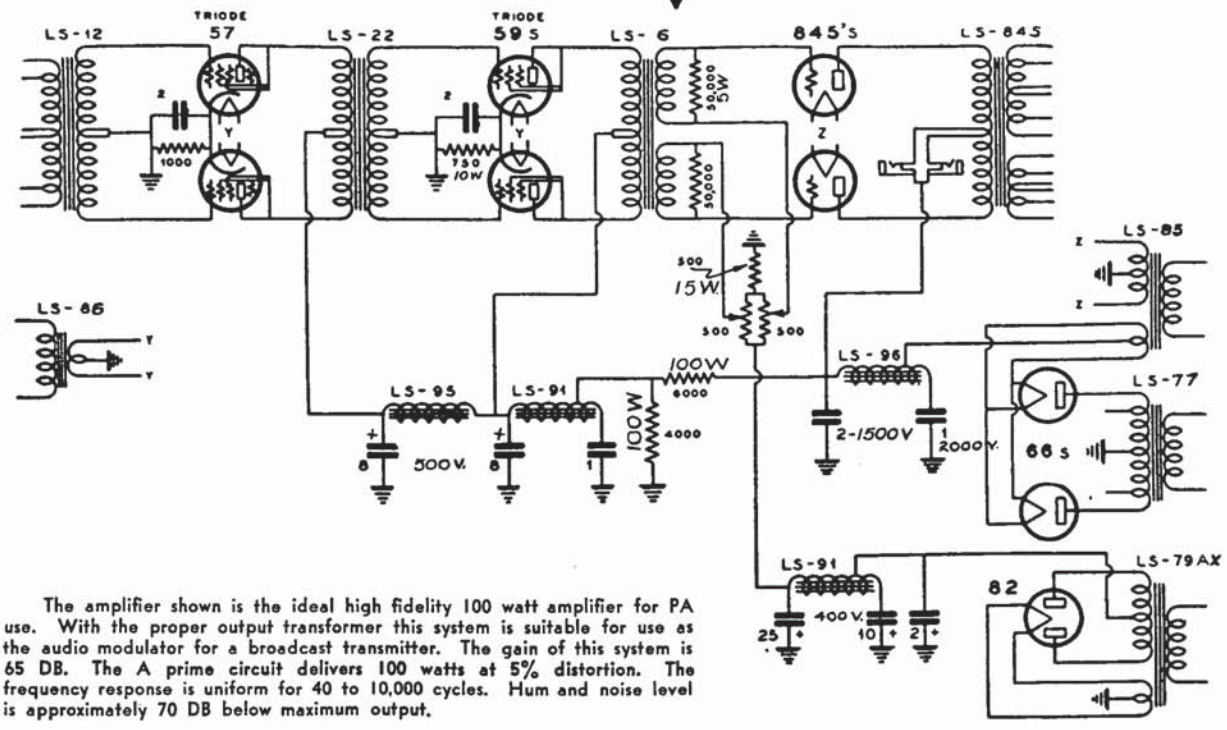
In this circuit from *MJ*, a Japanese audio experimenter's magazine, the driver stage is transformer coupled to the 845 grids.

Because of the high drive requirements of the 845, interstage step-up transformers are often used to provide undistorted signal voltage of adequate levels to the output stage. The amp provides 80 watts output Class AB_1.

This is the audio section of the Musicians' Amplifier Senior from *Audio* January 1951 (reprinted in *The 2nd Audio Anthology* available from Old Colony). It is a "booster amp" which is itself driven by a power amp. Good for 40 clean watts Class A. This amp is a descendant of the Western Electric 87 and the Altec 287F - a design which dates back to the 1930's.



from the 1936 United Transformer Company catalog



The amplifier shown is the ideal high fidelity 100 watt amplifier for PA use. With the proper output transformer this system is suitable for use as the audio modulator for a broadcast transmitter. The gain of this system is 65 DB. The A prime circuit delivers 100 watts at 5% distortion. The frequency response is uniform for 40 to 10,000 cycles. Hum and noise level is approximately 70 DB below maximum output.

The Core Issues:

Choosing a Power Transformer

by Michael S. LaFevre, MagneQuest Transformer Co.

"The Core Issues" will examine the function, construction, design, and operation of magnetics for audio applications. This series will combine practical advice in the form of useful "rules of thumb" with enough pure theory to give us some concept of how these magnificent devices work. This column is not an academic engineering tutorial but rather a guide to becoming an informed consumer.

This series begins with a look at the theory and operation of the power transformer. Power transformers are relatively uncomplex devices compared with output transformers and are often given only the most cursory attention by audiophiles. More often than not, they are treated generically. "Oh, all you need is a transformer that will supply, say, 360-0-360 VRMS @ 200 mils for the plates, a 6.3 VCT @ 4A filament winding, and 5 volts at 3A for the rectifier tube." Beyond this point, the consumer is often at a loss as to how to properly select a good unit or is misguided by myths about magnetics. Where do we go from here?

In the ideal world, power transformers are conceptually pretty simple. We want the transformer to either step up (increase) or step down (decrease) the voltage supplied to the primary. Power transformers, like all transformers, are simply ratio devices. If you have 100 turns on the primary connected to a 120 VAC supply and you want 360 volts on the secondary, then there must be 300 turns of wire on the secondary--i.e. a 1 to 3 ratio. To obtain our 5V winding, the primary voltage of 120V must be stepped down by putting fewer turns on the secondary. The exact number needed is 4.1666 turns. In the ideal model, turns ratio precisely equals voltage ratio.

The ideal model assumes a perfect conductor with zero resistance. Therefore, the size of the conductor is wholly unimportant and can be infinitely small for convenience. But, and this is a big but, we do not live in an ideal world. In the real world, we must contend with a variety of electrical and magnetic phenomena that blow our ideal models to hell and back. There are always losses when using real materials, e.g. copper is one of the better conductors, but it significantly inhibits the flow of electrons. Similarly, losses occur due to the properties of core materials.

Due to the resistance of copper, not all of the 120 volts applied to the primary will be available to be stepped up or stepped down. Some of the voltage will be burned up (gone forever) in travelling from one end of the copper to the other. The telltale sign of this inefficiency is heat. The lost voltage is reincarnated as a temperature rise. The steel laminations also introduce losses that are not accounted for by the ideal model. Our ideal model assumes infinite permeability and proposes that the laminations will not, in fact cannot, be saturated ("overloaded"). Real transformers aren't like this, unfortunately.

The value of this ideal model is to demonstrate the underlying simplicity of the device and to reinform us as to where deviations from the ideal occur. But you can't buy an ideal transformer.

If it's not possible to have an absolutely perfect transformer, "one that simply transforms", then what should we realistically seek? First and foremost, we want to obtain our specified secondary voltages -- using our earlier example, we need 360-0-360 while the transformer is delivering its fully rated 200 mA current. Also, we would like to minimize the variation in this voltage even when the circuit is pulling considerably less than the full current for which it is designed. In other words, we want the voltage to remain relatively constant from no-load to its maximum current capability. This is called "voltage regulation". Many power transformers (notably stock Dyna iron) exhibit pronounced voltage sags at maximum rated current. A well-designed and properly built power transformer can achieve a remarkably high degree of voltage regulation. Next, we would like it to run relatively cool. And, we would like it to be as physically small as possible without sacrificing performance. And we would like it to be as inexpensive as possible without trading off real performance for dollars.

Let's take a look at a few dubious claims about power transformers you're likely to encounter in the audiophile press. In philosopher's parlance, these are "fallacious arguments". By examining these fallacies, we can develop a better perspective on important performance parameters that must be considered in choosing transformers.

One of my favorites was an ad that advised hobbyists to buy the house brand of power transformers because they were heavy -- the assertion being the more weight, the better. Another good one was the high end manufacturer who claimed that to get your money's worth you should buy a transformer that runs hot. A widely held and popular belief is that you should buy a mil-spec trans. The supporting logic is that because Uncle Sam has an unlimited budget and only buys the best components, the smart consumer benefits by buying them on the surplus market for pocket change and makes a real killing because its "mil-spec" and, therefore, a high-performance unit. But by far the most common misconception is that a power transformer with double or *triple* the current capacity actually required will yield a better performing transformer than one that is rated at the maximum current honestly necessary for proper operation of the circuit at hand. This is a potentially dangerous assumption.

