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Sound Practices

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. . . AND MUCH MORE !!!

The Triode Renaissance

After many years of popularity among elite Asian and European audiophiles, the single triode amplifier has finally captured the fancies of a few prominent UK and US audio journalists. I don't mean to suggest that we're slow on the draw or anything, but as anyone who has ever heard a well-appointed triode system understands, it was only a matter of time before "triode fever" caught hold in the Atlantic world. A good single-ended triode amplifier is a wondrous thing.

Like anything else, triode amps are not for everybody. But a lot of listeners are discovering — often to their great amazement — that the triode sound is just what they were looking for. Partnered with appropriate speakers, triodes do all of the audiophile things with grace and precision. Although triodes excel at three-dimensional presentation, the greater weight and presence of triodes shifts the basis of listening from the "high end" photographic/visual aesthetic of imagery and detail to physical, immediate, and direct apprehension of music. It's funny that you can attain heights of presence and impact with a tiny amp and sensitive speaker well beyond what most 82 dB speakers powered by 500 Watts produce.

Think about it. There has to be a good reason why for decades some of the world's most serious audiomaniacs have been investing large sums of time, money, and emotional currency in creating systems around single triode amplifiers. They never seemed to care that the 300B tube was obsolete or that a 2A3 puts out as much power as a two dollar chip. Unless the many thousands of seasoned audiophiles who "went triode" are free of reason and taste, there must be something to this strange business. If it were simply a whim or fad, the triode wave would have died off long before it reached us. In spite of low power and generally unimpressive measurements, single triode amps are exploding in popularity in markets where fifty watts used to be considered a bare minimum.

Given prevailing conceptions about the necessity of big power, the high profile players in the first triode wave are big monster triode amps — *Ongakus*, *Yoshinos*, *Cary 805s*. A *big* amp in this context means well up in the two digit power range, something that seems reasonable to hook up to a "modern" speaker. In this respect, a 211 amp or an 845 amp is a capable ambassador for this new/old technology to an audio culture where high power is the usual way of getting the job done. In the context of what we *think* we know about musical reproduction, it's hard to take a three watter seriously. Until you hear one, that is.

Perhaps it has to do with traditional conceptions of manhood in our culture or something. Maybe it's an undiscriminating "more is better" attitude. The reality is that killer single triode amps come in all sizes: from milliwatt jobs which will only run hyper-efficient horn tweeters to fifty watt class behemoths. The big triode amps in vogue today may be great stuff, but they constitute only a small corner of the total triode universe. In other audio cultures, the low powered triode amp proved to be the small ax that cut down the big tree.

One phenomenon which accompanies and propels the triode amplifier as it moves around the globe is the growth of DIY. After decades of appliance consumer mentality, we are beginning to see this in American and European audio circles. Triode amps, especially small simple ones, are the ultimate amateur constructor projects. Glorious sounds can be yours with five resistors, five caps, two tubes, and a set of transformers. Anyone of average intelligence willing to work and think can build a simple triode amp. Not only can you get maximum sound per dollar when you roll your own, maybe even ultimate sound *period*, you get a whole range of new rewards from audio when YOU build it. Many newcomers to DIY are finding that the time invested in learning the basics of building is the best audio investment they ever made. This is what the triode renaissance really has to offer us, aside from great sound — a path to new levels of involvement and new ways of being an audiophile. Try DIY. It can change your world.

A DIRECT COUPLED SINGLE TRIODE AMPLIFIER

by Ciro Marzio and Cristiano Jelasi

The Loftin-White Circuit

The outstanding characteristic of this amplifier from a technical point of view is the use of a direct coupled circuit — that is, no capacitors or coupling transformers are used between stages. It is basically descended from the classic Loftin and White design presented for the first time in 1929 in the well-known American magazine *Radio News*. This article caused a sensation not only because of the measured performance of the amplifier, which was exceptional for the times, but also because of the extreme simplicity of the design.

The original Loftin-White amplifier had a frequency response extending from 50 Hz to 10 KHz at -0.5 dB without making use of any form of negative feedback, an innovation invented only a year earlier. In addition, the "comfortable" (in those days) output power of slightly more than three watts, makes the amplifier's great success easy to understand. While the design rapidly spread among hobbyists, it was also commercialized, ready-made or in kit form, by many companies.

The original Loftin-White (Fig. 1) used a 224 tetrode (the predecessor of the 24) in the first stage and a 250 triode (the predecessor of the 50) in the output stage, achieving an elevated gain of about 50 dB for use with phono input. Our amplifier will use all triode gain stages and it will provide an appropriate measure of gain for use with typical line level sources.

We realize that presenting an amplifier based on a design developed sixty five years ago may seem strange to many of you, but to this day this circuit topology provides an unsurpassed musical performance. The popularity the Loftin-White circuit enjoys among Japanese audiophiles and experimenters is enormous, and even in France this classic circuit is highly regarded among extremist audiophiles for its great musicality. According to Jean Hiraga, one of the main popularizers of this type of amplifier in Europe in recent times, approximately 30% of homemade "audiophile" amplifiers built in Japan during the 1970s and 1980s were Loftin-White types.

Our Loftin-White

A monophonic version of this amplifier has been part of one of the authors' home music systems for a long time. This design was built to listen to music, not for presentation to other experimenters as a construction

project. However, since the circuit is not excessively difficult, we decided to present it practically without modification.

They way we built it, the amplifier has some specialized features. Our "prototype" is constructed in such a way that it can be converted for a variety of tube combinations with a few simple changes. This feature requires specially wound power and filament transformers. Most would choose to set up the amp for particular tubes and then forget about it.

Output Tubes

There are numerous possible candidates for the output stage. We decided against using famous power triodes such as Mullard PX4, Telefunken RE604, Mazda PP3/250, Western Electric 275A, etc., which have valuable sound characteristics but are too difficult to find for our purposes.

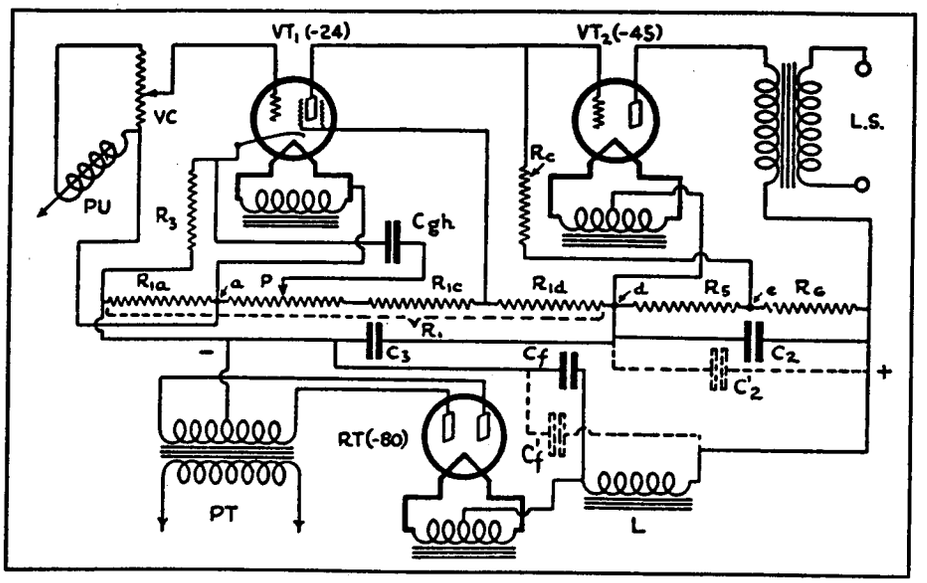
There are a number of more accessible tubes, including: 2A3, 6A3, 6B4G (which differ only in the voltage of the filaments and the bases), VT52, 300B, 842, 10, 10Y, 801A (the last three are succeeding versions of the same tube), 45, and 50. Of these, the first five have internal impedances of circa 700-800 ohms and work best into loads of circa 2500 ohms. The last six require higher values of primary impedance for the output transformer.

In general, the construction of a high quality output transformer is less problematic as the impedance of the primary is lowered. In other words, quality being equal, an output transformer with a lower primary impedance costs less, at least among the models of the same maker. Given these considerations, we chose to go with the lower plate load tubes.

The old U.S. made versions of the 45 and 50 tubes provide subjective performances of high levels, but are they are very hard to find. Performance is slightly inferior in the Chinese versions, which are easy to find and are still in production. Let's consider the candidates one at a time:

2A3 - There are two versions, a relatively rare mono-plate version and the more common bi-plate version which is actually two elements mounted in parallel in the same envelope. The mono-plate version was made by Fivre and Brimar and is characterized by a more airy sonority, rich in harmony and of great introspection. Mid and high ranges are absolutely superb, the low range is profound and well articulated. This is absolutely one of the most musical directly heated triodes.

The Fivre version is the most celebrated of the two mono-plate 2A3s, having a very particular filament structure. Twelve filament sections are arranged in parallel on a rectangular frame, a design feature which some argue is responsible for its wonderful sound. By the way, the Telefunken RE604 has the same filament structure and it is the only triode we know of that's able to reach the heights of the Fivre 2A3 single plate.



The original Loftin White circuit

Aside from the desirable frequency characteristics of directly coupled circuits, the Loftin White design offered significant economic advantages since no high voltage coupling capacitors were required. In those days, high voltage capacitors were costly devices. In the circuit pictured above, further economy was realized through the use of low value (1 mF) filter caps in conjunction with elaborate electronic hum balancing measures.

← **A 1930 advertisement for a "new and amazing" Loftin-White amplifier kit based on the venerable 45 output triode.**

The bi-plate version does not reach the same summit: the inevitable difference between the two parts making up the tube renders the sound a little less limpid — the bass is slightly inflated, the introspection of the highs less developed, and the details not fully focused — in short, it is a little euphonic. However, the listening results are much better than those obtainable, for example, with a KT88, a 6550 or a EL34 mounted in pseudotriode. The bi-plate 2A3 is easy to find and it is still being produced in China. The sonic difference between the old western-made tubes and the Chinese ones is not particularly marked. Nominal output power of 3.5 watts.

6A3 - Like the 2A3 but with filament voltage of 6.3 Volts instead of 2.5 Volts. There are mono-plate versions of vintage American and contemporary Russian production.

6B4G - Like the 6A3 but with octal socket instead of 4 pin UX4. Only bi-plate. Still being made by the Chinese.

300B - The most famous of the directly heated triodes. Owes its fame to the great musicality of the Western Electric version, which is endowed with a full and rich-bodied sound, yet at the same time introspective and analytical. It provides a faithful reproduction of the timbre and color of the instruments, even if not at the level of the Fivre 2A3 mono-plate. However, the 300B is superior in power, articulation, and impact of the low range. Despite its sonic glory, its excessive price (circa 1,600,000 lire per pair) leads us to look at other choices. Western Electric has long since ceased production of vacuum tubes.

The Cetron 300B version, while having a sonic personality similar to the Western Electric tube, is however a bit inferior in richness of harmony and introspection. The performance is nevertheless good but the price, although 40% less than the Western Electric tube, is still decidedly high.

The Chinese versions of the 300B are of slightly inferior performance to the Cetron version. The price of the China 300B is a little more reasonable, but the performance is barely better than that of a 2A3 bi-plate. In our opinion, their use is justified only where an output power approaching ten watts is indispensable.

The nominal power of the 300B is 17 watts, but Western Electric recommended their use for maximum power of 11-12 Watts (per Western Electric specification #1459).

VT52 (45 Special) - Enjoys an excellent reputation for its musicality. Very similar to the WE 300B in the refinement of the sound and the *savoir faire* with which it renders details and nuances of the musical event, but with less authority and articulation, at least in the low range. It is somewhat difficult to find, having been out of production for decades. (ed.—VT 52 is a military number. There is no exact commercial/industrial equivalent.) Maximum nominal power of 4.5 Watts.

Input tubes

With regard to the input stage and driver the choice is a bit easier and, for practical purposes, can be restricted to a few types: those of the 6DJ8 family — E88CC/6922 and the 12AX7 family of tubes — 5751/ E83CC/7025. We have had good results with Philips, Telefunken and Mullard brands but no doubt there are other equally valid versions.

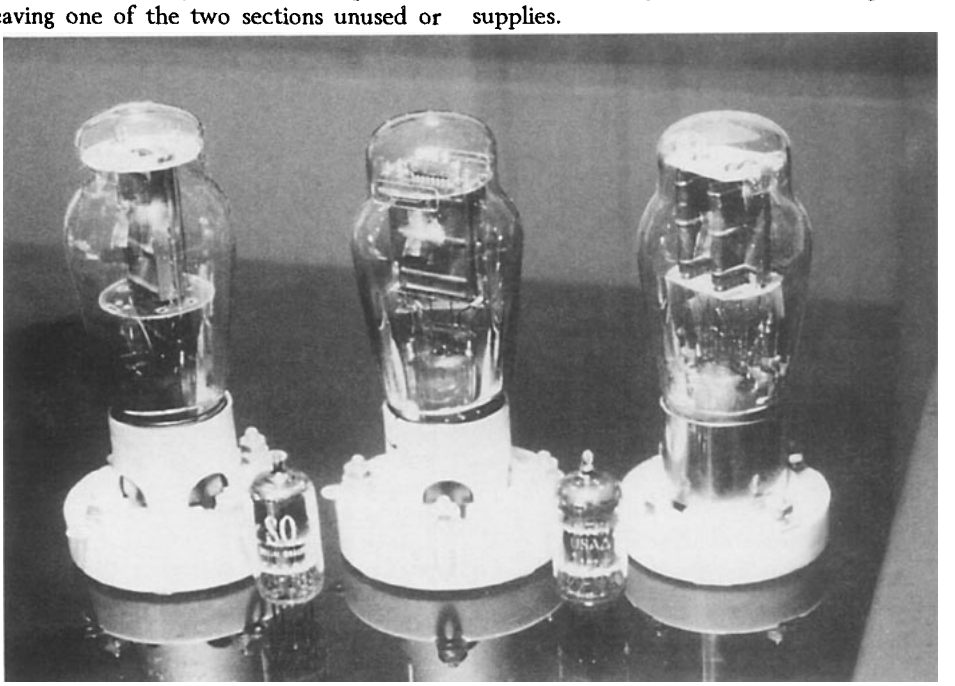
If more gain is required as when driving the amp directly from a CD player or a low output preamplifier, try the 5751 (which has an amplification factor of 70) or, if the gain is still not enough, the E83CC (amplification factor equal to 100).

All driver tubes we have mentioned are twin triodes, therefore you have the option of leaving one of the two sections unused or using both in parallel. To use both sections in parallel, reduce R4 by 10-20%.