Let's start with the weighty issue first. The assumption is that you will get more for your money. But more of what? Often, but not always, a transformer is beefy because it utilizes a low grade of electrical steel. Transformer laminations come in a multitude of grades ranging from M6 to M55. The lower the number, the lower the core losses as measured in watts loss per pound of material. This is because the reluctance (the magnetic equivalent of resistance) of

M6 is lower than the lesser grades with a higher number behind the "M". The higher the number, the higher the losses; therefore, you must use more (all other things being equal) of M19 for a given VA (power) rating than if you use M6. As the number increases, the saturation point falls lower and lower. Even if you run M19 at lower levels of flux density, magnetic distortion is still greater than for the more premium grades of laminations at the same operating level. Simply put, you must use more M19 to build our example transformer than you would need using M6 and your iron losses will be greater if all the other design considerations are equal.

This is not meant to say that you should always reject a power transformer if it is heavy. Some power transformers built with M6 are heavy, and some transformers built with M19, M22, or M27 are designed to provide reasonable performance levels. The big mistake is to make decisions based solely on weight without knowing anything about the composite performance capabilities. We must know what the voltage regulation of the unit is, what temperature rise to expect, how current capacity was calculated, what flux density level the unit runs at, etc. Just don't buy on weight alone since it might indicate cost constraints imposed by the manufacturer (M19 and M27 cost 40% to 70% less than M6) and a heavy unit may have poor overall performance characteristics.

Another misconception is that a transformer should run hot if you're getting your money's worth. Actually there is a small grain of truth in this assertion, but only if you don't particularly value characteristics like good voltage regulation, low magnetic distortion, and the like. The aviation industry, for instance, will tolerate extremely high temperature ratings in order to gain small size and weight. But for audio projects, especially quality projects like building 300B amps, this would be a very unwise tradeoff. To get a transformer to run hot, we can do any number of things: use a poorer grade of lamination, keep the size of the lamination small, use small diameter wire in the windings, or operate a good grade of lamination at very high flux density levels. Presto, it'll run hot. Sort of like a New York City Saturday Night Special. Will it survive? If it is built with class B insulating materials that are rated for 105° C operation and it truly runs hot (say it has a 75°C or higher temperature rise when pulling a full load) on the surface, then we are probably flirting with disaster. But even under these conditions, more than likely, it will survive. Forced air cooling would provide an added measure of safety.

Remember that inside the transformer there will be localized hot spots that operate at 15 to 20° C hotter than the surface. The aviation industry gets away with running iron hot because they specify insulation materials rated for 155°, 180°, or 220° C environments and they're willing to sacrifice some performance factors for small size/weight. Most consumer and industrial power transformers use 105° or 130° C materials which are adequate for a transformer without serious design flaws. If your manufacturer specifies temperature rise, look for a unit with a 35° to 55° C rise. Transformers with a 55° to 75° C rise are less desirable but worthy of consideration if all other performance factors are acceptable. Pass it by if rated at 75° C or higher rise. Again, don't make decisions based on any single performance criterion -- look at the composite characteristics.

Let's examine the most common misconception: that radical derating of transformers leads to better performance. In our ideal transformer model, the voltage ratio is equal to the turns ratio. If you built an actual transformer according to the model, the actual voltage increase will be smaller than anticipated. Why? Because there are always resistance losses in the copper and iron losses in the laminations. How much less depends on the grade and size of lamination, the size and length of the wire, the varnish or impregnant used, the type and amount of insulation employed, type of housing, and yet other factors. The principal determinants are the copper and iron losses mentioned above.

In practice, we can compensate for voltage losses by adjusting the turns ratio. To achieve a given voltage ratio, we need a slightly higher turns ratio. The adjusted turns ratio is calculated by taking into account a number of factors which are related to current flow: copper and iron losses and temperature rise (resistance and core losses go up with temperature). We need to calculate losses at full load so our transformer will deliver the target voltages with good regulation. The current values plugged in to the formulae must be the ACTUAL maximum conditions which the circuit will demand of the transformer. Otherwise, the secondary voltage will be a surprise.

Suppose a customer specifies a 400 mil transformer instead of a 200 mil transformer. OK, this requires a significantly different design. It will be larger and it will need heavier conductors in the primary and plate windings to offset increased I^2R losses. The voltage regulation of this transformer will be about the same with 400 mA as the smaller transformer would have with a 200 mA load. The customer is right in one respect-- if he only draws 200 mA from a 400 mA transformer, there shouldn't be any problem with voltage sags as with the Dyna iron. But is he home free?

By overstating current requirements, our friend will end up with a transformer that delivers a voltage higher than optimum for a given circuit. The compensated turns ratio for 400 mA is higher than for 200 mA. Therefore, he *might* get better voltage regulation and a cool running transformer, but at a voltage which is assuredly higher than bargained for. Not only the plate voltages but all secondary voltages will be too high since copper losses in the primary will be less than anticipated. The ultimate costs of this error could include decreased reliability and longevity of tubes, caps, and other parts or even improper operation of the circuit. The wise move is to get a competently designed unit at the desired voltage and realistic current levels.

A few more notes on current capacity: The current rating of transformers is what I would call a "soft" number. If a manufacturer says his unit is rated at 300 mA but provides no further info, we have not learned enough to evaluate the import of his claim. Perhaps it will deliver 300 mA, but only at a 90° C rise or it might drop so much voltage at 300 mA that the initial design target voltage is inaccessible. Voltage regulation might be poor indeed at 300 mA. To really judge this claim you would need to know at least the temperature rise and voltage regulation from no-load to full load. Current capacity specifications can vary between very conservative and wildly optimistic. Be sure you're comparing apples with apples. If two units give the same voltage and current specs, try to find out more about how it was designed with respect to voltage regulation, temperature rise, flux density level, etc. Don't treat the two units as "generic" equivalents

performance-wise without first getting as much information as possible.

Here are a few characteristics to look for when choosing a power transformer.

- A 40° to 55° C temperature rise
- M6 material
- A copper current density level of 600 to 1,000 circular mils per amp (the higher the better)
- Between 3% and 6% voltage regulation
- Insulated hardware
- A flux density level under 15 kilogauss
- Mechanically quiet
- Electrostatic shielding between primary and secondary windings
- Designed for the current that your application requires

Don't use this as a rigid checklist since there are many good designs out there that will fail to meet one or more of these criteria. In general, these are indicators of a quality transformer.

Lastly, a few comments on mil-spec transformers. Many audiophiles are under the misconception that mil-spec transformers are somehow superior to other, commercially available units. In reality, Mil T-27 addresses issues relating to physical packaging of transformers almost exclusively. Specific requirements are laid out to ensure a high degree of mechanical integrity for phenomena such as vibration and shock, salt spray, flammability, fungus proofing, altitude testing, etc. On electrical matters such as voltage regulation, current capacity, temperature rise, core material and grade, or permissible flux density, Mil T-27 is wholly silent. In fact, unless the government agency or the approved contracting agent specifically lists particular performance parameters, the units supplied must only meet longevity (as measured by insulation life), corona standards, and minimum standards for insulation resistance.

Unless you're privy to the actual contracting order, you cannot be sure of the actual performance parameters (if any were specified) to which the transformer was designed. You could wind up buying a unit that offers no real advantages over other designs. But, of course, those surplus items are available cheaply and have great appeal to constructors on a tight budget. But it really is taking a shot in the dark from a performance point of view.

When shopping for transformers for your next project or design, it may be useful to review some of the points in this article - especially the "indicators of quality" outlined above. In certain cases even more information will be necessary. For instance, this article does not address very important issues like rectification and filtering on AC voltages and currents, a topic of great import in choosing your power components...More on this important topic later.

In the meantime...Happy building!

Coming Soon in "The Core Issues"

The Myth of the Torus -or- Why donuts belong on the breakfast table and not on your amplifier chassis.

Audio Tips

That Faux Marantz Look

If you're interested in giving your next project that classy vintage Marantz look try Hammerite brand bronze hammertone paint. Available in aerosol and brush on. Careful application of light coats results in a finish closely approximating the color and texture of a Model 8B. Many other colors available.
For a dealer near you contact:

Hunting Specialty Products
265 West St.
Lebanon, OH 45036
1-800-733-4413

Lafayette manuals

Looking for a manual for a piece of Lafayette equipment? Pete rescued much of this info from the dumpster and oblivion and he's making quality copies available to you the hobbyist.
He has operating manuals, service notes, schematics, and other data for some but not all Lafayettes. Send an SASE with your needs for more info to:

Pete Markavage
27 Walling St.
Sayreville, NJ 08872

EICO Manuals

According to the nice lady who answers the phone, they got 'em *all*. Sorry, no HF-60 kits left. In fact, no parts - just manuals.
Call or write for details:

EICO
363 Merrick Rd.
Lynbrook, NY 11563
1-516-599-5744

...now we just need to find the Pilot and Knight manuals.

from the archives

Excerpted from

Prerequisites for Capturing the Musical Experience

by Robert Fulton

Robert Fulton has been a recording engineer for more than 30 years. For the last 15 years, he has been designing professional and home playback equipment

One of the questions that's asked of us most often at seminars is, "What's best, solid state or vacuum tubes?" Isn't that a nasty one? I sometimes answer by asking, "What year are you talking about?" Let's go back to the time of Edison. Thomas Alva Edison, the inventor of the phonograph, the ticker-tape, the light bulb, and hundreds of other items, had patent after patent after patent. Edison, in his magnificent genius gave us the vibrations on foil. They were called "hill and dale" recordings, up and down, just as the natural diaphragm would move up and down. People I used to know told me of incredible recordings and playbacks made of Sousa's band. What an incredible thing Edison must have put together with a moving diaphragm and a special chamber. No vacuum tubes, no microphones, no wires, no amplifiers, no speakers, no transistors, no resistors, no capacitors, no rectifiers, nothing. All mechanical, not unlike the ear.

Then we got more sophisticated and we added the thing which, in a way, Edison helped to invent. You recall, as he was working on the light bulb, he put another element in the vacuum and showed that current could be passed in one direction, from the heated cathode or filament to an other element, an anode or plate. Edison just stored that away and basically gave us the diode, or rectifier.

It was for De Forest to come by and put a third element in the tube, called the grid, or the stop-and-go light for the electrons inside. This grid was a little wire mesh which would increase the flow of electrons, or decrease them, depending on the type of bias or voltage that was impressed on the now third element. This was the classic triode tube - simple, honest, reasonably linear. And it could be counted on to give a reasonable replica of the input voltage at its output. It kept things in time, was quiet, spoke with dignity and majesty. And so in the '30s, all the amplifiers had triode tubes in them, numbers like the 01A, the 56, the 27. There was the 45, the pristine Class-A amplifier of all time. Then there was the more powerful 2A3, and then the 6A3 and the 6B4. The transmitter people had the absolutely magnificent 845 power tube.

Now after that, the British and others put additional elements in the tube for greater power output and gain (numbers). When the tetrode and pentode, with other elements in them, arrived on the scene, this increased the complexity but also the distortion, and ruined the linearity. Everyone started making amplifiers that had high power sensitivity at the expense of quality. The minute we did that we were reduced to a hog-calling contest. And in order to make it palatable for even the average American, we had to put in a thing called feedback, negative feedback, where we feed a portion of the output signal back into the input to try to con Humpty Dumpty back together again.

Oh yes, the numbers became better, and this got better, and that got better, and we talked ourselves into it. Later we learned that feedback was a bad thing. The concept is bad. It's not always executed badly for industrial power applications, but the concept is bad musically. When you feed enough signal back, you now have destroyed the musical experience. That first note is already on its way to the speaker, and you're feeding it back again and recirculating it back through the amplifier again and again. Not for my ears, thank you.

Now, solid-state comes by and takes the same bad ideas, with the same kind of remote cut-off characteristics, even sharp cut-off, so they become literally switches, on and off. We dump all that in there and say, "aha", just like the vacuum tube. We've already prostituted the vacuum tube for audio by putting more than three elements in it. Not too swift.

As usual, poor audio is at the low end of the stick, and we have to take the hand-me-downs. After the 2A3, the 45, and the 845 power tubes, everything's a hand-me-down. A company makes the 6550 available for industrial use, the British come out with the KT77. Where does that leave us? Right back in the soup. Williamson comes by and says well, we'll make triodes out of them, we'll put another tap on the output transformer and run the screen there. In some ways it got very bad, even horrendous. There was no way to put Humpty together after that one.

In a way I can see how not-ready-yet digital is sneaking in. We have no regard for the beauty and majesty of music when we cut it up and slice it up and feed it back and chop it off. It's one thing to make an operational amplifier for industry, for turning things on and off, but let's not mess up audio. Let's not apply the same lazy technology to audio. Audio for music is more demanding. Real audio isn't just one signal, real audio isn't just a sine wave. Real-time audio is thousands, I mean we're talking hundreds of thousands of bits and pieces of events coming by in an instant of time. And we're going to mess it up by playing games with the signal, and not letting it come through in a natural, unabated way? It's already having enough problems just getting electrified from the acoustic instruments.

To really answer the question at the seminar would be to say something like this: you want to tell them that neither one is any good, that they're a travesty, both of them. However, we can't tell them we've literally emasculated everything when we ran it through those wretched devices. So what we can say is that it's very possible, in this modern day of enlightenment with the topology available to us, to do something. But when was the last audio tube made? I challenge you, when was the last audio tube made in the United States? When was the last audio transistor made? These are topics for a separate discussion. We could say that, given "A" and given "B", it would be technically possible at this

time to build an amplifier with vacuum tubes, and an amplifier with transistors, which could be equal, musically speaking. I'm not saying it's being done in either discipline. We've done it in our laboratory on a one-to-one basis. When was the last time you found a good 12AX7? Gets kind of quiet, doesn't it? When was the last time you were able to purchase a super high-quality output transformer, or for that matter a decent power transformer? It seems like the transformer people have all gone away. The vacuum tube people have all gone away, there's no new design going on, just the same old humdrum. The same is true in the solid-state field as applied to real audio.

Engineering students ask, "I wonder if we should regulate the whole power supply on this one?" It should have been completely regulated from the beginning. We try to get by for nothing and it's not working. And so, accidentally a few receivers come from outside the country and perform musically above some of our better equipment - kind of a tragedy. Of course, most imports cannot separate anything out, nor can one identify the correct timbre of many of the more complex instruments. Audio is an American heritage. Are we going to keep it that way?

I really believe that someone somewhere ought to be working on a really good output device for amplifiers. The output stage has got to perform. It's got to have control. It has to have musical sensitivity, and be graduated. It must have enormous reserve. We can't get it with gimmicks. We need to produce a design with teeth in it and with real power in it. We've got to imitate the triodes of old. They're past us now. It's gone away. There's an occasional rumble of new development here and there but nothing's happening because something is always overlooked. We're not applying ourselves, we're just dabbling at it. I think it's a sad commentary on out time in history that we don't have a device that really cuts the mustard.

Some have had the audacity to suggest that now that the amplifiers have been perfected, we have to do something with the speakers. Hogwash. Pure, unadulterated hogwash. In some ways, some speakers are better than any amplifier that's ever been produced. The amplifier has a long way to go, a long, long way. We barely had vacuum tube technology down to where we could even get a handle on it, and all of a sudden we're ushered into solid-state. We still haven't overcome that disastrous dilemma.

We're a long way from putting an amplifier together that's musically satisfying. Yes, we can put together amplifiers for shaker tables, for industrial use, and for calling the hogs. Might even work at the State Fair, but to take home and put in a music system? I'm afraid we're still working on that.

DISCUSSION

Over the years, Fanfare has given us some thought-provoking commentary on the audio scene. As a music lovers' publication, it is on somewhat neutral ground as regards the audio business and it provides a forum in which the technically proficient can speak to fellow music lovers. In this excerpt, the late visionary Bob Fulton presented a fundamental critique of the devices which are brought to bear on the challenges of musical reproduction.

He takes in the big picture, portraying almost the entire history of electronically reproduced audio as a downward spiral. In compliance with the "no free lunch principle", the most linear devices, e.g. triode tubes, compromise other specs - power, total distortion, economy... - and they were abandoned for such extra-musical concerns. In Fulton's position the choice is clear and the industry chose wrongly.

A paradoxical subtext of his article is that the complexity of music demands technological simplicity. Music is an incredibly complex and subtle phenomenon but the most appropriate technology for reproduction is one which is elegant, honest, and simple - or at least one free of unnecessary complexity. It is interesting that the earliest and most obvious ways of reproduction are the most well tuned.

"We can't get it with gimmicks", as Bob puts it. Indeed, clever "engineering", he would argue, is typically at odds with the goals of "audio musicianship". "Something is always overlooked".

Perhaps some day we will see the better device Mr. Fulton wished for. Until the day science catches up, artists like Bob Fulton will constitute the vanguard.