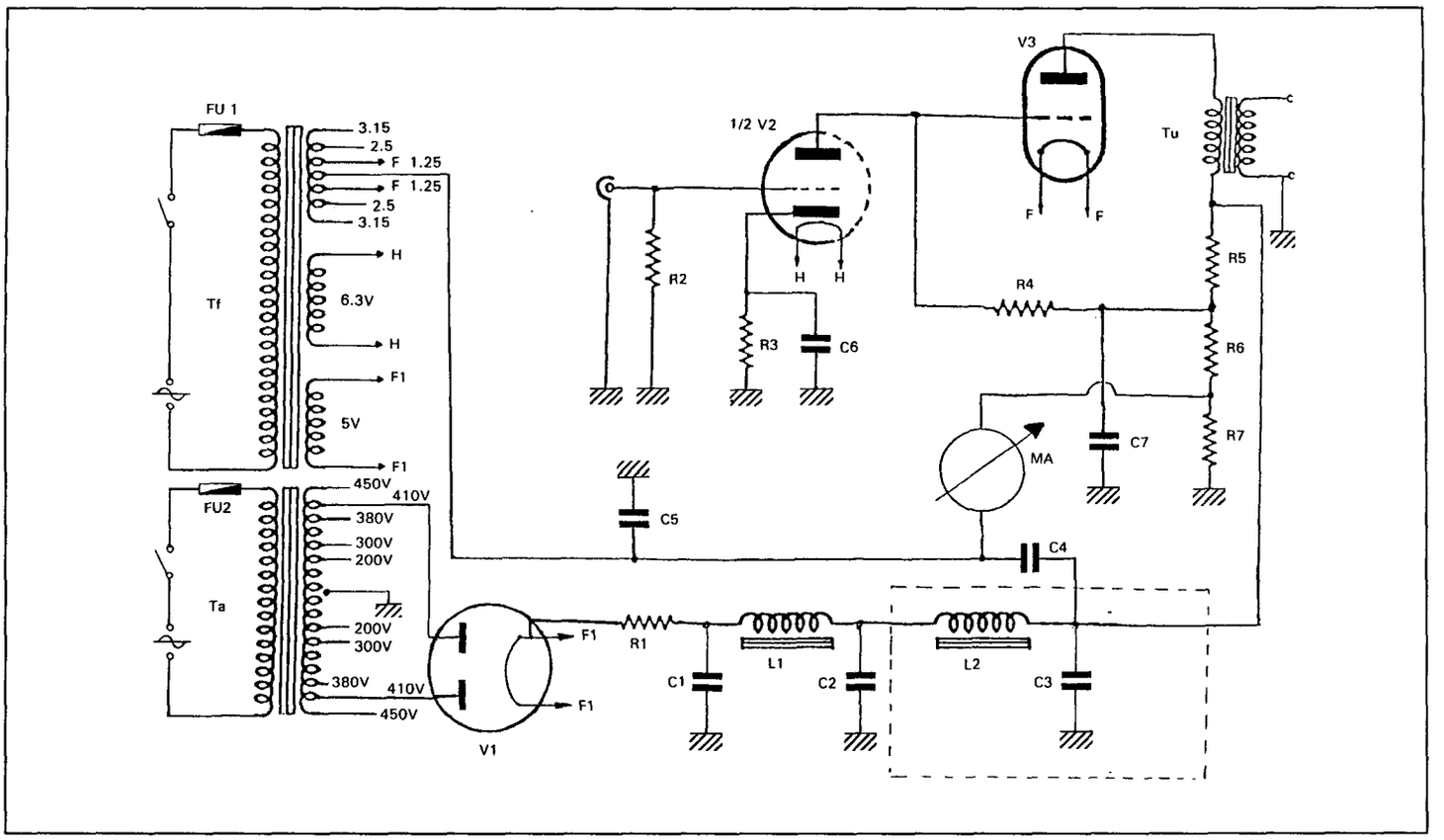
Both solutions present pros and cons. By using both sections in parallel we'll halve the internal impedance of the tube, with a consequent improvement of performance in the low range and lower sensitivity to power supply disturbances. Yet we can expect that we will also have a higher loss of definition the greater the difference between the two sections.

If you want to use this amplifier in a full range application, paralleled sections might be a rewarding compromise, especially for those using the bi-plate 2A3 as final tube — which itself is made up of two triodes wired in parallel. Use carefully selected tubes whose performance between sections is almost identical. The final decision is obviously best made by listening and is left to your tastes. On the other hand, when using the amplifier for high frequencies in a multiamp system, using only a single section should give better results in nearly all cases.

The circuit we present is optimized for the use of the 2A3 — or one of its equivalents driven by a E88CC. You can also use the VT-52, keeping in mind the different voltage ratings of the filaments. The main reason for this choice is the ease of obtaining 2A3s. To correctly use the other input and output tubes, it will be necessary to make some small adjustments in the power supplies.



Three Triodes: Hytron VT-52, Fivre single plate 2A3, garden variety bi-plate 2A3



PARTS LIST

R1	330 ohm	10 Watt
R2	220 K	1 Watt
R3	33 K [2.2K for 6922]	1 Watt
R4	330 K [100K for 6922]	2 Watt
R5	47 K	5 Watt
R6	33 K	3 Watt
R7	3.75 K non inductive	25 Watt
C1	47 uF polyester	630 Volt
C2	100 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	630 Volt
C3	140 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	630 Volt
C4-5	15 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	400 Volt
C6	47 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	25 Volt
C7	15 uF polyester + 0.22 uF paper/ oil + 0.022 uF silver mica	400 Volt
L1-2	10 Henry	120 mA
V1	83	
V2	E88CC/6922	
V3	2A3; 2A3W/5930	
MA	meter 100 mA full scale	
Ta	secondary 2 x 450 Volt, 150 mA	
Tf	secondary 5 Volt, 3.5 amps with tap at 4V; 6.3V, 1A; 2 X 3.15 V, 3A with taps at 2 X 2.5V and 2 X 1.25 V or as required	
Tu	Primary impedance 2500-3500 ohm	

Type	Plate Voltage	Grid Voltage	Plate Current	Internal Resistance	Transcon-ductance	Amp. Factor	Load Resistance	Output Power
E88CC/ 6922	100	-1.2	15	2,650	12,500	33		
5751	100 250	-1 -3	0.9 1.0	58,000 58,000	1,200 1,200	70		
E83CC	100 250	-1 -2	0.5 1.2	80,000 62,500	1,250 1,600	100		
2A3/ 6A3/ 6B4G	250	-45	60	800	5,250	4.2	2500	3.5
VT52	300	-61	44			3.8	2500	4
300B	350 400	-74 -87	60 60	700 700	5,500	3.85 3.85	3000 3000	8.3 11

Pin	E88CC/6922; 5751; E83CC	2A3/6A3; VT52; 300B
1	plate #2	filament
2	grid #2	plate
3	cathode #2	grid
4	filament	filament
5	filament	(absent)
6	plate #1	"
7	grid #1	"
8	cathode	"
9	center tapped filament *	"

Type	Filament Volts	Filament Current
E88CC/6922	6.3	0.3 A
E83CC/12AX7W	6.3; 12.6	0.3; 0.15
5751	6.3; 12.6	0.35; 0.175
2A3	2.5	2.5
6A3/6B4G	6.3	1.0
VT52 Hytron, RCA	6.3	1.0
VT52 WE	7.0	1.18
300A/B	5.0	1.2

* not on 6922

Output Transformer

This is obviously an extremely critical component. The quality of design and construction counts much more than a precise impedance value for the primary. We use a transformer primary of 2500 ohms but it is possible to use higher values, up to 3500 ohms. For an amplifier of this qualitative level it is necessary to find a component that is up to the task.

Given the high cost and difficulty in obtaining the best models of manufacturers like Tango, MagneQuest, and Partridge here in Italy, we are happy to report that Elettrica Brenta manufacturers good quality output, plate, and filament transformers suited to this amplifier. Their address is:

Elettrica Brenta
Vico Amerigo Vespucci #2
Fiesso D'Artico (VE) ITALY
39-41-516155 phone/fax.

Passive Components

When constructing equipment capable of attaining high peaks of musicality, the quality of the passive components assumes critical importance. This is particularly true for capacitors. Note that in the list of components, electrolytic capacitors are *not* recommended, not even as power supply filters. We bypassed the high value capacitors (with exception of C1 which is placed in a non-critical position) with others of small capacity in silvered mica and/or paper and oil. This practice is common among extremist experimenters who know how much the quality of these components can influence the final result.

We used metalized teflon condensers made by CSI for C2, C3, and C4. The quality of these components is absolutely stratospheric, but so is the price. Also, they are problematic to find. Truthfully, the difference between these and regular condensers in polyester or paper in oil of good quality is minimal provided they are adequately bypassed by good condensers of small capacity. If you find yourself having sleepless nights over not finding CSI condensers, you can use teflon Siderealkaps or whatever makes you happy.

We suggest that you first build the amplifier using normal carbon resistors (which have the advantage of being non inductive and sounding quite good) or, for higher dissipation, ceramic wire wound resistors. Carbon resistors are considered more musical than metal film resistors by many experimenters, but not by all. Conduct tests to verify your personal preferences. If you feel the need, you can substitute special (and costly) resistors such as Caddock, Vishay, or tantalum film resistors.

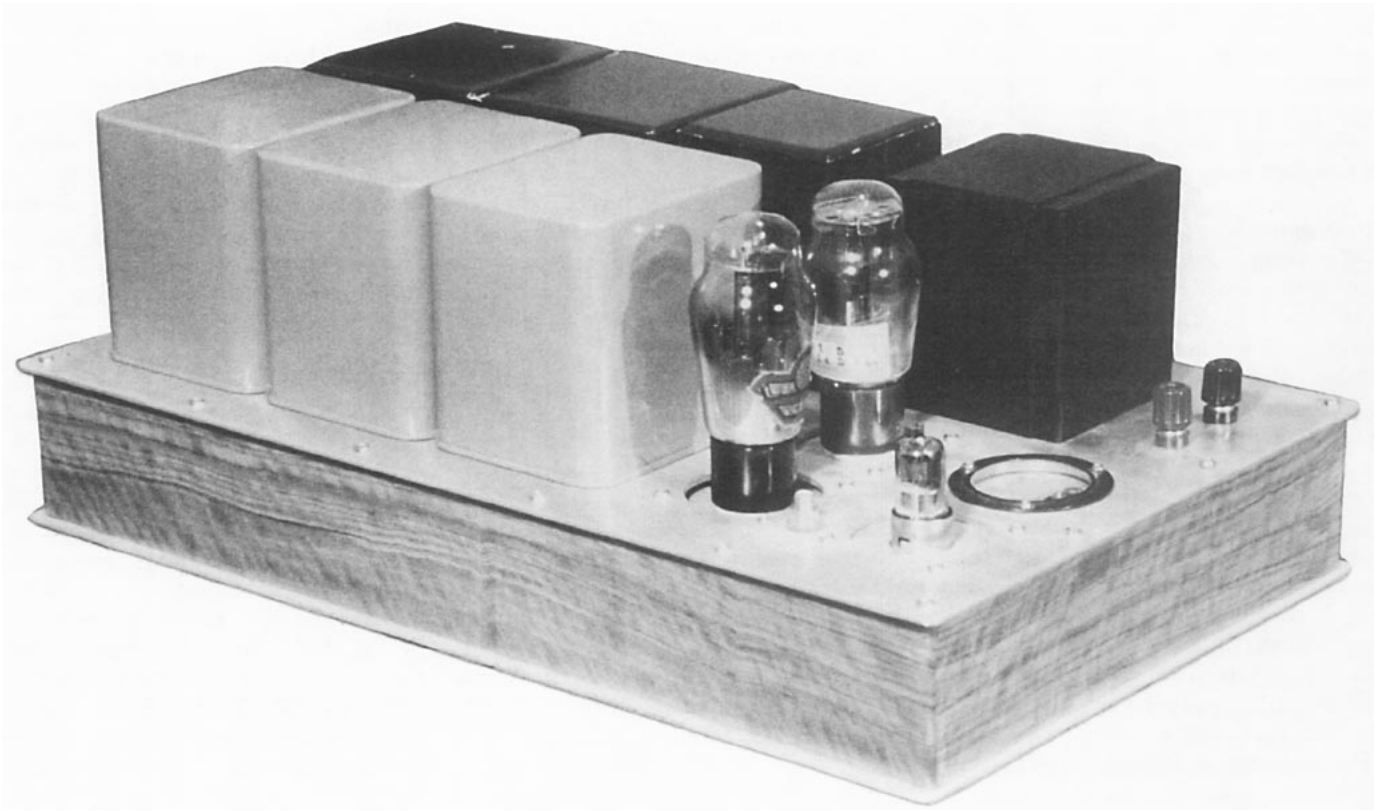
If you decide to substitute the input load resistance R1 with an attenuator, remember that the quality of this component will have a determining influence on the final result. Avoid film components here. It is much better to use two-way switches to switch resistances of the right value. This way, there will always be a single resistance (and two switch contacts) on the signal path and one to ground. Needless to say, the quality of the switches should be very high. Given that a set of quality attenuators will increase final cost of the project by 10% to 30%, we suggest you use them only if it is really necessary to adjust the volume at the amplifier input.

To calculate the value of the resistances in an attenuator, you can use the following equations:

$$Rb = Rt \times \text{inv. log } (-A/20)$$
$$Ra = Rt - Rb$$

Where Ra is the value of the resistance in series with the grid of V1; Rb is the value of the resistance of entry to ground; Rt is the total resistance of the attenuator; -A is the desired attenuation expressed in decibels.

A discussion similar to the one made for resistances is in order with regard to cables. To begin with, we suggest using a good OFC conductor, possibly teflon insulated to protect against inevitable encounters with the



tip of the soldering iron. After auditioning the amplifier, if you feel the need to swap wire, you can substitute the initial cabling with esoteric cables in oxygen free silver or other exotic materials. We used cables of aeronautical military specifications in silver plated OFC. They cost less than "signature" cables intended for the hi-fi market and offer high quality musical performance.

When you decide on the placement of the wires remember that you can utilize three dimensions and not just two as in a printed circuit. Try to achieve a tidy cable layout from the electrical point of view first, rather than from the visual: the two do not always coincide. Don't privilege apparent or "cosmetic" order to the detriment of the more important electrical order. Always remember that the ground leads must converge at one single point near the input to avoid the possibility of promoting various sources of hum.

Filament Supply

Each of the secondary transformer windings provides alternating current. The secondary of the special transformer we used has various voltage taps with a common center tap. Some builders use DC heated filaments either to eliminate hum problems or to be able to stabilize the voltage. While it is true that directly heated triodes are in fact more sensitive to brief variations in current than indirectly heated ones, we didn't find that the use of stabilized filament supplies provides significant sonic advantages — except perhaps in areas where the AC mains supply is subject to numerous and sudden jumps. We also haven't encountered any serious hum problems using AC filament supplies.

Plate Supply

The plate supply we installed has a transformer with a single secondary with several taps to allow for a choice of output voltages to meet the B+ requirements of various final tubes. The alternating current is rectified through a full wave vacuum tube rectifier.

Our preference for rectifiers is the 83, a directly heated mercury vapor double diode, but nothing prohibits you from using other types of rectifiers such as GZ33, GZ34, GZ37, 5R4GY, AZ50, etc. The listening results obviously differ a little according to the rectifier tube used. The ideal filter would be made up of a two-section "pi" filter, which would result in an insignificant level of residual noise from the supply.