IT WILL STAND

Herbert Reichert, Staten Island, NY

"You take some music, sweet flowing music, some movin' and groovin'... heart beats drums beat... hear those sax blowing - sharp as lightning - hear those drums beat loud as thunder... see why it will stand... some people don't understand it that's why they don't demand it... you might as well claim it... sinking deep into the heart of man. It will be here forever and ever... I feel good, let's do it again... It will stand."

Norman "General" Johnson

1957 - I am eight years old and my mother has just set me loose in Marshall Fields to pick out my birthday present. I go straight to the mahogany and glass listening booths and put the tonearm down on Elvis' "Loving You". That was my first record purchase. As I type this I am listening to that same record.

1966 - Down in the basement, walls covered with Hendrix posters, I turn the volume up on Sonny Boy Williamson and the Yardbirds. This time the music is not coming from the 15 inch speaker in my parents' Columbia hi-fi but from my own Garrard turntable, Olsen preamp and two Fender Reverb amps. Strange system but it played Rock and Blues to suit my teenage chemistry.

1992 - Thirty-five years of Elvis, Bach, Louis Armstrong, George Jones, Irma Thomas, Patsy Cline, et. al., has taught me one sure thing: there are an infinite number of musical thrills, goosebumps, tears and laughter available in front of your home music reproduction system.

Reproduction of music in the home asks the listener to fill in perhaps 90% of the total information. No other private emotional experience requires this involvement. Yet billions of records and millions of reproduction systems testify to man's desire for this type of experience. How much and what type of information does one need to become involved in a recorded musical experience? CD has made this the most important question in audio. I am convinced that more information is better BUT the *quality* of information is far more significant. What is crucial is that the system makes us want to listen and not limit the types of music we want to explore.

What does this have to do with WE-300B's? Let me explain. I never really wanted a "Hi-Fi" system, just something rugged and honest that puts me in sync with the music. I wanted to feel the Stratocaster and Deluxe Reverb. I wanted to respond to the weight and tone of a Steinway and Bosendorfer. I liked to hear the tubey sound of a Hammond organ. I built Dynaco kits in college and Hafler kits in the 70's. My Hafler/Advent system of '79 was all the "Fi" I felt I needed.

One day at a friend's house I heard a Marantz 7C, 10B, 8B, Quad ESL system playing the Dellar Consort (Shakespearean songs). I wanted to go home and get my favorite records and just get lost. I was so impressed I became determined to purchase the same system. Finding the prices out of reach, I began to build my own. I bought books on speaker building, subscribed to Audio Amateur and began to read "Electronics Made Simple". I bought a Dyna MK-III and a PAS-3 and modified them. Now things were getting interesting.After building 3 way speakers with paper cones and Alnico magnets I designed my own EL-34 amp and bought a Super-It as a reference preamp. This system sailed through complex Mahler and loved John Lee Hooker.

At that time I met a man who would become my audio mentor. He had designed the best system I had ever heard. We worked out an arrangement: my Acro UL-II for his long term advice. I was given schematics to study and build. He preached pure triodes, low source impedance, high transconductance and no global feedback. Shortly thereafter, I met a gentleman that had been building amps since 1950. When asked if he had any advice regarding the design of a fine music system he had only this to say, "BELIEVE NOTHING YOU READ AND TRUST ONLY YOUR EARS".

1988 - After two weeks of listening to my first triode amp (6B4-G's) I put my EL-34 (triode connected) amp back in the system. A few records later I returned to the directly heated triodes. The difference was shocking. The EL-34 seemed artificial and "reproduced", lacking in weight and body. The triode amp was clear, direct, present and most of all VIVID.

Soon my mentor urged me to "take out the feedback." I was somewhat apprehensive. Certain that the quietness of my feedback amps would be lost and in its place there would be noise and distortion, I resisted. A month later curiosity got the best of me - I snipped the feedback leads. At first, all I heard was more gain and less noise. Two changes were obvious immediately after reconnecting the feedback.

First, feedback gave the sound a pronounced reverb quality I now recognize in any amp or preamp. It is a "phasey" effect that makes music sound canned and tends to distance the listener from the performance. Second and equally obvious was a loss of information and voice articulation. After listening to electronics *sans* feedback one instantly

wonders where the information went when one returns to feedback. It is a clean subtractive effect. "More feedback = less information" sums up my experience.

A system's strengths and weaknesses affect our listening habits and even our tastes in music. Whenever I listen to a new component I find myself going back to the record stacks in search of a record that will sound satisfying with the new component in the system. Therefore, one task is to design a system that likes as many types of music as possible.

Some of my most profound musical pleasure has come from my AM car radio. I always wondered why. On the other hand, I have heard more unlistenable twenty thousand dollar systems than I can count. This too stirred my curiosity. What makes a system plug into your heart?

If the music is strong it can come through an inexpensive system if the basics are correct. After auditioning systems of up to $250,000 I realized that the qualities which I had come to value were not available at high end salons. Also, I suspected that the reviewers promoting these systems might themselves be victims of cultural drift and had taken a wrong turn in the maze of sonic discovery.

What to do? I began to look backwards through audio history for the "fork in the road." As far as I can tell there is a break at the point when speakers got smaller and amps got bigger. At this point everything in the audio chain began to work harder and massive corrective measures were required. At a previous point we had high output (5-10Mv.) cartridge driving simple two tube (passive EQ) phono stages which in turn drove simple transformer coupled power amps into first order crossovers and very efficient horn speakers.

Less than one watt was sufficient to play any type of music in the home. Five tubes, two capacitors and one or two transformers *were* the signal path. The power supply was equally simple; tube/choke/capacitor or a simple pi filter. These few parts were operated in a narrow linear part of their range with 6-12 dB of headroom at each stage. A 109 dB/1 watt/1 m. speaker requires about .002 watt for satisfying home listening. Imagine what this does for the linearity of each stage of the audio chain.

Today we have parts counting in the hundreds and power ratings in the hundreds just to play chamber music in our studio apartments. The driver stage of a modern tube power amp is special if it has 3 dB of headroom driving any of today's audiophile speakers. That "edgy" sound you hear at your local hi-fi shop might be the equipment straining at its limits.

One should not assume that all vintage systems are better than today's best high-end systems, though some might be, but rather that elegant engineering, low parts count and maximum linearity/minimum phase were once the *only* way to design. Entire theatres were powered by fewer parts than those in a modern D/A converter. Not to mention the relative material quality or manufacturing excellence of these parts.

As my building and investigation continued, my mentor began to explore single ended amp design. He was using single 300B's for his mid range and single 2A3's for the tweeters. This time I did not hesitate. Using some Dyna ST-35 outputs I built a RCA-45 single ended amp. One watt. The sound was so direct, even at low volume, it brought tears to my eyes. As I turned up the volume pot, my home made speakers got the best of my amp. Anything above very low level listening drove the amps deep into grid current. I searched for more efficient speakers. My records, heart, and - most of all - ears led me to the 1940's vintage Altec system I presently use.

I bought some Tango transformers and built a 300B single amp just to hear for myself why the Japanese have enthroned this tube. I understood the reason moments into the first record. It has a texture and color in the midrange that is as rich as a painting. Comparing this amp to contemporary US tube products is like comparing Cinemascope or Technicolor to video.

My story is not about what plays music best. It is about my audio journey and the mindset which inspired it. I think that one shouldn't buy records because the sound on one label suits our system better than another. Instead, the system should accommodate a variety of material and encourage discovery. Exposure to new types of musical experiences can be an important part of learning to know ourselves. It can lead us to understand other arts (i.e. literature or painting). In my case the music led me to develop my understanding of electronics, math and physics.

What is sure is that there is a universe of recorded music out there and the methods of getting the music to your heart, feet and mind can and should be as distinctive as your own character. If your system produces a response of goosebumps, tears and laughter, if it stretches your soul, if it feels good, you will listen again and again. The music will stand.

Mono Mia !

by Vinny Gallo

I was born in the tragic slums of tragic Buffalo NY in 1961. I grew up there in an Italian-Black-Puerto Rican neighborhood. The Disco Superstar Rick James was my neighbor and is still good friends with my Uncle John or John "The Bull" Fantazzo, as he's known on the block. My family moved next door into my Grandmother's house when I was two, one month after my father was sent to jail. Don't ask. Anyway, he got out when I was 15 and threw me out of the house a year later on my 16th birthday. Don't ask.