The components in the dotted box on the schematic are for the optional second section. Even with a single section pi filter you will obtain excellent listening results.

Opinions over the sonic delivery of the GZ34 are extremely varied. The well-known journalist Jean Hiraga (editor of "La Nouvelle Revue du Son" and managing editor of "L'Audiophile"), for example, considers its sound coarse and lacking in detail; in contrast, the authoritative Joe Roberts considers this tube, at least the Mullard version, to have a resounding musicality. We must frankly say we are not enthusiastic about it and we consider all the other rectifier tubes mentioned and other similar ones decidedly superior. In any case, with so much difference in opinion the last word must await your own ears; when you have a chance do some comparative listening.

A final improvement could be obtained by using dedicated rectifiers and separate filters for each stage: this would offer a lower common impedance and therefore less coupling between stages. At present, one of the authors is using this arrangement. We are not providing a schematic with this type of dual supply arrangement, but we may do so in a future issue if there is sufficient interest from our readers. Surely in this case the already considerable size of this amplifier would increase.

Preheating the Filaments

In a directly coupled amplifier, the voltages present at the tubes are interdependent and consequently, while the tubes are heating up, the grid voltage of the output tube is wildly incorrect for a moment. The consequence is a brief period of excessively high current through the final tubes. Obviously, such abuse shortens the life of the final tube. To avoid this problem, it is necessary to delay the plate voltage until after the filaments of the tubes have reached normal operating temperature.

Given that we used separate transformers to feed the filaments and for plate supply, the simplest solution is to use separate switches for the primaries of the two transformers. The filament transformer will go on first, followed by the plate transformer after an interval of thirty seconds. Another option is to employ a timed circuit, particularly recommended for the super absent-minded, or for those who have small children or irremediably clumsy relatives.

Adjustment of the Circuit to Various Tube Combinations

The values of the components listed are adapted for use with a 2A3 or VT52 driven by an E88CC/6922. Using an E83CC or 5751 as a driver requires that the value of R5 and R6 be doubled. Plate voltage requirements differ according to the tube combinations used. For the final tube, a difference of cathode-anode potential no higher than 300V is recommended for the 2A3, the 6A3 and the 6B4G, and no higher than 330V for the VT52.

Although the data sheet for the 2A3 suggests a maximum plate voltage of 250V in single ended use and 300V in push-pull, many hobbyists report using 300 volts on the 2A3 even in single ended use without problems of any kind and without shortening the life of the tube.

The maximum plate dissipation is 15 watt for the 2A3, 6A3, 6B4G, 18 watts for the VT52 Hytron, and 15 watts for the VT52 Western Electric or Sylvania. We remind you that to calculate the dissipation of the plate just multiply the plate current by the plate voltage, i.e. the difference of potential between anode and cathode. Don't try any slyness; these values cannot be exceeded without a notable reduction in the life-span of the tubes.

System Considerations

Naturally, source material and preamplification of high quality should be used with this amplifier. Given their extreme transparency, they reveal the sonorous personality of the components which are mounted in the audio chain. Obviously this is true also for recordings; we have found ourselves rediscovering recordings whose high quality we had never realized before because of the excessive zeal less gifted amplifiers subjected them to.

With regard to speakers its a good idea to seek high efficiency systems, especially if you intend to use these amplifiers in full range. In a multiamplification situation, the question of limited power is obviously less relevant. The synergy between these amplifiers and the large horn systems is truly remarkable. The colorization in the mid range of speakers such as Klipschorn and Altec "Voice of the Theater" seems to dilute to the point of being perfectly acceptable. Systems which are already timbrally correct acquire a transparency, musicality, and realism that is extraordinary. Truly extraordinary.

Listening Notes:
We know well that listening notes written by the authors of a project can raise some skepticism, but we will seek to be as impartial as we've been when listening to amplifiers constructed by others. Besides, our long cohabitation with these amplifiers means that we really know their personality.

The first version we listened to has the biplate 2A3 as final tube. We then compared it to the 2A3 single plate. We used this amplifier full range with homemade monitors using JBL components. These speakers have a 95 dB per watt efficiency at one meter and a linear frequency response 3 dB down at 25 Hz. The listening impressions are reported separately for each of the listeners.

Ciro
Version with 2A3 biplate output tube: The midrange is airy and natural, with a good sense of presence and a remarkable musicality. The delivery of the voice is very good, lacking strain or roughness of any kind. The highs are present and pleasant but not overly detailed. Even the bass has good presence and articulation but at times one would want a bit more control. The dynamics and the microcontrast are remarkable even at low listening levels. Despite the reduced output power, considerable listening volumes are reached. Small groups are rendered with good image and detail, although there is some difficulty in distinguishing single instruments of large orchestras, especially in passages with greater dynamic impact.

The musicality of harmony is maintained on a level superior to average. In biamplification service on the mid/high range, the results are better yet. When the amplifier is freed from the task of reproducing the full range, it conveys musicality and naturalness playing the large orchestras and portrays the most demanding passages of the harmonic structure with ease.

Version with 2A3 monoplate: Its as if a veil were lifted and the sound stage, previously already refined and of high quality, reveals details and colors that at first were hidden to perception. The focus of the images is clear, the instruments have well delineated contrast and almost material consistency. The mid and high range are scintillatingly transparent, while the delivery of the lower parts of the spectrum is solid and responsive.

Maybe the bass is not quite as controlled and defined as your better "solid state" amplifiers but this unit offers articulation, a richness of timbre, a truly exceptional naturalness, not far from the fabulous low end performance of tubes like the 300B, the 845 or the 211. Percussion and winds are of a dazzling fidelity and naturalness. The musicians are alive and present on the stage, one feels their breath and movements. The dynamics and the microcontrast are at exceptional levels and the volume of sound is remarkable and apparently slightly greater than with the biplate version.

The large orchestras are naturally reproduced, with remarkable introspection and great rendering of perspective: not only are the instruments arranged on a profound and extensive stage even beyond the speakers, the empty spaces between one instrument and the next are respected. One single caveat: the power is not always sufficient to guarantee a realistic listening level with the most imposing organs. Obviously with high efficiency speakers, such as Klipschorns, this would not be a problem.

In biamplification things improve, elegantly overcoming the problems of power and those minor failings of impact and authority in the low range. The result obtained is of true realism and exceptional enjoyment.

Cristiano
The thing which strikes me the most in this amplifier is its extreme musicality. Hours and hours of listening, with whatever type of music, don't tire one's ears the slightest bit. The stereophonic image is extremely solid and the monoplate 2A3 abundantly extends the scene outside the speakers, reconstructing a stage that is very ample and deep. From this point of view the 2A3 biplate is a little less good.

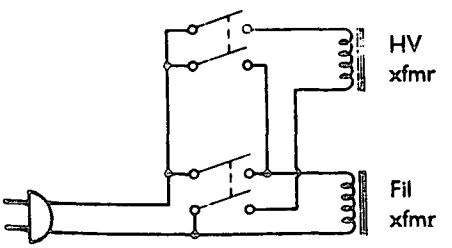
The introspective capacity is exceptional: I've discovered on some particularly "unheard of" recordings that one notices that the musicians are alive, in fact breathe, the pianist from time to time uses the pedals while the contra bassist delicately runs his fingertips over the strings. How to describe with words the emotions felt? More than once, listening with closed eyes, I opened my eyes and was disappointed to find myself not in front of the orchestra, but in front of the stereo. This is something which had never happened to me during listening sessions with notable amplifiers, such as the Audio Research Classic 60.

AUDIO TIPS

Delayed B+ with two switches
In order to maximize the useful life of vacuum tubes, it is desirable to delay application of plate voltage until the cathodes have reached proper operating temperature.

Slow turn-on rectifier tubes such as the GZ34/5AR4 and 5V4 provide some insurance against premature B+ syndrome. In situations where solid state rectifiers are employed or where controlled warm up is essential, thermistors, relays, and thermal time delay switches can be used to control the application of plate voltage.

Slow turn-on is an important consideration in direct coupled amplifiers such as the Loftin-White design. Because operating voltages in the circuit are interdependent, tube-endangering conditions can exist if full B+ hits before the filaments are cooking. You sure don't want to fry any Fivre 2A3s!



A simple but effective way to stagger turn-on is to provide separate switches for plate and filament supplies as proposed in the accompanying article. Turn on the heaters, wait a minute or so, then fire up the B+. Easy enough, but it is not impossible to reverse the desired switching order. It is definitely not a sound practice to switch off the filament supply while the amp is playing!

Shown above is a foolproof method for wiring two switches to two transformers such that the filament or heater supply will be switched first on/last off regardless of the order in which switches are thrown. All that is required are two DPST switches and you'll be ready to fire it up gradually.

This is precisely the great value of the directly heated monotriodes: the ability to make you forget that you are listening to reproduced music. In short, it is the realization of the dream of every true audiophile.

The only negative point: the incredible precision with which this Loftin-White amplifies the signal foregrounds any defect of the other components in the chain. On the other hand, it is very acquiescent with regard to speakers.

Conclusion

At the end of this long description we can summarize by saying that we are highly satisfied. These amplifiers not only allow one to obtain excellent musicality but are also rather easy to build. They answer a quest that — notwithstanding the recent revival of monotriode amplifiers — is not fully addressed by the products currently on the market: that of amplifiers made to bring out the best in high efficiency speakers.

If you begin looking, you will discover that high-efficiency speaker systems are more popular than you would think from reading contemporary audio magazines. It is true that there are too few very efficient loudspeakers available on the market today. However, there are quite a few audiophiles using home made and vintage high efficiency speaker systems with low powered tube amplifiers.

Ignore the fashions dictated by the mass market. As far as pure musical enjoyment is concerned, nothing could be better than building a nice set of single triode amplifiers and hooking up a pair of high efficiency speakers. Enjoy!

The Authors:

Ciro Marzio: perennially divided between the "jobs" of master lute maker and anthropologist. Interested since childhood in everything that makes music. Practically addicted to music. Actively involved in D.I.Y. audio since he was thirteen.

Cristiano Jelasi: Doctoral candidate in International Trade. Extremist D.I.Y.er and stubborn "bricoleur". Began building audio equipment at the age of nine. And never stopped.

Ciro and Cristiano live in Ischia, Italy, where with a bit of luck you might actually find a pair of Fivre monoplate 2A3s!

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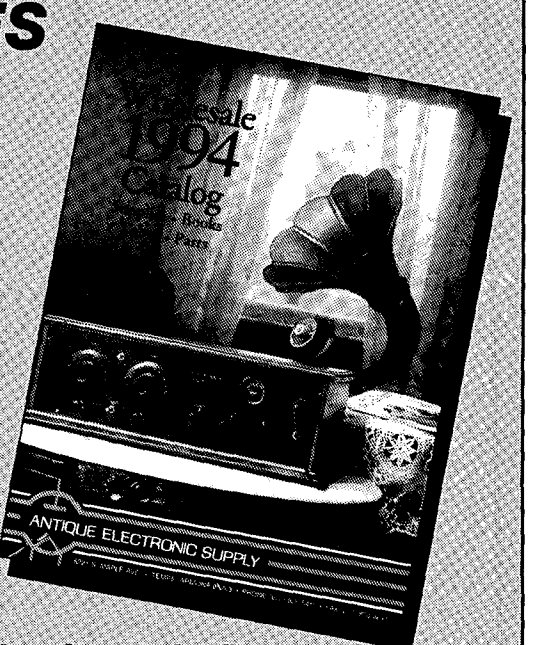

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The Audio Observatory

30339 Abelia Road, Canyon Country, California 91351

Volume 2 Number 4 November 1993

PBJ Interconnect
Kimber Kable
2725 South 1900 West
Ogden, UT 84401
801.621.5530
$62 for a 1 meter pair, and $14 each additional meter per pair. XLR connections are available at no extra cost.

Following a review by *Stereophile's* Corey Greenberg is very much like being forced to follow Robin Williams with a plate spinning act. If there's an audiophile out there who's not read CG's review, promptly crawl out from under your rock and check this stuff out. In essence, PBJ is actually Kimber's fabric shielded KC1 sans the shielding. But in truth, PBJ is among the finest analog cables that you can buy, and one that truly *humbles* a number of high priced pretenders. Let me tell you about it.

First of all, PBJ has a rather unique appearance. Consisting of three braided wires, the PBJ looks distinctly undernourished next to some of the more, shall we say, well endowed cables. This frail appearance is welcome during installation as the PBJ is flexible and easy to maneuver behind components. RCAs, while somewhat common looking, are very sturdy and fit well on every RCA jack used throughout the review period. My only note of concern is that PBJ lacks any type of strain relief. The usual admonition to always pull a cable off by the barrel of its RCA, and never by the wire itself, is especially true in the case of PBJ.

Let's get this out of the way. The performance of the Kimber PBJ rivals *any* interconnect that I've used during the Cable Madness Survey. Whether used between DAC and preamp, preamp and amp, or tone arm and preamp the PBJ always allowed for a remarkably natural and unstrained sonic quality. It's easy to forget about this cable once inserted into a system. It never calls attention to itself, and thereby away from the music. Specifically, the PBJ is very neutral tonally with any distortion being of an extremely minor nature.

Detail is plentiful, but of an almost gentle character. Subtle clues of image and location are always clear, but never etched or pushed forward. Soundstage width and depth, again, rivaled that allowed by any other cable used during the CMS. Best of all the PBJ allowed timbres to be reproduced in a very lifelike manner. Whether a light brush of a cymbal or a muted pizzicato, the beginnings and endings of each note rang true. In a sense, the PBJ is a very hard cable to write about because of its essential and basic neutrality. It must be very, very easy on the signal indeed.

One initial concern that I had with the PBJ proved to be groundless. My system (at the time of the evaluation) required a 5 meter length of cable between the preamp and the amp. In the past I've run into problems with hum when using unshielded cable in this length. To my delight, the PBJ was as quiet as any shielded cable when used in this application. No doubt much of this lack of noise is a function of the braiding of PBJ's dueling ground conductors. In any case, this is one unshielded cable that effectively banished any fear of hum resulting from long lengths of unshielded interconnect acting like an FM antenna.

As regular TAO readers know, I abhor comparing products. Still, I'd have loved to have been able to make the comparison between the PBJ and the Kimber KCAG silver interconnect. My experience with silver cable has been somewhat limited. In the main I've found silver cables to be detailed in the extreme and lacking the nuance and gentility of the PBJ. If the KCAG missed the boat on subtlety one may rightly conclude that although silver is a superior electrical conductor, it may in fact take the back seat to copper in passing the musicality of low level electrical signals.

But enough of my ramblings. Recommending the Kimber PBJ is one easy task. For it would be hard to believe that anyone, using a system of any price, might truly find the PBJ wanting. And, while it goes without saying that I can't name a single interconnect at its price point that can begin to challenge the overall performance of the PBJ, a more amazing fact is that I can't name a single interconnect at any price that I *know* can best it. Kimber's PBJ is an audio classic. Highly Recommended.

KIMBER KABLE
2752 S. 1900 W.
Ogden, UT 84401
(801) 621-5530

DINOSAUR

j.c.morrison, n.y.c.

Mixing romance and technology in the interzone

I had a friend named Larry, he's either in jail or dead now, but his particular talent was riding and working on bikes. Larry built at least four motorcycles that I can remember, each one more spectacular than the previous. Now, when I say bikes, I do not mean any of that motorcycle Zen crap, which is precisely just that: crap. For example, he had an Indian which was so heavily tricked and kinked, that it had no peer for straight line acceleration and ultimate speed. It was bored and ported and tuned and cut and stripped and he remachined his own carbs and cams so that every one of the one hundred and twenty five suicide clutch horses he pulled out of it belonged completely to Larry. The weight was down to 450 lbs. *wet*. He took the corner at the FDR and Houston Street at ninety, which perhaps can only be done by a handful of people on this planet, and he could do it in any condition.

Larry, by the way, loved Beethoven.

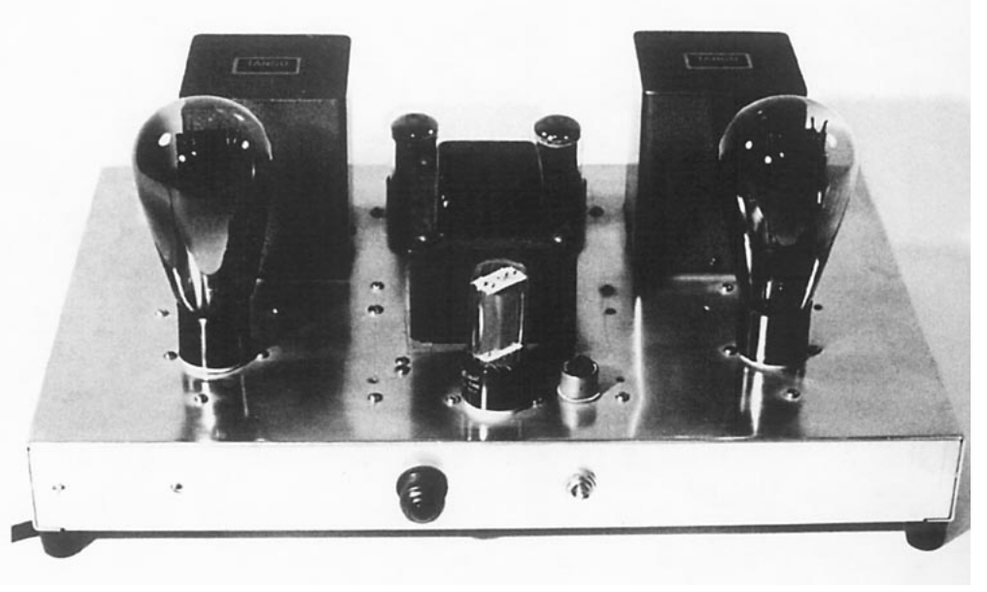
This kind of "combination" art/tech/attitude is something that doesn't usually get much respect (and maybe rightfully so), but perhaps it deserves a closer look. While somewhat difficult to find or experience in *normal* environments, a quick look at the margins of acceptable behavior will reveal all kinds of cool mixings. The prejudice of "normalcy" is all you have to give up to enjoy this stuff. Traditional opposites are not *necessarily* meant to be that way.

Artists and critics have nearly always pretended that they hate each other. Interpretation offends many artists, or at least appears arbitrary and stupid, especially when it comes in the name or spirit of Science. I think this conflict is unnecessary.

Hi-Fi always involves a mixing of "separate" worlds: the practices of the creative artist (the musician and the audio software) and the those of the interpreter (the listener and the audio hardware). This is an especially interesting thing to mull over if you are a designer of audio reproduction systems. In the lingo of the cyber-psychoanalytical-pop culture we love so much, audio design is an *interzone*.

An *interzone*, for those unfamiliar with the concept, is the area where traditionally opposite ideas, practices, or social institutions overlap, usually much to the chagrin of the status quo. (Computer networks, for example). This is always happening, but it has only recently been identified as a potentially valuable human activity. Most people still view such stuff as immoral or dangerous.

American high technical culture, at least the kind which brought you the Hoover Dam and the A-bomb or Apollo 11, is generally big, authoritarian and impenetrable. I like the metaphor of the "black box" in connection with this concept — and I imagine it to be *anodized*. Hi-fi, like most things, has also been seduced away from its down-to-earth beginnings by the power of the "black box" although, as I hope to show, there has also been a counter-seduction, which is a powerful source of hope for me personally. This activity amounts to nothing less than a *counterculture*.



The 1960s counterculture was romantic, anti-urban, anti-science, and anti-tech. But there was always a dark romantic contradiction near its core, symbolized by the motorcycle and the electric guitar. With time, this apparent contradiction has transformed itself. Today, practitioners of these "dark arts" often command remarkable technical skills. Counterculture values remain an important source of vitality and community. Romance, art, and high-tech mix seamlessly.

High Technology has, in fact, radically changed in the last twenty years. Not only is it counterculture tech, it is *visceral tech* — it fits close to the body. Examples are many: the walkman, the PC, the cellular phone, the pacemaker, the soft contact lens, anabolic steroids, the digital sampler, in vitro fertilization, the organ transplant, the cam actuated whammy bar, the UZI, etc. High tech and pop culture are so wrapped up in one another, it's hard to imagine them separate again.

It is in this interzone that audio design has nervously persevered. Droogs listen to Beethoven, remember? They also have been known to dabble with Link Wray and Anthrax. To some it may seem absurd to mix ancient hand-blown triodes with C-core single ended transformers (I love Tango) with trick lamination materials, JFETs, military VHF tubes, Caddock/Mills/Vishay resistors and handrolled copper or silver foil caps, with silver wire and blue-tack all over everything, just to get a little closer to the Billie Holiday of your dreams, but not me.

My desire is to be connected to the music in a *substantial* fashion, and by this I mean viscerally-supported. This "substance" is difficult to articulate and yet we all know when it is not there, as in the case of a person who is clever enough, but somehow lacking in substance. If the music hits you like an ak ak fired up your nose, or if it slides up on you like a lover, if you *change* as a result of listening to your hi-fi, then the hardware is doing its job. I have no use for "background music" in this life! That is my interpretation.

And what is interpretation anyway? Interpretation points, that's all. It points into the big world which is much bigger than any of us. It doesn't finalize or even explain why, it just points us in one direction or another (with no absolute sound). This is why there is no one amp or tube or gadget better than any other. The point is to design your way in with whatever works. The technology that accomplishes what I need is what I work with.

The hundred-watt bipolar current amp with AC and DC feedback belongs to the very realm of power and control technology that the "black box" symbolizes. Certainly something happens when you level its polished barrel at your record collection. It is very effective. Your music has no choice but to submit. And it definitely sounds that way too. Tiny Lilliputian arias suspended obediently between your speakers.

The black boxes the police use to determine how far you ride your motorcycle over the speed limit have not deterred anyone. The illusion of control becomes a little less real and a little more bogus if you simply look at it from another angle. The right technology and the right attitude can take you *around* the policeman, *over* the Audio Puritans, *away from* the tacky materialists and on to different places. This is what art does.

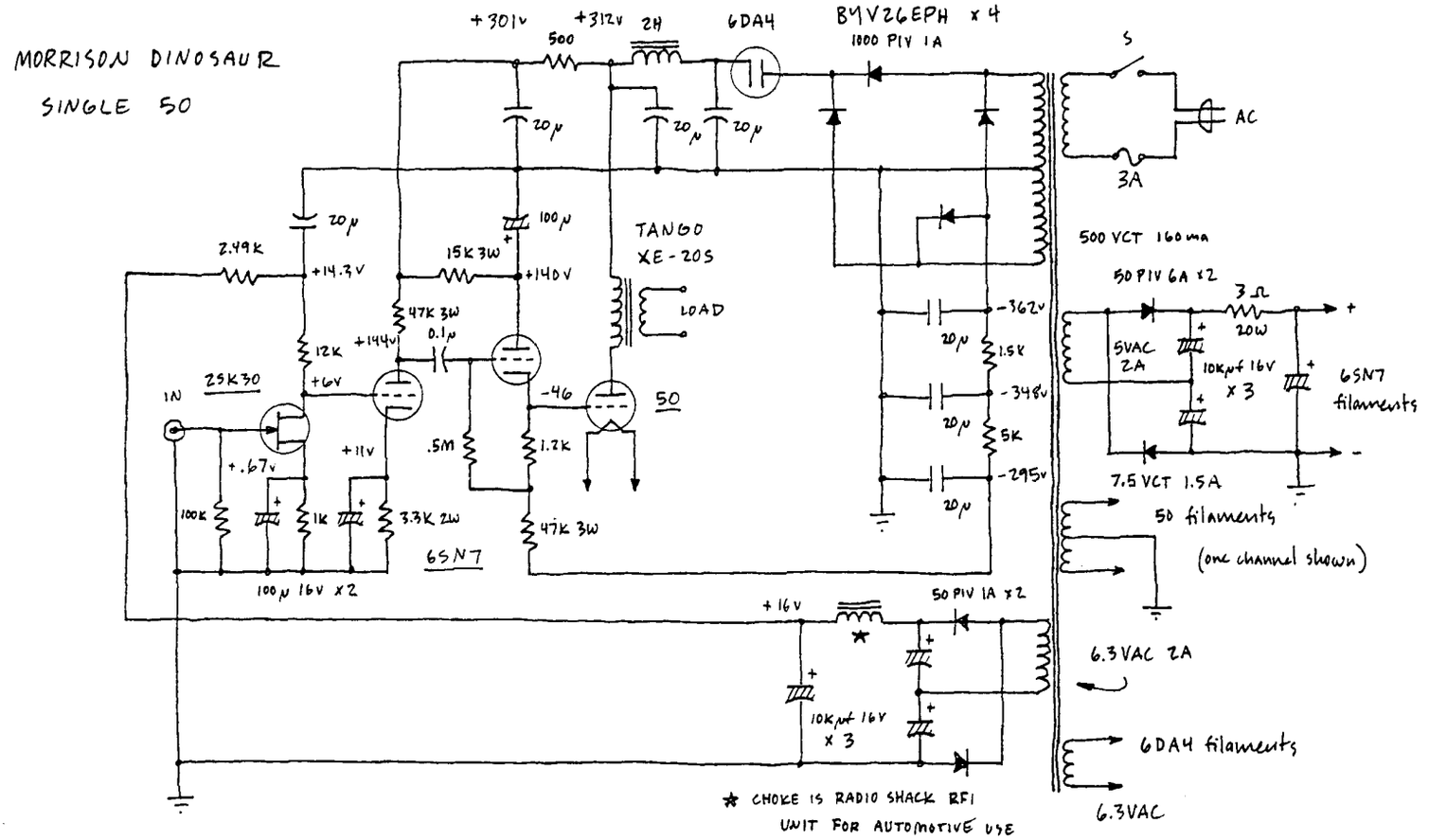
So how does one go about applying this kind of hubbub to the design process? Let's walk through some important design decisions so as to explain by example. To start with, it must use the power transformer I pulled off a Harmon Kardon TRIO 6BQ5 PP integrated so I don't have to look at it sitting on my shelf anymore; it must fit in my beater prototype chassis; and, most importantly, it's gotta be a killer.

The output tube we are going to meet here is a rare and, in many ways, difficult device to work with. The ubiquitous all-weather 50. By the way, there are no more 50s. They're all in Japan or in the various tube collectors' clutches — tube collectors are the builder's nemesis — so don't bother looking or even wishing to build this amp with a 50. (A 300B will drop right in though, providing you have a 5 volt filament transformer. It will work beautifully.)

The 50 was designed to provide big power (4-5 watts) for single-ended applications. It is a low mu, medium impedance power triode and as such requires considerable grid swing in order to cough up its "paltry" few watts. The solution, in those days, for the problem of getting 90 volts of "high quality" grid signal was a step up transformer. The spacing of the cathode, grid and plate in this tube is optimized for a low input impedance, which limits the grid leak to 10K ohms max. Most interstage trannies have no more than a couple hundred ohms of secondary resistance. I cannot describe in blunt enough terms just how challenging this little prerequisite is. I have personally labored over six driver stages to get to the point where I am now, and although spectacular, I'm still not convinced this new one is the final word. If you do not want to resort to a transformer, be prepared to suffer.

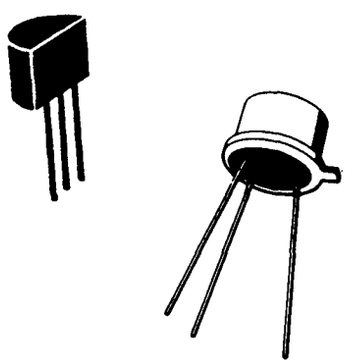
Okay, you say, what's the big deal? Why not just hook it up like they say in the tube manual and be done with it? Good question.

Different kinds of type 50 tubes.



The difficulties come in the following order: 1) big triodes (which the 50 is) tend to have great bass but dark upper midranges and treble (IGNORE the tube manual's suggested operating points); 2) high and medium impedance power tubes are very driver stage dependent (which the 50 definitely is); 3) finding a great interstage trannie is difficult and I have not been impressed yet with what I've heard from such trannies, they usually tend to worsen the upper range of a big triode; 4) most importantly, the 50 has the potential to bridge an interesting gap: its character combines the positive qualities of the low Z power triodes (2A3 and 300B) with those of the high Z power triodes (such as the 10, and 211). While the 45 shares this ability with the 50, and actually does it mo' better, I intend to use this amp with a midrange driver that needs more than the 2 watts available from a single 45!

The nature of this border between high Z and low Z power is, in many ways, a taste thing. The most wonderful aspect of the sound of a tube like the 10 is its utter respect for ambience, nuance and detail. This is the most truthful power tube I've ever worked with. (The 10 and the 45 are my favorites). It can be merciless. If your recording sucks, you're gonna know about it. The 2A3 and 300B, on the other hand, tend to glorify things. This is not to say that they are incapable of accuracy or detail — Komuro and Reichert have so far made me eat my words over and over as regards 300B amps. Still, if the 2A3 and 300B have one thing they do extremely well, it is render the texture, weight and tonal balance of music with elegance and beauty. This, and the comparative simplicity of driving them makes for popular amplifiers.



Different kinds of FETs

I want to have more of what can be had from the high Z triode family. Once again, the thing I am struggling for in designing a circuit around the 50 is to develop its character for walking down a middle line between these two apparently contradictory ideals: accuracy and elegance (which is what we all try to do on some level).

The point is that the tube manual doesn't help out in this situation, and a cookbook approach ain't getting you nowhere. So, you try out every trick in the book and then some. Empirical research is the kind way to describe it.