I remember my Grandma's house. It was small and it had a smell, not a good smell or a bad smell just a certain smell. There was no TV, no radio - just this old wind up 78 machine with this big metal horn that had flowers painted on it. Underneath in a shelf, she had 9 records: three by Domenico Modugno- you know, the guy who wrote *Volare*, four Caruso records, and her two favorites - one by Dean Martin and one by my father singing "Fools Rush In". Before my Pops went to prison, he was a nite club singer. He got to record one single. If I think back, other than the fact that I hated her records, Grandma's windup machine sounded astoundingly good.

In the neighborhood, my Best Friend was this guy named Butchy, Butchy Megadino. His Pops was the biggest bigshot on the block. He was the biggest in the neighborhood, which to me seemed like the whole world. His name was Stefano Megadino. I say *was*, cause he was gunned down in front of Ray's Pizza Parlor in 1978 - 13 days after he joined Audiomart. He was the 13th guy to subscribe. Poor guy, he was so excited.

Mr. Megadino was tough and he worked hard to stay on top. But he would also spend a lot of time fooling with Hi-Fi. Mr. Megadino loved Modernization. He loved being the first to buy a new gadget and he always got his new Caddy first, or else! And he had the first and only Color TV in the neighborhood. I remember me and my Mother going over the Megadino's to watch Super Bowl III on COLOR TV. What a shock, COLOR TV! Everybody loved the Jets and that modern slickster, Broadway Joe. Everybody, except me. My hero was the simple conservative Johnny Unitas and the good-old-fashioned Colts. I cried when the Colts lost.

Mr. Megadino's biggest obsession was his Hi-Fi gear or *stereo equipment*, as it was called. And since I was like a son to him, I got to witness first hand the buying and selling of a lot of gear. I helped unload the first SAE 50 watt amp, the first GAS Ampzilla, the first Mark Levinson preamp. I loaded up Dahlquists, Magneplanars, Quads, KEF 103s, all of it.

Man, it was great - he was on top of the world. He had all the latest technology in the palm of his "black hand". Plus everytime he got something new, I could make a few bucks hooking it up for him. He refused to fix or connect anything. The guy would pay me to change the batteries in a flashlight. I still don't know if he *wouldn't* or *couldn't* do things like that. Anyway, his son Butchy was the same way. So they both needed me.

Mr. Megadino would always use one of his four copies of Tony Bennett's *Cloud 7* on Columbia featuring Chuck Wayne on guitar to show off any new gear. He had good taste. I was Hi-Fi HOOKED. Obsessed and in love with the stuff. Also during this time my hippy cousin, Asti Bunza, who was 18, was turning me on to all kinds of music. He had 24 LPs, the most of any kid in the neighborhood. He had every Beatles LP.

I was also spending a lot of time just going to stereo and record stores just staring and dreaming. Buffalo was a tough place for a kid to make a buck, especially in the early 70s. I had to really hustle. I had a bunch of contracts mowing lawns in rich neighborhoods and in the winter I would shovel a lot of driveways for a buck a driveway. I beat up this kid once who was stealing my customers with his gas engine snow plow. I also got 25 cents a day for lunch money, so right there I could save $1.25 a week, even though I was always starving. And I saved ever penny I made.

My friend Butchy was the opposite. He spent but he refused to work. He had a lot of habits to support - pinball, ice cream, candy, comic books, pot, and cigarettes plus a six pack every Saturday night. He was also a King Farouk with the girls. So he needed a lot of money. his father was generous to him but it wasn't enough. So Butchy became a thief, a BIG thief, a big FAT thief. It was OK with me because he stopped trying to borrow money.

One snowy Sunday morning after church, I went to Butchy's house and within 5 minutes he talked me into robbing the corner bar. It was called the Jolly Jug. Five days earlier, the owner bought some hi-fi gear hot, *very* hot, from a local junkie named Elmo Wright. Our plan was to get the hi-fi stuff and all the liquor we could carry out, so we used Vito Padulla's newspaper wagon for the job. Everything went smooth. The hardest part was divvying up with Butchy. We argued for an hour splitting up the booze. When we got to the hi-fi, neither of us would budge. We cut the stereo system in half. I kept one Dynaco MK IV amp and Butchy got the other one. I got the PAS 2 preamp and Butchy took the FM-1 tuner. We each got one A-25 speaker. The AR turntable fell out of the wagon and broke during our getaway so we left it behind in the snow.

In my Grandma's house, I slept on the couch in the living room. I didn't have my own room, so when I got home with my stuff I set it up in the basement. I already sold my share of the liquor to Frankie Bones at the Social Club at 220 Connecticut Av. He gave me two 20s, 40 Bucks. Forgeta 'bout it, I was rich! So the next morning I skipped school and went straight to my favorite stereo store. I needed a turntable to listen to my new system. I shopped all day checking out the latest and greatest and finally settled on a $75 Technics SL-20 with a $15 Grado P-mount cartridge. Total cost 90 bucks- the guy said if I paid cash no tax.

OK, now I had the 40 from the booze heist but that left me 50 short. I would have to spend 50 from my hard earned lawn mowing & snow shovelling money. Twenty five lawns and twenty five driveways - that was a lot of grass and a lot of snow. But I

couldn't get that SL-20 out of my mind. Those Japanese were geniuses at selling us pork eating Americans shitty good looking stereo stuff and between beef jerkys and bags of chips we were trading in our great old mono tube stuff to pay for it. Even the Italians did it. I was only 13 years old, how could I know? What's *your* excuse? The real funny thing is that old Technics and Pioneer stuff doesn't even look good anymore. It didn't hold up.

But that day I was thrilled and I rushed home and hooked up my half stereo system. One problem left- the Technics didn't have 78 speed and I had no records of my own. I had to use a 78 on 45 speed. I chose my fathers single and played it on 45. At 78 RPM, Pops was an OK song stylist, but in 45... MAN, he was singin' the *blues!* My pops just became a great Black blues legend in 45! But after a couple plays I was bored. Plus the Grado wasn't tracking 78s too good. I *needed* records.

Suddenly I got a flash, My cousin Asti Bunza the hippy got drafted and was getting ready to go in the Army. I heard he was selling his record, poster, and bong collection so I rushed over to make him a deal on the records. We settled on $11 and two joints that I found at the school playground about two years earlier. Besides, I had no need for that kind of stuff. I got all 24 LPs. He was a hippy and I was a happy. I went home and blasted all four sides of the Beatles' White Album. WOW! It was brilliant, trust me.

That was my first system and it was great and it was only one speaker and one amp. Unfortunately, that would be the last time I would be completely happy with my hi-fi system for years to come. What happened was I put the White Album away and ran over to Butchy's to try to try to buy the other amp and speaker from him. Unfortunately, Mr. Megadino wanted to buy my half. He was getting hooked on tubes again. Dynaco was his first setup and he was a sentimental guy. And besides his Ampzilla had blown up one too many times. I couldn't refuse the "Boss of Bosses" so I sold him my share of the stereo. But the guy did pay me very well.

Anyway that started a long period of buying and selling audio gear. I've owned it all- old stuff, new stuff , Levinson to Fairchild to Krell to Audio Research, back to old Marantz, then to Western Electric. Every amp, every speaker. All of it and for what? What did I get? A pain in the AASSSS. That's what. And why? Was it the equipment? My room? My records? *Me?* Forgeta 'bout it! I was OK, my records were the best, my room was beau-ti-ful, and some of the gear was good, especially the old triode amps. So what was the problem? Huh?

Think about it. Are mechanical and electrical reproducers supposed to take the place of live music? NO, they're not. They are what they are. They are their own thing. They have their own place in our lives and they shouldn't even be compared to live music. I really believe that great hi-fi should sound like the best radio you ever heard. Great hi-fi affects your ears and emotions in its own way, reminding you of sounds and sound impressions. For example take a photo of a chick that you love. It is not an actual reproduction - you can't touch or smell her. But you can get a strong emotional reaction from the stimulus of the photo. Some chicks even look better in photos and sometimes a simple black and white photo can be the most beautiful. Hi-fi works the same way.

Great Hi-Fi should sound like the best radio you ever heard.

Hi-fi is its own beautiful thing and for me the more simple it is the better. Mono, that's right, MONO. Ya heard me, MONOphonic. For years people listened to it and loved it. But some hustlers told us stereo was better while they were selling us two of everything. Well, it's not. Trust me. It might be more but it's not better.