The basic circuit architecture is shown in fig. 1. There is more than a passing resemblance to Prof. Morikawa's original four stage topology (you may remember Kondo's *Ongaku* also shares this arrangement), which amounts basically to two directly couple gain stages RC coupled to a cathode follower driver directly coupled to the output. *(continued page 16)*

RCA Cunningham Radiotron RADIO TUBES

50

RCA-50
POWER AMPLIFIER

Filament		Coated		
Voltage		7.5		a-c or d-c volts
Current		1.25		amp.
Direct Interelectrode Capacitances:				
Grid to Plate		7.1		μμf
Grid to Filament		4.2		μμf
Plate to Filament		3.4		μμf
Maximum Overall Length				6-1/4"
Maximum Diameter	②	③		2-7/16"
Bulb				ST-19
Base				Med. 4-Pin Bay.
Pin 1-Filament			Pin 3-Grid	
Pin 2-Plate	①	④	Pin 4-Filament	

BOTTOM VIEW

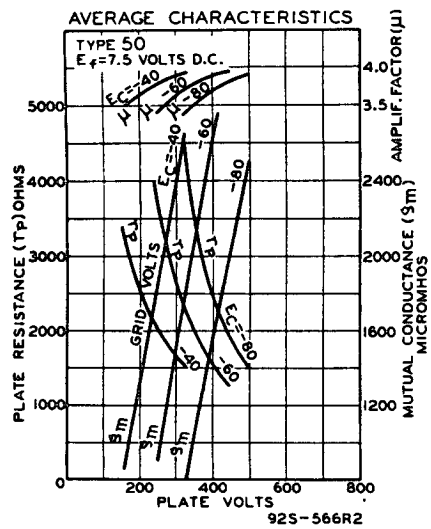
AMPLIFIER (Class A)

Operating Conditions and Characteristics:

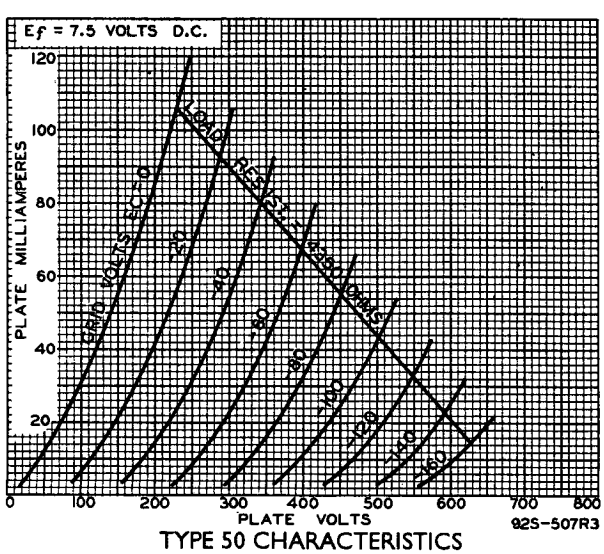
Filament	7.5	7.5	7.5	7.5	a-c volts
Plate	300	350	400	450 max.	volts
Grid *	-54	-63	-70	-84	volts
Amp. Fact.	3.8	3.8	3.8	3.8	
Plate Res.	2000	1900	1800	1800	ohms
Mut. Cond.	1900	2000	2100	2100	μmhos
Plate Cur.	35	45	55	55	ma.
Load Res.	4600	4100	3670	4350	ohms
U.P.O.	1.6	2.4	3.4	4.6	watts

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

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



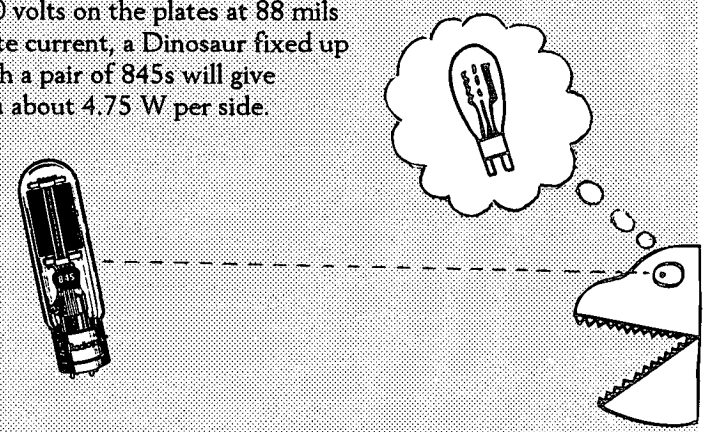
JULY 1, 1935 RCA RADIOTRON DIVISION RCA MANUFACTURING COMPANY, INC. DATA



TYPE 50 CHARACTERISTICS

Feed your Dinosaur 845s!

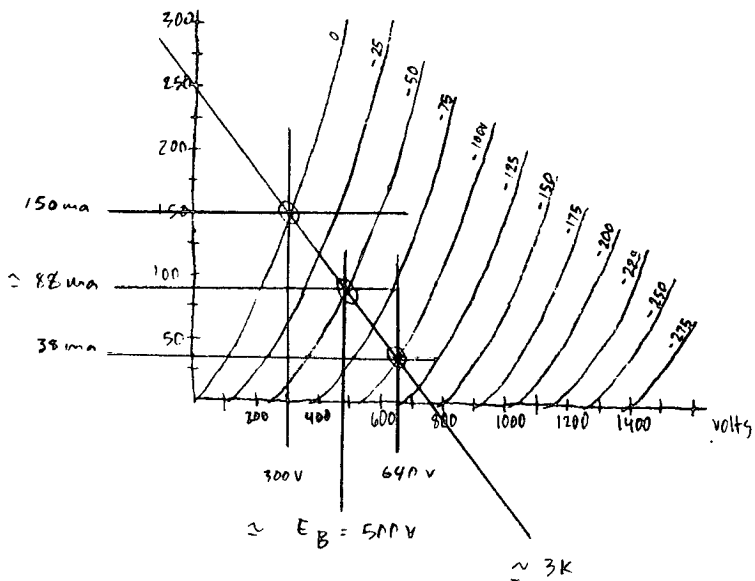
Can't find any 50s? Adapt. Tube vendors now have Chinese 845s at low, low prices. I say get 'em cheap and run them low and hot! The Dinosaur loves 845s. With only 500 volts on the plates at 88 mils plate current, a Dinosaur fixed up with a pair of 845s will give you about 4.75 W per side.



Several changes are necessary to adapt this circuit for 845s:

1 — Increase B+ to 500V. This means a different power trans (800 VCT) and power supply caps rated for at least 500V.
2 — Adjust B- (bias supply) for -50V on the grid of the 845.
3 — Make two 10V, 3.5A DC filament supplies for the 845s.
4 — Increase dropping resistor for driver stage from 500 ohms to 8.2K, 3W.

OPERATING CONDITIONS FOR 845 AT 500 VOLTS



Load resistance = 765V / 250 mA = 3060 ohms
Plate voltage = 500 V Plate current = 88 mA
Neg. Grid volts = 50 Power out = 4.76 W / 8 ohms

I have used the Morikawa circuit before but still prefer simpler, sneakier circuits. In the case of the 50, however, the benefits have outweighed the difficulties and I have come much closer to real satori by employing this arrangement. There are some twists of my own, as you can see.

The B+ supply is 320 VDC. The bias on the 50 is -48 VDC. The JFET has a 13V B+ and everything else should be obvious. The shared power supply is not optimal but I swore I would use up all my dumpster diving parts. The TV damper diode is to provide a slow turn on for the direct-coupled output stage — the 50 warms up much faster than the 6SN7. Yes , I did not put 425V on the 50 for max. power, instead I set it for maximum ecstatic release from ego. The 3.5 watts at 1% THD are all I need.

In summary, here are Morrison's rules of engagement (remember that my criteria are a little specialized and require some things not generally recognized as necessary or relevant):

1) No amp plays all 10 octaves perfectly (I'm shooting for middle/upper frequencies)
2) Burn the tubes up (max current for the voltage applied). This is fundamental to my use of tube technology. If it is sweet, emotional sound you want, set the tube on fire. With few exceptions, high current/low voltage operating points sound clearly better—anyone can hear this. If it means less power/gain and a little more second harmonic distortion (per stage), you will make it up in other areas (circuits or unbypassed cathode resistors, for example).
3) Match the supply voltage to the job. This is really just the other half of rule #2. It means that once you have established the outer limits of current you can drag through your triodes, you find the appropriate amount of voltage swing you need and design the power supply to match, with some headroom left over.
4) Use the smallest possible component values. This is important in terms of bandwidth, transient time and settling time. That means no monster coupling caps, no big load resistances or impedances. Highly touted equipment with mega joule power supplies and feedback are often pointed to with pride in light of their penchant for releasing a torrent of power at the drop of a pin. You will notice, however, that few go on to shout about how long it takes for these wunder toys to recompose themselves. Turning off is one of the most difficult things for an amplifier to do. Where the restoring force comes from has been a topic of heated discussion all century. My opinion is that the charge/discharge time for the power supply should be as fast as possible. I use 20 mF SCR polypropylenes liberally in power supply applications.
5) Silver wire. Yes, it sounds mo' better.
6) Don't pull the same trick twice. Make each stage *complement* the one before.

The use of a solid state device will probably raise some eyebrows, but this little JFET helped me get to a place previously unreachable. The quiet and delicacy this little chip added to the mix was indispensable in taming a hardness the cathode follower has always produced in this arrangement. Think of it as a very small low voltage tube if it makes you feel better about the whole thing.

And that's it. I suppose there's always more, but if I've helped fire your imagination or provided a little insight into what's involved, I'm grateful for the opportunity. Great amps and preamps require heartfelt design, and numbers never tell the whole story.

AHHH, THE SOUND OF OUR HAND-WOUND SINGLE ENDED TRANSFORMER.

(IT'S OKAY TO COUGH, IT'S NOT *REALLY* A LIVE PERFORMANCE)

You don't hear transformers at a live concert, and you won't hear ours at home. That's because our handwinding provides the correct wire tension, precise interleaving, exact turns counting and makes beautiful music. And now for a brief technical interlude:

	Model	Application	Primary Z	Primary DC	Primary L	Power	Price
	FS 006	Parallel SE 2A3/300B	1250	120 mA	12 Hys.	40W (max)	$300
	FS 007	SE 807	6000	60 mA	64 Hys.	50W (max)	$350
	FS 030	SE 300B	3000	60 mA	32 Hys.	40W (max)	$300
NEW!	DS 025	SE 300B	2500	60 mA	18 Hys.	25W (max)	$149

Guaranteed MINIMUM frequency response for all units is 30Hz - 20KHz +/- 1dB.
Insertion loss <0.5 dB (<.65 dB for DS 025). All units fitted with 16-9-4 ohm secondaries.

MagneQuest also handwinds the Peerless 20-20 Plus Series, for your dream push-pull amps. One listen to any MagneQuest transformer will leave you in ahhh.

MagneQuest, 1404 E. Bristol St., Philadelphia, PA 19124 Voice/FAX (215) 288-4816

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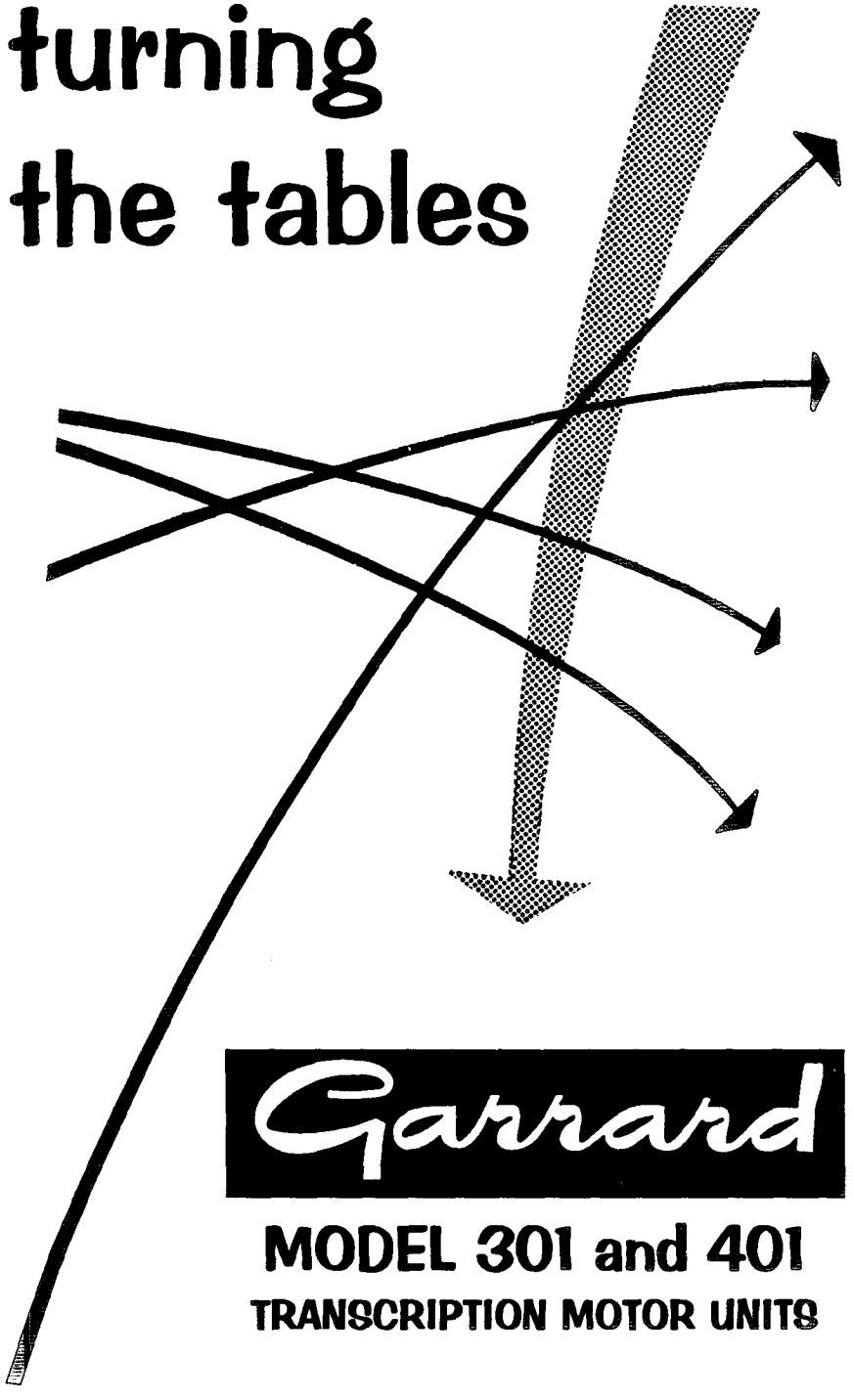
HANDBUILT WITHOUT COMPROMISE TO PERFORM WITHOUT EQUAL.

turning the tables



MODEL 301 and 401
TRANSCRIPTION MOTOR UNITS

by Haden Boardman, Audio Classics, UK

It's funny how products long since departed to the great listening room in the sky are often capable of showing modern, more expensive items more than a thing or two. Garrard's 301 and 401 idler wheel drive turntables are both prime examples of the triumph of classic designs.

Born in 1953, the 301 was Garrard's first transcription turntable produced to play all three existing disc formats: 78 RPM, RCA's new 45 RPM 7" singles and 33-3 RPM 'Long Playing' microgroove discs. Hence the name — *three*-on-*one*. The 301 was immediately recognized as a reference class instrument. It was to remain at the top of the market for a decade.

The earliest 301s were finished in a classy silver-grey hammertone. These early units had a grease nipple in the side of the bearing. When the deck was installed this reservoir was filled up to the limit with lubricant. All you had to do to maintain proper lubrication of the bearing was to tighten a knurled cap slightly through the access hole on top of the motor plate, thereby forcing more grease into the business end of the assembly.

In early 1957 the finish was changed from 'hammerite' silver-grey to creamy white enamel. Later in that same year the bearing assembly was modified to take oil rather than grease.

Not surprisingly, the earlier grease bearing fitted units are more sought after on the second hand market. The earliest 301s have a bearing made with a phosphor bronze lining as well as thrust pad. Later oil-lubricated units have copper-sided bearings. These have a screw hole on top of the chassis instead of a side mounted grease nipple.

If you are buying a 301 and are unsure of which version you are looking at, the later oil bearing units are marked "schedule two" on the name plate. Most of the grease bearings are fitted to decks finished in silver hammertone paint. Only a few specimens of the cream-coloured version had the "better" bearing.

For years, I did not realize the difference. A friend of mine exports a lot of 301s to Japan. They go potty over a grease bearing and will pay him loopy money for one. For years I thought they were crazy. However, owners of oil bearings need not despair. I personally can hear very little difference between the two bearings if they are in good condition.

The next big change occurred with the introduction of the 401 in 1964. The basic ideas were unchanged, and the 401 is essentially a 301 in a Saville Row suit. The major styling rework was courtesy of Eric Marshall, who had also styled the more mass market 'Lab 80'. The 401 echoed the latter quite a bit. Standard 301 production overlapped with 401 production for a couple of years.

Garrard 301/QUAD rig in traditional overly resonant cabinet

Technically, the 401 offered better magnetic screening. This was mainly because the micro switch was mounted under the motor plate rather than on top of it as in the 301, although the motor casing was redesigned to reduce induced hum in the cartridge. The eddy current brake was more substantial and offered greater variation in speed—just over half a semitone each way rather than just under a third of a semitone. A stroboscopically marked platter which was an option for the 301 came standard on the 401. And for the first time on a British-made turntable, the 401 had a neon lamp to illuminate the strobe markings.

Reading a couple of period reviews in *Hi-Fi News* and *Gramophone* I get the impression that the 401 had a bit of a frosty reception. Percy Wilson, reviewing for *Gramophone*, did not like the styling, complained that the 301 was no worse than the 401 as far as hum pick up is concerned with correct mounting of the arm, and he felt that the 401 offered no overall improvement in performance.

The earliest 401's strobe lamp does not operate all of the time. You had to hold the pitch knob down to activate it. Only a handful of decks were like this. A few years later, the neon lamp changed from the elaborate item mounted under the platter and reflected by a mirror to a plastic window next to the platter to an ugly, one piece thing placed in the hole left by the original's window.

Early in the 1970s, cost cutting really caught hold. The chassis was redesigned. Quality control went out the window as did the finish. Instead of elegant charcoal metallic, you get flat brown. Worst of all, the Garrard logo was changed from a superbly cast emblem to a decidedly low-rent piece of pressed steel. However, these late-model decks offer good performance, as long as everything is assembled and set up correctly.

At the same time Garrard felt the Japanese pinch. Their budget decks (SP25 anyone?) were knocked out of the sales charts by newcomers such as Pioneer's ground breaking PL12D.

The 401 was killed off in 1976. At the same time unscrupulous dealers started flogging smaller, neater junk such as Linn LP12s. 401s came to be considered a joke. The flat earthers were about to have their few years of glory.

Eventually Garrard resorted to badge engineered Japanese garbage. Needless to say they bit the dust in 1982. Quite sad for a company that employed several thousand workers for most of its existence.

At about this time our Japanese friends were building strange tube power amplifiers with quaint tubes like 211s, 845s and 300Bs. A few of them started using older 301s and 401s in preference to some of the imposing Japanese super decks that were on the market back then.

Half a dozen companies set up shop buying unloved Garrard turntables, and other vintage kit on behalf of shops in Tokyo's 'Akihabara'. A couple of these companies are still at it. One reckons there are now more 301s in Japan than back in Blighty.

The main reason these decks were ditched in the trash can was because of incorrect installation. Both decks are fitted with motors of monster proportions. Forget farty Philips VCR motors (as fitted to the LP12) or even the beefy unit fitted to the TD 124. Garrard went well over the top. When the 301 was introduced, 78 rpm records were the norm. This plus the fact that very few pick ups tracked at much less than 10 grams meant that the motor needed to be *big*.

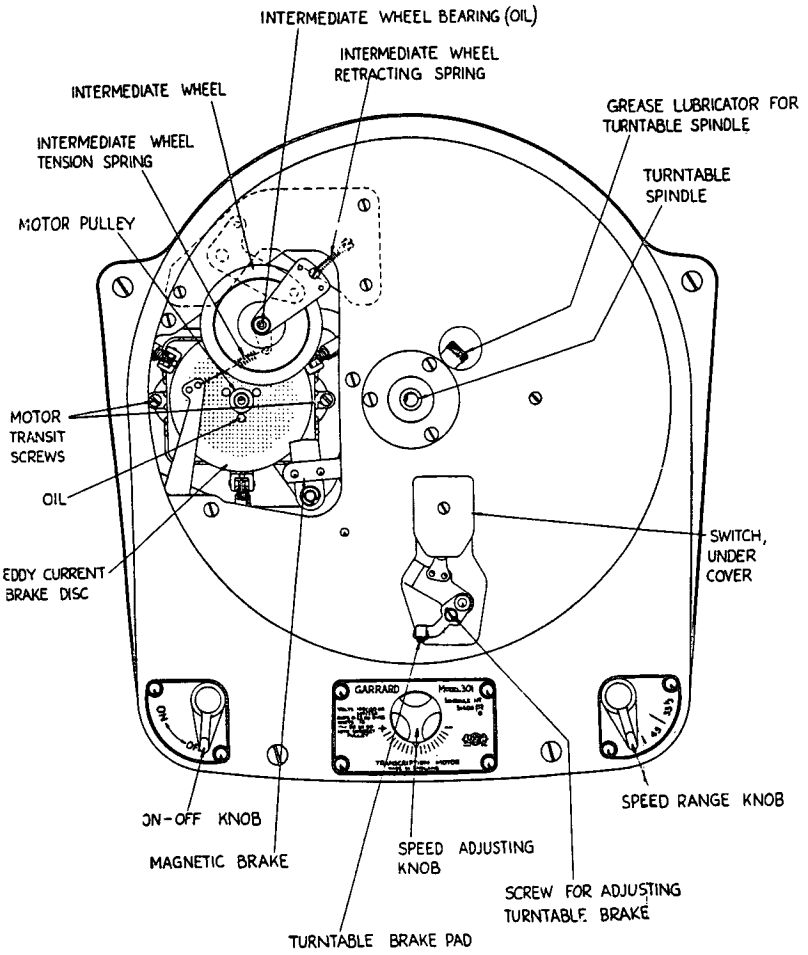
Garrard 401 motor unit with FR-64 and SPU Gold Reference

The problem is that it's a wild and untamed thing. It tends to shake the hell out of the rest of the chassis. Not a problem if your plinth is very heavy and can 'sink' the unwanted energy. Problem was that no one recognized it as a problem at the time. When the 401 was new, only one company in England offered a suitably heavy plinth (it was actually made out of slate). In most installations, the poor old 301 had to make do with plywood or worse.

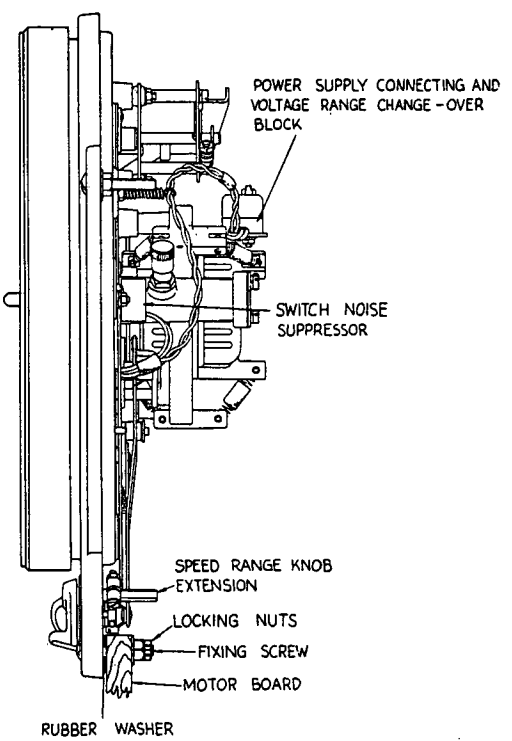
In short, the problem with the 301 was a *plinth* problem and nobody realized it at the time. The popular 'radiogram' console cabinets of the day were great resonators for the 301's vibrations. The classy hardbound Garrard instruction manual was way off track as well. The makers recommended a sprung motor board, a recipe for disaster. A popular plinth was made by S.M.E. that applied the same theory. One would have thought they knew better.

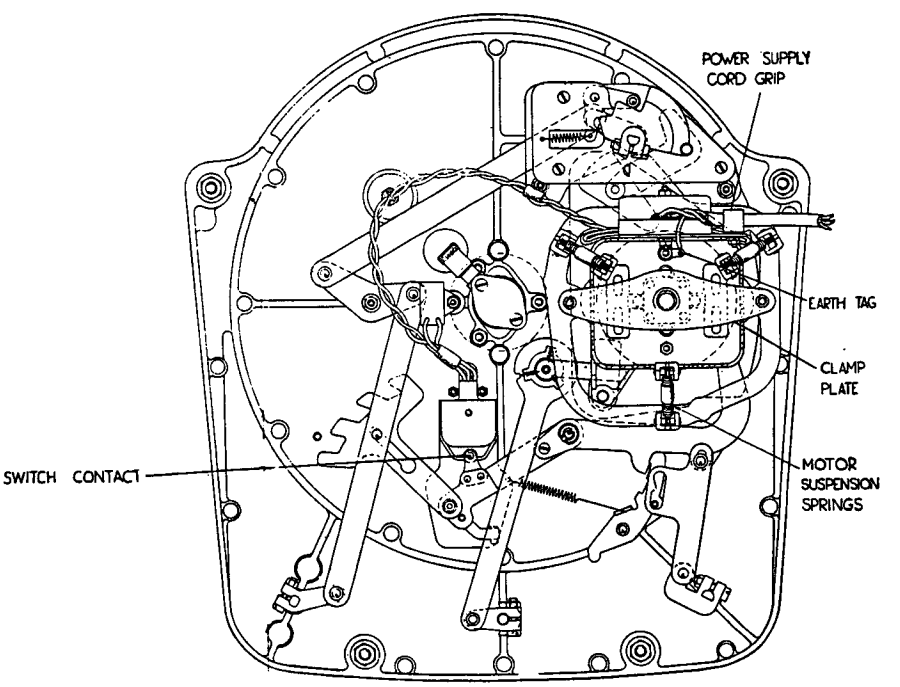
A solid, heavy plinth cures 95% of all unwanted motor noise. Half a dozen kitchen table outfits have recently popped up offering suitable items. Most of them are pretty good, if a little on the expensive side. Just remember — the more mass you provide, the more you banish noise.

Another reason these units throw out so much vibration is due to the eddy current brake system. This awful device labours the



Model 301 — Mechanical Details





huge shaded pole motor slightly, to allow adjustments in turntable speed and to adjust for slight variations in the size of the idler wheel.

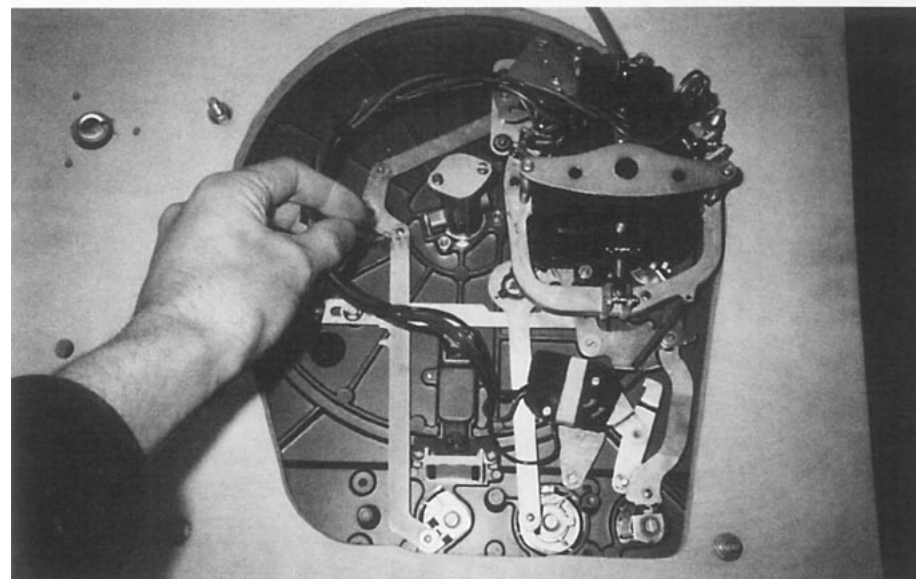
Garrard's pre war turntable, the '201' (two speed, 78 rpm and 80 rpm), was even harder on the motor. This system used a centrifugal governor working against a felt pad. It's no wonder the motors are always burnt out on pre WWII radiograms.

Anyway, back to the eddy current brake. Through a series of levers, turning the pitch control knob slides a magnet over an alloy disc fitted to the shaft of the motor. With the knob turned fully counter clockwise the magnet is positioned over the disc and slows the poor old motor down, resulting in the deck running 2 1/2% slow (just 1 1/2% for the 301). Turning the knob clockwise positions the magnet off the disc, allowing the motor to run at its normal mains electric frequency. 2 1/2% fast of course! Normal operation is with the brake half applied. And that is the problem, the brake is *always* in operation.

To make matters worse, on the last 401s the alloy disc was very badly positioned, and tended to oscillate on its axis. The nearer the magnet to the disc, the more it labours the motor and slows it down. The further away, the less the effect. Now imagine our poor motor having the above applied 50 or 60 times a second. You have to hear this to believe how bad it is.

The 301 has a slimmer disc which is easily dented in transit if someone forgets to tighten the transit clamp. On the plus side, the magnet itself is not positioned over the disc. Instead, two 'arms' are positioned on either side of the disc. These connect to the magnet and allow the eddy currents to be 'steered'. This system is an advantage over the 401 because the disc is within a field between the two arms, and thus the speed is not affected as much.