Fortunately, one time I was stuck with only one amp and one speaker that I really wanted to wire up and listen to. Happens all the time when you try to put together classic vintage systems. Anyway, I tested them out and I was shocked. It sounded great! The gear was good but I realized that a big part of it was that it was mono. So pure, so simple, so beautiful. I never went back. It was like the first time I saw "Raging Bull", suddenly Black and White was hip again.

No more breaking my back to find two of everything, no more taking the whole room apart to fit in two of everything. Plus systems are half the price. And all the gear and many of the records I like were meant to be listened to in mono. Just try to get those big multicell horns to sound good in an average sized room in stereo, Not a chance. No longer did I have to sit in one narrow spot exactly between two speakers to enjoy the music.

Another great thing about mono is that it sounds right no matter where you are in the room. My system sounds great even from the next room or outside. My neighbors are always yelling up from the street, "Hey Vinny! That sounds Beautiful".

Mono, Mono, that's right, MONO MIA! Thank God. Less gear to fix, less wires. Stereo is a SCAM. How does dividing a recording in two make any sense anyway? What if you have a five piece band? What side does the fifth guy come out of? To me, the mono sound is perfect - coherent and whole. Stereo sounds like a special effect. Listening to stereo is like having to wear 3-D glasses every time you go to see a movie.

Many of the best records are mono anyway. There's so much great music recorded before stereo took over. And there are a lot of BAD stereo records around. Most of the time, they don't even get the special effect right. Good mono beats bad stereo everytime - just like good records sound better than bad CDs.

Stereo is like having to wear 3-D glasses everytime you go to see a movie.

I say most of you stereo equipment nuts hardly have time to listen to your gear because you're too busy shopping for special interconnects. Try this instead, set yourself up a simple mono system and listen to the music. Then you can share a pair of those special interconnects with your best friend. Keep it simple and have fun! If you shoot for the simple thing, you got a better chance of success. You might be surprised. Chew the fat, shoot the breeze, mull it over, think about it and give mono a try. Love, Vinny.

Whither Tubes . . .

by Eric Barbour

...the thermionic device and modern American civilization...

In making polite conversation with strangers, the subject of hobbies occasionally comes up. Now, most people admit that they lead rather ordinary lives. A few profess an interest in a specific hobby of some kind, as opposed to a general interest in outdoor activities and the like. Most of those hobbies consist of rather polite and traditional crafts: knitting, painting, model-making, ham radio, photography. But when I am posed the question in turn, things get weird in a hurry. I have to be honest, I tell them the truth: vacuum tube electronics. The response is predictable. Ordinary people give the mother of blank stares, then follow up with mumbled attempts to change the subject -- thus indicating their total lack of understanding.

A few people are "hip" to the idea of building and listening to tin boxes full of glowing-hot glass bulbs. Often these people are themselves into ham radio or some other electronic pastime. The rock musicians will always give out with this "it gives a real smooth sound man, good guitar amps use tubes too man" bit, while not understanding the reality of it in the slightest. And the people who make their living in electronics will give me a dirty look and mutter "what kind of crap is this???". And so the polite conversation veers off in another direction, dragged off by the person who initiated it. Even the older ones, who remember that thirty years ago tubes *were* electronics, shake their heads.

I pay no attention to them. After all, I am under NO obligation to explain it. Usually when I try, the blank stares just get blanker. Hell with 'em. Do I make light of adults who play with toy trains? There is no accounting for taste in one's amusement. Conversely, I feel no qualms about ignoring the critiques of others regarding my avocation. Even so, the reactions of others do inspire *some* thought -- here's an analogy that occurred to me recently.

PARALLELS

If you know anything about art, you will remember the biggest movement of the 1940s and 50s. It was called Abstract Expressionism. It was raw, dynamic -- distilled emotion on canvas. There was even a rough expression for it: AB-EX. Virtually all of its practitioners were men, and a more rugged bunch would be hard to find. Jackson Pollock. Robert Motherwell. Frankenthaler. Stella. Whether they splashed, dribbled, or poured their paints, they did it with abandon. And they believed in abandonment in their lives. Many were classic "two-fisted drinkers".

Franz Kline, *Cupola* 1958-60

They didn't care about society, about the rich people who bought their works. They could be found pissing in fireplaces, smashing furniture. To hell with refined sensibility -- art was PASSION. AB-EX was MANLY, in a culturally sanctioned, almost traditional way.

Is it any wonder that the same period, 1945 through 1959, was the Golden Age of high fidelity? It was a time when tubes had magic, when sound was a dynamic living art. Of course, it was a bit *too* dynamic; it had to change.

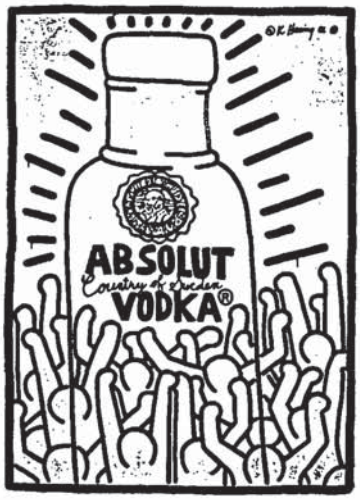
So then came the Sixties...
Pop Art. Warhol. "The English Invasion".
Tiny Tim.
Transistors.

With the imperial rise of the transistor, the Americans who dominated the world of High Fidelity -- Saul Marantz, Avery Fisher, Norman Pickering, David Hafler, and many others -- gave way to new, strange names: Sansui, Sony, Matshushita. The "giants" faded away, sold out to the "Shining Solid State Future".

The hard economic facts simply caught up with them. As the AB-EXers were ignored away by the ever trend-obsessed art establishment, the money gravitated toward the Pop world and its fascination with advertising and publicity. The honest and raw lost out to the shallow and user-friendly. Truth was too ugly so it was veneered over with a superficial, self-regarding phoniness. The American Empire, after peaking in the '50s with the greatest period of prosperity in human history, began its slow and erratic decline.

The merchandizing of culture reached full speed in the Seventies, a period of sexual hedonism and cocaine, the neurotic's drug. Where the cultural prophets of the '50s experimented with marijuana and opiates, inward looking drugs, the '70s and '80s were a time of greed and popular use of stimulants like cocaine and amphetamines.

During this same period, the Art World started capitalizing its name. The new prophets were the shallowest of all: Hockney, Haring, and especially Kostabi. Not artists at all but cartoonists, little boys who snubbed AB-EX and embraced the Almighty Dollar like no artists in American history ever had before. Their "art" was produced and reproduced as a pure commercial product on a worldwide basis.



Keith Haring, 1986

The metamorphosis of the audio market during the '60s and '70s mirrored the shifts in the art scene. What started as a small, grass roots industry run by and for enthusiasts became a mass market, run by faceless accountants in Tokyo.

RETURN OF THE IRRATIONAL

In spite of the grim mechanics of the market, tube amplifiers have been increasing in popularity. Even while GE, RCA, and Phillips/Sylvania were dismantling their vacuum tube production facilities, audiophiles in the know were looking for tube amplifiers. The seminal cause of this resurgence of interest was the appearance in 1989 of a magazine about tube audio: *Glass Audio*. Along with it came a frenzy of activity in the small market for vintage hi-fi equipment. The number of small companies that manufacture new tube equipment for the specialist audiophile also started to increase, and has continued to do so. Yes, it's irrational, but then, so is music itself. And, by the way, there has also been a resurgence of interest in Abstract Expressionism.

Owning an ordinary solid state stereo system is like owning any other household appliance. Every Joe Consumer has to have one - even if he doesn't use it much. The "stereo", usually Japanese and always full of cheap, convenient transistors, is an appliance like the microwave oven: easy to use, stable, the electronic buddy. Part of the glory of technology for Joe is that Science Makes Life Easier; his motto, "Give me convenience or give me death."

Nothing in the American household is less rational and less convenient than a vacuum tube stereo system. Modern tube gear is expensive compared with solid state "air boxes" that can produce the same "amount" of sound. Tubes need lethally high voltages, they produce vast amounts of waste heat, they wear out and must be changed every few thousand hours. Tube systems require personal involvement and they require dedication since the old support system for the technology is vanishing. Not good, not easy like an appliance. In short, inconvenient. By the conventions of Rational Middle America, tubes are bad.

Then why are there 100+ companies making tube equipment today? Why do "relics" like the Marantz 8B sell for many times their original retail prices? Any why do audiophiles continue to get excited about tubes? Despite the inherent advantages of tubes in amplifying music, it's not a rational thing, just as AB-EX was not a rational art form by any definition.