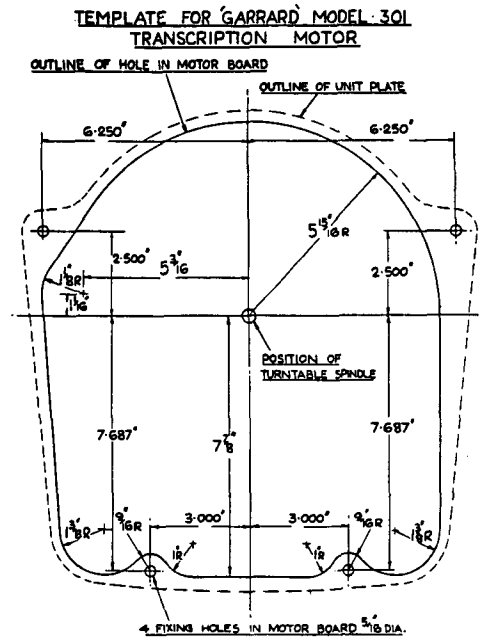
A simple tweak is to reduce the voltage to the motor — 20% is about the right reduction. There are two ways of doing this: using a transformer or by wiring a light bulb in series with the motor. On UK supplies a 40 or 60 watt light bulb gave best results. Once you have a bulb socket wired up it is easy to try different wattage bulbs. Remember the lower the wattage the higher the resistance and the less voltage the motor gets. Therefore, the less noise the brute puts out.



Loosening the wiring harness from the 401 motor can reduce rumble

A major upgrade is to remove the eddy current brake completely and fit a dedicated variable frequency power supply. The problem is that there are not too many power supplies capable of supplying an 80-90 volt sine wave variable between 45 and 60 hz at a power of over 12 watts. Reducing motor voltage means the deck takes a second or so longer to reach full speed. Big deal, in practice this is just not that serious an inconvenience.

One point to watch on all 401s is the power harness. Half a dozen wires hang out of the motor. These go to the double pole mains switch and the neon lamp at the front. Halfway along the journey to the switch, the wires are secured to the chassis by a little spring. Since this is too close to the motor, it acts as a path for the energy from the motor to travel down to shake the rest of the chassis. I usually remove the spring and simply let the wires dangle.



The main bearing has come in for a lot of hammer recently. Unless your original one is damaged, leave it alone. I have tried four different bearing mods and all of them except one produced more background noise. The other one provided a marginal improvement at first, but became noisy after a couple of weeks' use. At the moment, I am still waiting for the guy to return it to me. I think it is all a load of cobblers! The only bearing mod not tried is by a guy called Shindo. Apparently he is a major guru in the Japanese hi-fi scene. If anyone has any experience of Shindo's 301 mod, let us know the story.

Good lubrication is important. If the bearing has been neglected, then the copper sides will have worn quite badly. You can check for this by gently rocking the platter from side to side. Any play means a new bearing housing, or trying to find someone to remanufacture yours. It only takes a few minutes to remove the entire shooting match, so take it out, clean it, check for wear and then rebuild it with a good oil. If your deck is the grease bearing type, the original Garrard stuff seems about best. None of that in stock? Then fill it with Castrol CL (chassis lubrication) grease.

Remember to oil the shaft as you refit it to the housing. Oil as you go. *Never*, ever have a good grease bearing modified.

While you have the bearing apart check the thrust pad for wear. Note that someone at Garrard chose to change the shape of the thrust pad from the original flat surface to a convex shape in the 401. In my opinion, this is not quite as good as the original 301 design. It might be worth considering a modified bearing for your 401 because of this factor.

Same applies to the motor. Strip, clean and rebuild applying oil as you go. The motor runs fast and gets hot. I tried using good quality car engine oil which worked quite well. The best was a dedicated motor oil designed for VCR motors made by Hitachi. Frankly, even old 3 in 1 is better than nothing, so don't lose sleep if you cannot find anything exotic to lube your table with.

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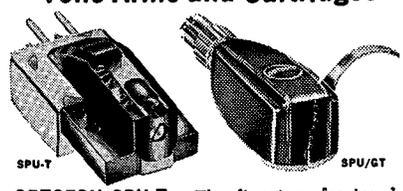

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Ortofon SPU — The world's longest lived stereo component?
(1959 Advertisement)

The poor old idler wheel tends to come in for a lot of unfair stick. Everyone blames it for producing rumble noises. Completely wrong, of course. An idler only needs replacing if it has developed a flat spot, usually the result of leaving the deck in the on position while no power is being applied. Just to prove the point, my 401 is on its original idler! A couple of drops of oil on the idler bearing helps keep it sweet.

One subtle difference between the two decks is the shape of the platter. On the 301 it is totally flat. The 401 platter was designed together with its mat to have a 'hollow' in the centre, while the edge of the mat is very slightly undersized.

Records are supposed to be 'dish' shaped. That is, the outer edge and centre are raised compared to the middle where the grooves are. This is still recommended by the E.E.C. Most modern decks have a dish shaped mat or platter. The problem is not all record manufacturers follow standard practice. If you go through your record collection it will more than likely be a fifty-fifty split.

After exhaustive listening tests and half a brewery of beer consumed, I settled for the 'flat' platter as the best option. To be truthful, mine is a little more complicated than that.

Mats serve two functions. One is to dampen out platter resonances, and to protect the record from trapped dirt. Some may argue that it serves to 'couple' the record and platter together. Personally, I think the latter is horse shit.

I tried all sorts of things to stop platter resonances. Slightly filling the underside with shellac, plaster of Paris, concrete, blu-tak, plasticine. None of them worked very well, although they did help a bit. After deciding several years ago that most mats are designed to smear dynamics and take the edge off detail, I wondered how I could do without it.

By pure accident a glass platter was popped on top of a 401's bare metal platter. Rapping them with my knuckles produced very little noise. The two materials had damped each other out. So that is what I now use. A slim glass platter on top of the original item. The glass is easy to keep clean and is flat. With warped discs a Mitchell clamp holds the ensemble together. Normally the clamp stays in its box.

All of my listening these days is with an Ortofon SPU cartridge. Without doubt one of the most underrated pieces of vintage hi fi. It deserves an article of its own. One problem with the brute is that it weighs nearly 40 grams! Only one or two arms can balance it, let alone match its compliance. Personally, I cannot manage without it. Every time I listen, it sends shivers up my spine. I have tried others, but I'm hooked. Forget drugs — score an SPU, its more mellow.

Contrary to popular belief, Ortofon still makes SPUs. At least two versions are available in the European market: Original and Gold Reference. Only the Gold Reference is imported to the UK, although I have sourced the other from Italy and Germany. This must make it the longest production run of any stereo hi fi component!

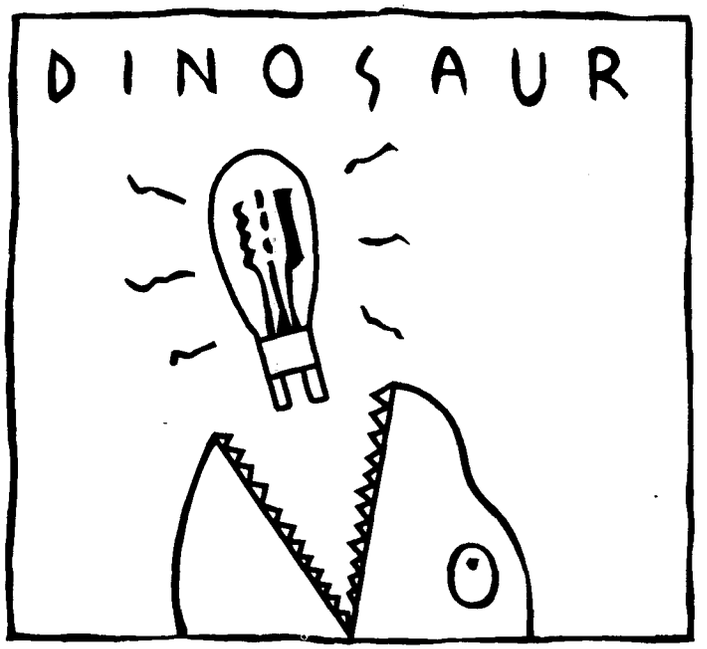
The best arm I have tried with an SPU is a Fidelity Research FR64S. Possibly the first 'tweaky' arm to use silver wire. (I would love to get hold of the 12" FR66, has anyone ever seen one?)

Arm and cartridge choice is not critical on either of the Garrards. Just make sure your arm matches your cartridge. Since they offer totally uncoloured sound and have no suspension system to upset, virtually anything goes.

When set up correctly, with a decent high mass plinth, and a good arm and cartridge, I know of no deck that conveys such speed and authority. On upbeat rock music everything is in control. Bass notes seem so much tighter than any belt-driven deck I have ever heard. With classical you appreciate the deck's totally silent background; nothing is added, and nothing taken away. Ella never sounded so good (except live at Albert Hall).

Quite a lot of manufacturers use vintage Garrards. 401 users include Glen Croft (Croft Acoustics), Ole Moller (Copland), and Yoshiaki Sugano (Koetsu). Even Tim de Paravicini of famed Esoteric Audio Research uses a 301.

With Dr. Digital now peddling even worse new medicine in the form of DCC and minidisc, you should rescue an old Garrard before it is too late. You owe it to yourself.



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UK GARRARD RESOURCES

Martin Bastin makes the "Max Plank" plinth system. Made entirely of plywood, but weighs more than the Slate Audio marble plinth! Martin is a firm believer in the superior sonic qualities of this material. A very complicated plinth to make; all of the voids underneath the deck are filled. Must take a day to make each one.

Also supplies bearing upgrades and remachines all parts of tired Garrards other beers can't reach. A genuine good egg with a lot of his own theories and ideas. Does a good overhaul service.

Martin Bastin, 225 Tettenhall Rd., Wolverhampton, West Midlands, WV6 0DE.
Tel. 0902 751861

Loricraft Audio offers a complete service on any turntable. Makes a fairly decent plinth system and turntable power supply (well, OK, its just a transformer and a light bulb!) Has lots of nice tweaky things. Send an SAE for catalogue. Also operates a record cleaning service.

Loricraft Audio, 4 Big Lane, Goose Green, Lambourn, Berkshire.
Tel. 0488 72267

Slate Audio manufactures solid marble plinths for the 301/401 (UK cost around £350). Also sells glass platter mats.

Slate Audio, 47 Gemini Close, Leighton Buzzard, Bedfordshire, LU7 8UD.
Tel. 0525 384174

Technical and General offers genuine and replacement spares for most vintage turntables and cartridges. Services, repairs and overhauls. Has arm boards available for Thorens, etc. Prices range from expensive to just plain crazy. If you need an idler wheel or a knob they have someone remanufacturing them, not as good as the originals but better than nothing.

Technical & General, P.O. Box 53, Crowborough, East Sussex, TN6 2BY.
Tel. 0892 654534

That is about all of 'em in the UK— but no doubt someone will call and complain that I missed them off. Needless to say, anyone looking for a 301 or 401 should contact Audio Classics!

Audio Classics UK
8 Lowe Mill Lane, Hindley
Wigan, Lancashire WN2 3AF
Tel. 0942 57525, Fax 0942 525861

Meet the Tube. . .

the classic 45

Unlike the mighty 845, the type 45 doesn't draw a crowd. It doesn't glow white hot. It doesn't tower above other tubes. You don't say WOW when you see one lit up from across the room. The two watt power rating is a joke these days. In the contemporary Western audio scene, the type 45 is *not* considered a serious player. When you mention "45," what typically comes to mind is a seven inch record — not a stalwart power triode.

This is a big mistake. The 45 can produce some unbelievably natural, pure, and agile sounds. Unfortunately, speakers of adequate sensitivity to showcase the 45's talents are rare creatures, even more scarce than these antique triodes themselves.

Back when the type 45 was introduced in 1929, 2 watts was a reasonable power specification. Blew the popular 0.8 W Type 71A away for power. How loud would you want to turn up your table radio anyway? Nowadays, to opt to listen to a two watt amp is making a powerful statement. The 45 is a tube for audiophiles comfortable with their manhood. Or people with big horn speakers. In any event, despite its marginal measured output, some crazed tubeophiles swear that it is the best audio tube ever made.

Because antique radio collectors need them to keep old broadcast sets going and a strong export market in 45 tubes adds competition for this dwindling resource, the flea-power 45 commands a price equal to or above that of its twice as powerful sister, the 2A3. But included in the price is a valuable audio lesson: two watts can really play if you give it a chance. Don't think of it as two watts — think *two thousand* milliwatts!

Type 45 tubes were made for about 30 years and they came in many varieties. No two tubes in this heap are identical!

RCA
45

45

POWER AMPLIFIER

Filament	Coated		
Voltage	2.5	a-c or d-c	volts
Current	1.5		amp.
Direct Interelectrode Capacitances:			
Grid to Plate		7	μμf
Grid to Filament		6	μμf
Plate to Filament		9	μμf
Maximum Overall Length			4-11/16"
Maximum Diameter			1-13/16"
Bulb			ST-16
Base			Medium 4-Pin
Pin 1 - Filament		Pin 3 - Grid	
Pin 2 - Plate		Pin 4 - Filament ◊	
Mounting Position	BOTTOM VIEW	Vertical, Base Down ◊ ←	

CLASS A AMPLIFIER

Operating Conditions and Characteristics:				
Filament	2.5	2.5	2.5	a-c volts
Plate	180	250	275 max.	volts
Grid * ◊	-31.5	-50	-56	volts
Amp. Fact.	3.5	3.5	3.5	
Plate Res.	1650	1610	1700	ohms
Transcond.	2125	2175	2050	μmhos
Plate Cur.	31	34	36	ma.
Load Res.	2700	3900	4600	ohms
U.P.O.	825	1600	2000	mw.

* Cathode-bias is advisable in all cases; required if grid-coupling resistor (max. value 1.0 megohm) is used.

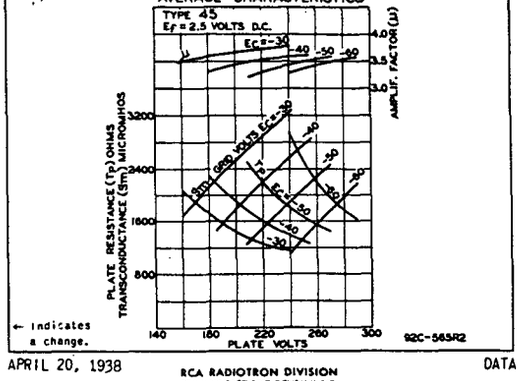
CLASS AB₂ AMPLIFIER

Values are for 2 tubes

Typical Operation:	Fixed Bias	Cathode Bias	
Filament	2.5	2.5	a-c volts
Plate*	275	275	max. volts
Grid	-48	-	volts
Cathode Resistor	-	775	ohms
Average Driving Power (grid to grid)	656	460	mw.
Zero-Sig. Plate Current	28	36	ma.
Max.-Sig. Plate Current	138	90	ma.
Load Resistance (per tube)	800	1265	ohms
Effective Load Res. (plate to plate)	3200	5060	ohms
Total Harmonic Distortion	5	5	%
Power Output	18	12	watts

* Grid volts measured from mid-point of a-c operated filament.
◊ Horizontal operation permitted if plane of filament is vertical.