Although tube amplifiers are owner-maintainable, electronically simple, and electrically rugged, they have a certain abandon, a tiny edge of madness. Although they are no more likely to go berserk than transistors, tubes are INTENSE. Being a very large, hot, glowing thing, a tube amplifier has a certain kinesthetic power that no semiconductor amp can simulate.

Audio as we know it is a male-dominated hobby. Surely women own stereo equipment as widely as men do. But to be *obsessed* with it is something that males pursue, typically with a bit of that AB-EX abandon. Let's face it, audiophilia is itself an extreme pursuit, but it has its own ultra radical element -- devotees of the vacuum tube. There are not many women among this group.

It's not as though listening to tubes takes male ears. It's not that men can hear better than women (in fact, the opposite holds true). And it has nothing to do with the phallic shape of the tube. What is operating here is a masculine kind of cultural bias; tubes require the user to take a chance, to brave the heat and the voltages, to accept the challenges. Tube audio resonates with the roles society defines for men, "man the hunter", "the tool maker" and "the risk taker". Because of this bias, tubes are seen as having no place in the domain of women "the child-rearers and homemakers".

The perceived maleness of tubes is a social and cultural depiction that has little to do with reproducing music. As tube equipment continues its rise in popularity and becomes less of an "ultra-radical" technology, perhaps it will lose some of that cultural baggage and be appreciated for what it is - not a nostalgia trip, not an eccentric pastime, not a test of one's seriousness as an audiophile - an important part of a vital hobby, an instrument of pleasure in the art of listening to music.

Eric Barbour has been an audio hobbyist since college days in the late '70s. He has a BSEE degree from Northern Arizona University. He is the president of the Great Basin Audio Society of Reno, Nevada, a contributing editor of *Glass Audio* magazine, and the owner of Metasonics, a mail-order maker of electronic kits for audiophiles. Contact Eric at 552 McCarran #284, Sparks, NV 89431. (702) 358-2019.

W.A.F. *by Joyce*

Guerrilla Tactics for the Audiophile Home

The first time you find him in the kitchen wearing your frilly apron and baking a newly spray-painted amp chassis in the oven you think it's kind of cute. You keep an open mind despite the fumes and try to sympathize with his need for a hammered metal look finish. Then on a dark night you stub your toes on that same chassis lying in the middle of the living room floor and you think, Not so cute.

Might as well face the truth. For every audiophile in the world, there's an afflicted spouse, housemate or friend. And, sooner or later, we all must learn the guerrilla tactics necessary for survival in the audiophile home.

Be Quick on the Offensive

Your favorite sewing scissors have once again mysteriously disappeared. You must confront him immediately. And remember, please, none of this wimpy you-wouldn't-happen-to-have-seen-my-scissors-anywhere type stuff.

She: "I want my sewing scissors back now." Place hands on hips and sigh deeply.
He: "What sewing scissors?" (puzzled look)
She: "Those sewing scissors." Point in general direction of work bench.
He: "Oh, those scissors. You know what those are great for?" (sheepish grin)

Never mind. Grab those scissors and head for the door.

Never Call a Part by its Name

You find yourself staring at an amazing jumble of audio parts piled up in the middle of your bed. You see capacitors, resistors, vacuum tubes and scary looking surgical stuff. You want the mess off the bed, but now remember, never refer to audio parts as anything but "parts". Forget the fact that you've tried to learn their individual names. When the time comes to put your hard-earned knowledge to use, you will invariably get them wrong.

She: "What's that transformer doing in the bathroom sink?"
He: (with a superior smile) "That's not a transformer, that's a high-voltage 6B7 for my 12K9."

Keep 'em on their Toes

It's Saturday night and the two of you are enjoying a quiet evening at home. You've got your slippers on and the tubes are glowing warmly on the latest amp. After weeks of tinkering and tweaking, the new amp is finally being inaugurated.

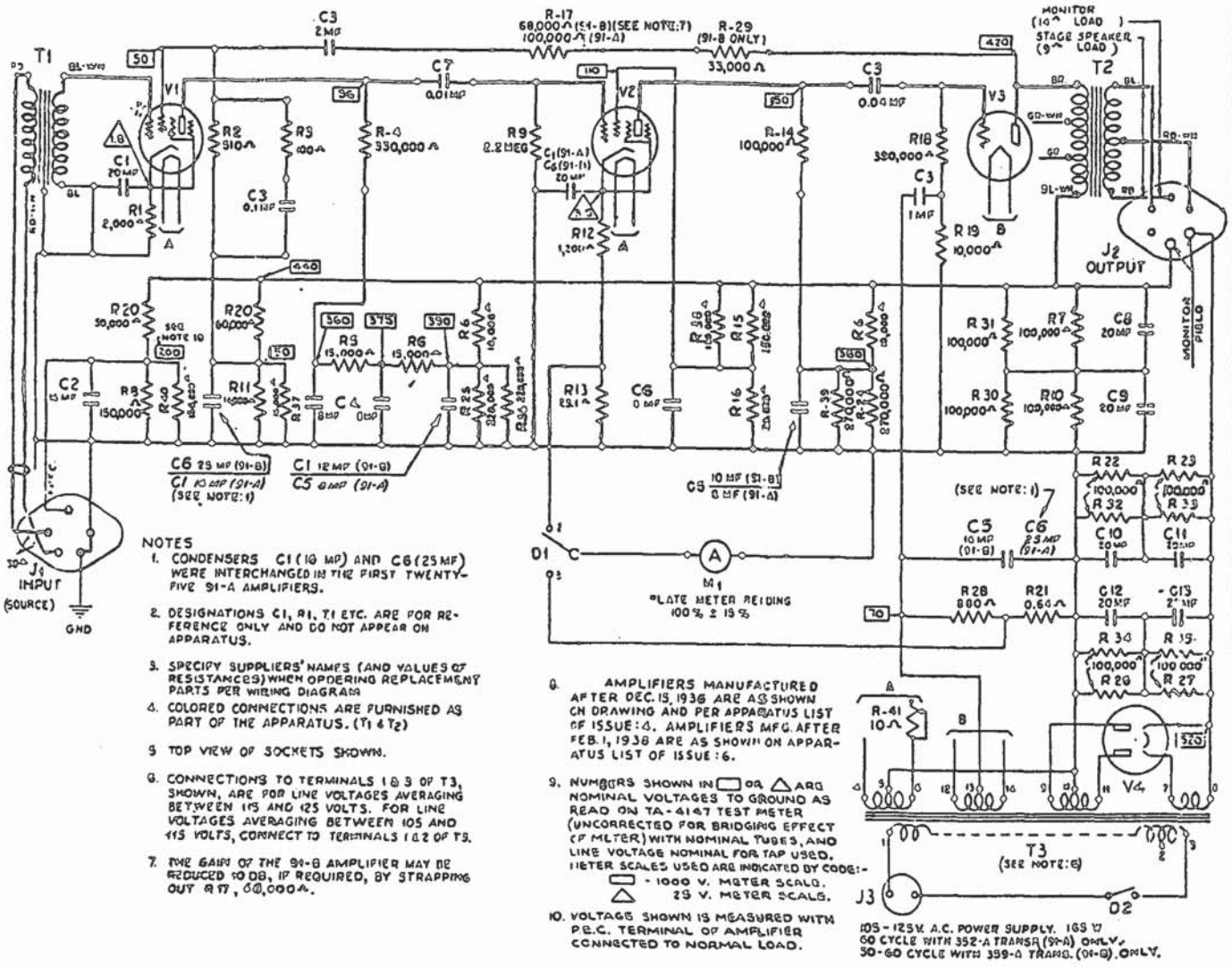
Your man is now sitting in the exact center of the couch, eyes closed in concentration. He turns his head slightly to the left, listens, jumps up and adjusts a knob. This goes on for a while. Eventually, the fine tuning subsides and a peaceful expression comes over your spouse's face.

This is your moment.

She: "What's that humming sound?"
He: "Huh? What humming? You hear a hum?"
She: "Well, I'm not sure, but just then when I walked past that speaker I thought I might have heard something like a hum."

Western Electric

No. 91-A AMPLIFIER



DESIGNATIONS		APPARATUS
91-A	91-B	REPLACEMENT PARTS
C1	—	AEROVOX B-20-20/25V, 16/100V COND
	C1	" B-20/25V, 12/500V COND
C2	C2	" B-18/400V COND
C3	C3	315Δ CONDENSER
C4, C5	C4	AEROVOX B-8-8/475V CONDENSER
—	C5	" B-10/500V, 16/100V COND
C6	—	" B-25/200V, 8/300V "
—	C6	" B-25/100V, 8/200V, 20/75V "
C7	C7	2300 CONDENSER
C8, C11, C13	C5, C11, C13	AEROVOX BL-20/500V CONDENSER
C9, C10, C12	C9, C10, C12	" B-20/300V "
D1	D1	H B H 21350 SWITCH
D2	D2	H B H 20992 "
J1	J1	AP-1570-5 SOCKET
J2	J2	AP-1570-6 "
J3	J3	H B H 734 MOTOR BASE RECEPT
M1	M1	RO-7800 METER
R1, R2, R11, R12, R37, R38	R1, R2, R11, R12, R15 R17, R37, R38	AO TYPE HO-810-5% RESISTOR
R3-5, R7-R10, R14, R16, R19, R23-R27, R30-36, R39, R40	R3-R5, R7-R10, R14, R16, R18, R23-R27, R29, R30-R36, R39, R40	" " " " 10% "
R6	R6	IRC PO 340-35,000Δ TAPPED 15,000, 10,000, 10,000 TYPE 2 TERM
R13	R13	63E5 RESISTANCE
R20	R20	IRC PO 367 SPEC. 140,000Δ 6% TAPPED 50,000 TYPE 2 TERM.
R21	R21	63E5 RESTANCE
R28	R28	WL TYPE 1"D 800Δ 20% 20 WATTS
R41	R41	WL 25A 10Δ 25W ADJ. TAP BIGG
T1	T1	285Δ TRANS
T2	T2	TH 222 "
T3	T3	TH 606 "
V1, V2	V1, V2	6C6 VACUUM TUBE
V3	V3	3000 " "
V4	V4	8700 " "

NOTES

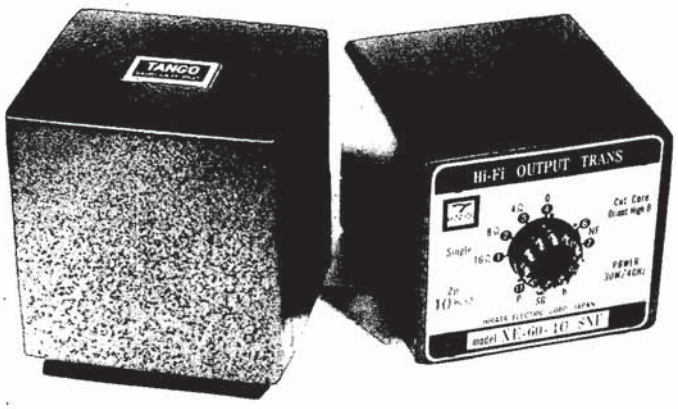
1. CONDENSERS C1 (10 MF) AND C6 (25 MF) WERE INTERCHANGED IN THE FIRST TWENTY-FIVE 91-A AMPLIFIERS.
2. DESIGNATIONS C1, R1, T1 ETC. ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON APPARATUS.
3. SPECIFY SUPPLIERS' NAMES (AND VALUES OF RESISTANCES) WHEN ORDERING REPLACEMENT PARTS PER WIRING DIAGRAM
4. COLORED CONNECTIONS ARE FURNISHED AS PART OF THE APPARATUS. (T_1 & T_2)
5. TOP VIEW OF SOCKETS SHOWN.
6. CONNECTIONS TO TERMINALS 1 & 3 OF T3, SHOWN, ARE FOR LINE VOLTAGES AVERAGING BETWEEN 115 AND 125 VOLTS. FOR LINE VOLTAGES AVERAGING BETWEEN 105 AND 115 VOLTS, CONNECT TO TERMINALS 1 & 2 OF T3.
7. THE GAIN OF THE 91-B AMPLIFIER MAY BE REDUCED 10 DB, IF REQUIRED, BY STRAPPING OUT R 17, 68,000Δ.
8. AMPLIFIERS MANUFACTURED AFTER DEC. 15, 1936 ARE AS SHOWN ON DRAWING AND PER APPARATUS LIST OF ISSUE: 4. AMPLIFIERS MFG. AFTER FEB. 1, 1938 ARE AS SHOWN ON APPARATUS LIST OF ISSUE: 6.
9. NUMBERS SHOWN IN □ OR △ ARE NOMINAL VOLTAGES TO GROUND AS READ ON TA-4147 TEST METER (UNCORRECTED FOR BRIDGING EFFECT OF METER) WITH NOMINAL TUBES, AND LINE VOLTAGE NOMINAL FOR TAP USED. METER SCALES USED ARE INDICATED BY CODE:-
   □ - 1000 V. METER SCALE.
   △ - 25 V. METER SCALE.
10. VOLTAGES SHOWN IS MEASURED WITH P.E.C. TERMINAL OF AMPLIFIER CONNECTED TO NORMAL LOAD.

"PLATE METER READING 100% ± 15%

105-125 V. A.C. POWER SUPPLY. 165 W
60 CYCLE WITH 352-A TRANS. (91-A) ONLY.
50-60 CYCLE WITH 359-A TRANS. (91-B) ONLY.

CLASSIC DESIGNS

Eddy Electric inc



TANGO TRANSFORMERS,

The heart and soul of the world's finest amplifiers, are now sold in North America exclusively by Eddy Electric Inc. These state-of-the-art magnetics offer a stunning improvement over outputs by Dyna, Fisher, Heath. They can replace stock outputs or provide the basis for original design amps far exceeding commercial amps in quality.

Eddy Electric will provide schematics, design assistance or complete installation with these units. Please write for our literature ($2.50) which includes transformer specs, and schematics for push-pull, single ended, and transformer coupled amplifiers. We especially recommend the CRD-5 for triode connected EL-34s and tthe FX-45-5 for UL and pentode connected DYNACO STEREO 70s.

PUSH PULL ULTRA LINER S. Imp. 4Ω. 8Ω. 16Ω

Model	Watts	P. Imp.	Frequency Response	Application	Price/Ea.
X-5	120	5/3.5K	4Hz~100KHz -1db	300B, KT-88, KT-66, EL-34, 6L6CG,	$575.00
XE-60-3.5	60	3K	4Hz~100KHz -1db		$349.00
XE-60-5	60	5K	4Hz~ 80KHz -1db		$349.00
XE-45-5	45	5K	5HZ~ 70KHz -1db	EL-34, 6L6GC, 2A3, 6B4G,	$235.00
FX-40-5	40	5K	4Hz~ 80KHZ -1db		$149.00
CRD-8	25	8K	10Hz~ 60KHz -1db	KT-66, 6L6GC, 6V6, 6BQ5,	$129.00
CRD-5	25	5K	10Hz~100KHz -1db	EL-34, 6L6GC, 2A3, 6B4G,	$129.00

SINGLE ENDED S. Imp. 4Ω. 8Ω. 16Ω.

Model	Watts	P. Imp	Frequency Responce	Application	Price/Ea
X-5S	40	5K	18Hz~ 70KHz -2db	300B, 50,	$635.00
XE-60-3.5S	60	3.5K	20Hz~100KHz -2db		$335.00
XE-60-10SNF	30	10K	30Hz~ 50KHz -2db	211, 845,	$349.00
XE-50-3.5S	30	3.5K	25Hz~ 80KHz -2db	300B, 50,	$275.00
XE-20S	20	5K	35HZ~ 75KHz -2db	300B, 50, VT-52, 2A3, KT-88, KT-66	$225.00
		3.5K	25HZ~ 90KHz -2db		
		2.5K	20HZ~ 80KHz -2db		
FW-20S	20	5K	50HZ~ 70KHz -2db	300B, KT-88, 2A3, 6B4G, EL34,	$175.00
		3.5K	35Hz~ 80KHz -2db		
		2.5K	25Hz~ 90KHz -2db		
U-808	20	5K	50HZ~ 50KHZ -2db	300B, EL-34, KT-66, 6L6GC, 7591,	$ 99.00
		3.5K	35Hz~ 60KHz -2db	7189, 2A3, 6B4G, VT52, 71A,	
		2.5K	25Hz~ 65KHz -2db		
		2K	20Hz~ 65KHz -2db		

Eddy Electric

60 HANNAH ST. STATEN ISLAND, NY 10301
PHONE: 718-876-9742 FAX: 718-816-8598