AVERAGE CHARACTERISTICS



← Indicates a change.

APRIL 20, 1938 RCA RADIOTRON DIVISION RCA MANUFACTURING COMPANY INC DATA

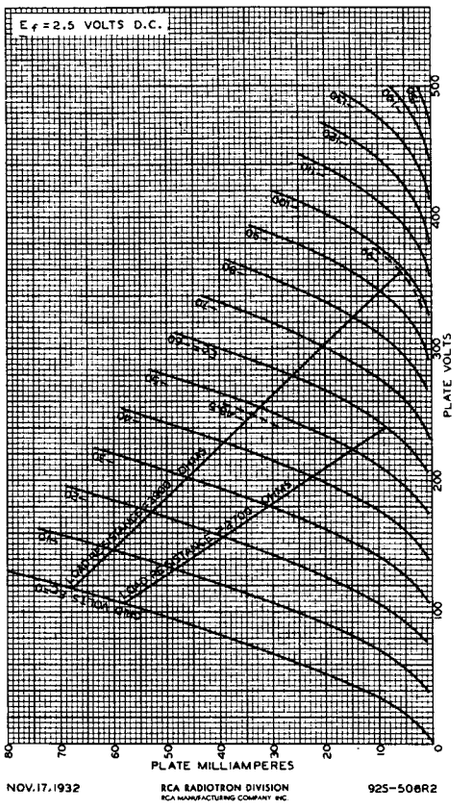
Put those 45s to good use! Build yourself Gordon Rankin's killer two watt direct coupled current sourced 45 amp — a micropower favorite.

Credits: Wavelength Audio, Alan Douglas. Photos: Alan Douglas

45

RCA
45

AVERAGE PLATE CHARACTERISTICS



NOV. 17. 1932 — RCA RADIOTRON DIVISION, RCA MANUFACTURING COMPANY INC. — 925-506R2

AMALGAMATED WIRELESS VALVE CO. PTY. LTD. SYDNEY, AUSTRALIA — JULY, 1937

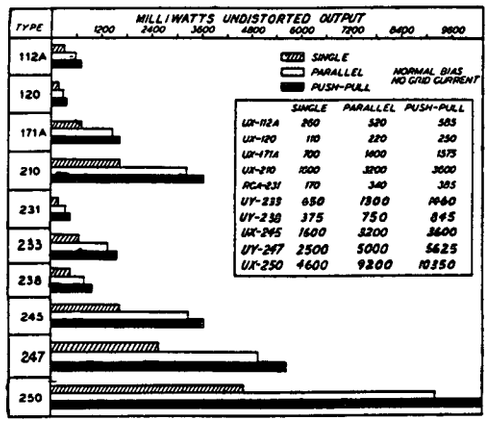
"RADIOTRON" RECEIVER TYPE TRIODE OUTPUT STAGES

VALVE	TYPE 45										TYPE 2A3					
CLASS OF OPERATION	A_1			PP A_1			PP AB_1				A_1	PP A_1		PP AB_1		
PLATE VOLTS	180	250	275	180	250	275	250	275	250	275	250	250	300°	250	300	300
DC. GRID BIAS*	31·5	50	56	31·5	50	56	55	68	55	68	45	45	*	45	62	65
KIND OF BIAS	SELF BIAS								FIXED BIAS		SELF BIAS			FIXED BIAS		BACK+ BIAS
BIAS RESISTOR OHMS	1020	1470	1550	510	735	775	810	830			750	375	780			
LOAD RES. " OHMS	2700	3900	4600	5400	7800	9200	3900	4000	3900	4000	2500	5000	5000	2000	3000	4000
ZERO SIG. I_P	31	34	38	62	68	72	61	67	38	28	60	120	80	120	80	80
MAX. SIG. I_P	v						68	82	68	82			110	165	140	115
POWER SENSITIVITY**	1·8	1·3	1·3	0·9	0·65	0·65	0·9	0·65	0·9	0·65	3·5	1·75	0·6	2·5	2·0	1·6
TOTAL HARM. DISTORTION %	5	5	5	2	1	1	2	2	2	2	3	2	5	1·5	2·5	2
DOMINANT HARMONIC	2	2	2	3	3	3	3	3	3	3	2	3	3	3	3	3
POWER OUTPUT WATTS	·825	1·6	2·0	1·65	3·2	4·0	4·85	6·0	4·85	6·0	3·5	7·0	10	10	15	13·5
MAX. GRID RESISTOR.	1·0 MEGOHM								0·1 MEGOHM		0·5 MEGOHM			·05 MEGOHM.		

* 300 VOLTS TOTAL SUPPLY — † AS DESCRIBED RADIOTRONICS 78 — ‡ AT MAX. SIGNAL INPUT.
** MILLIWATTS PER VOLT SQUARED (R.M.S.) — # PLATE TO PLATE FOR PUSH-PULL OPERATION.

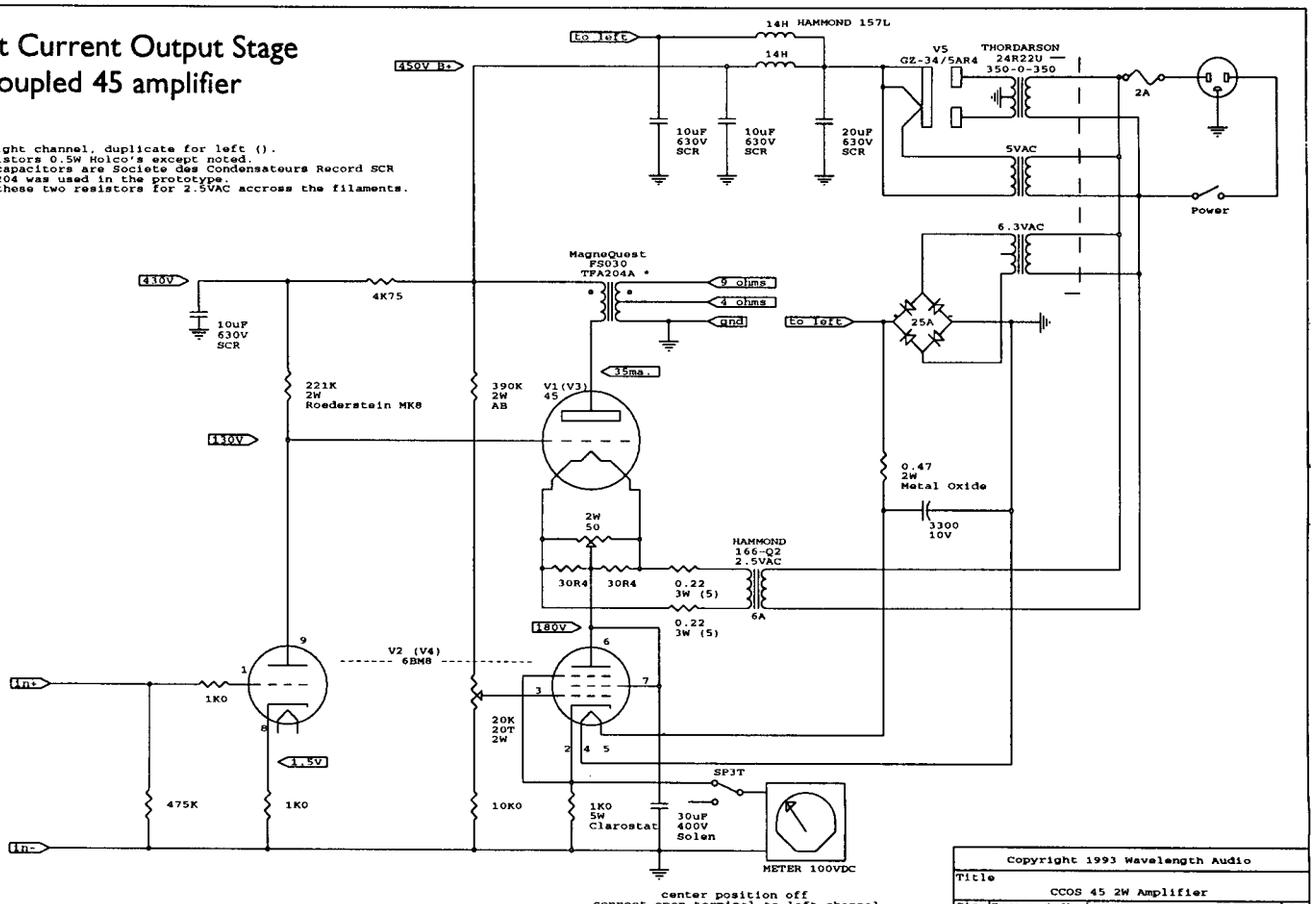
RADIOTRON
TRIODE OUTPUT STAGES

As this 1930s data suggests, a type 45 is equivalent to half of a 2A3. They didn't have 2A3s back in '29 when the 45 was introduced. The power tube competiton then was the flea power 71A (171A), the high plate impedance 10 (210) which required an expensive high voltage supply, and the type 50 (250). The 50 put out a big 4.8 watts, overkill for the typical in-home amplification task of the era — the radio played through a newfangled dynamic loudspeaker. With 2 watts out at low voltage, the 45 was well suited to early consumer electronics applications.



Constant Current Output Stage
Direct coupled 45 amplifier

Notes:
1) Shown right channel, duplicate for left ().
2) All resistors 0.5W Holco's except noted.
3) All HV capacitors are Societe des Condensateurs Record SCR
4) The TFA204 was used in the prototype.
5) Adjust these two resistors for 2.5VAC accross the filaments.



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Title	CCOS 45 2W Amplifier	
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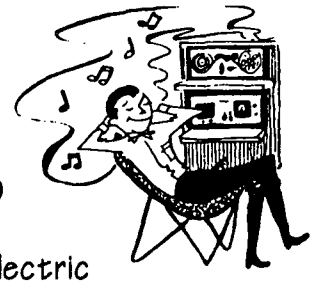
Date: September 20, 1993	Sheet	of

Casual Reactions



by Herb Reichert, Eddy Electric

CAN'T STOP RUNNING WATER:
The Edgar Horns and The Blue Island System

The horn skeptics are dropping like toddlers in a marathon. The phone lines are abuzz. The Edgar Horn System is opening musical doors and turning on perceptual lights for open-minded audiophiles across the United States and overseas. Here in NYC the High Fever boys are working their jig saws and keeping their irons ON. Based on our continuing auditions, the triode-amped Edgar horn is beginning to look like the greatest audio discovery since the LP.

I fully expect that the mainstream manufacturer/press coalition will soon discover what tens of thousands of Asian and European music lovers have known for almost two decades: that carefully engineered triode/horn systems will play the hell out of your records in a way that makes "recommended" audio systems seem sterile and emotionally distant.

We are so enthused that we have begun to collaborate on an all-out *Blue Island System* (BLue ISland System = BLISS) here in the old Staten Island Firehouse. The purpose of this system is to create triode magic that will take us to places we have never been before. Because of lower distortion and elevated dynamics, music recreated by the triode-horn combination follows a direct conduit to our nervous systems, hearts, and minds.

Triode maniacs take enormous, detailed soundstages and scary resolution for granted. This is Class A, no-negative feedback, triode turf. The real breakthrough is the EHS. Never before have the virtues of low power directly heated triode amplifiers been revealed without the serious dynamic compression of conventional cone/dome systems or the peaky resonances of theater horn systems. These wooden, cone driven horns showcase the beauty of musical presentations without asking us to overlook the ringing and serious colorations which come stock with most other horn transducers.

These observations are based on three very different systems which all have the Edgar midrange horn in common:

- A tri-amped setup with MOSFET-powered transmission line bass, a 4" throat mid-horn with a Focal 7V, and a Polydax PR-120-il tweeter.
- A system consisting of a single-ended 6B4-G PP amp, a Petit Onken bass cab, a 4" throat horn with an Altec 755C, and the glorious Onken OS-5000 tweet.
- My system, which currently employs Altec 515As in a VOT cabinet with a 1 1/4" inch stone top and no crossover and 2 1/2" throat mid horns with Dynaudio D-54 drivers in spiked, sand-filled cabinets. I use series 48 mF oil caps to cross over to the D-54 and a series 4 mF cap on the PR-120.

Any of the these systems will give you more goosebumps than ANY store bought system, but this is only the beginning. Beyond all the above lies the *Blue Island System!*

WHY BOTHER?

Before I describe the "soon to be completed" BLISS, I would like to remind our readers why I think any of this is important and why I think one should go to the considerable effort to "create" a system of this nature.

When we experience the beauty of art (painting, poetry, music, etc.), we very often consciously acknowledge our recognition of this beauty by saying something (i.e. Wow!) or doing something (i.e. pausing for further study). The simple experience of acknowledgment has great significance to our personal development. The mechanism of recognition must come from within. In other words, we must "comprehend" beauty.

Our ability to recognize or comprehend the sublime in art is probably founded in our experience of the sublime in nature of which we are an integral part. The beauty we recognize on the "outside" is DIRECTLY RELATED to the beauty we recognize on the "inside". The inner experience of beauty enhances the possibility of the outer experience and vice versa. Our efforts to seek beauty directly relate to our experience of "quality" in life. All of this is a sort of barometer of who we are now and what we aspire to be.

Man, I believe, endeavors to create and understand "sublime architectures" like those he perceives in nature. A Ferrari, the Sistine Chapel, Van Gogh's Irises, Mozart's *Don Giovanni*, the electromagnetic spectrum — these are all sublime architectures. High quality music reproduction can be a channel to an almost infinite variety of these architectures. To this end it behooves us to establish a type of audio engineering which is capable of illuminating these artistic structures in recorded music. If we can enhance our systems' "communicative skills," if we can design a system that showcases more "artistic intent," we can open doors to understanding ourselves, nature, and the hearts and minds of the composers whose music we choose to play.

We perceive the sublime in art through contrasts; big-little, hard-soft; near-far; light-dark; warm-cool, etc. You will have to trust me on this, but to my aging senses, the type of system we are undertaking here preserves the nuance and drama of these contrasts better than anything else available.

I believe that a fine music reproducing system, listened to in the privacy of our homes allows us two critical enhancements not available in commercial live-music venues. First, and most important, is the ability to choose the great performance we feel like hearing NOW! Not the second rate Beethoven we paid six months in advance for. Second, we can, dance, cry, scream, shake, or tear the roof off this place at will. Do not underestimate the power of these freedoms. I often enjoy radical changes of program too. Going from Laurie Anderson to Junior Wells, to Sun Ra, to Wagner, and

finishing with "Love in Vain" and "You can't always get what you want" might just be what I need to get my creative juices flowing. Our BLISS is intended to let us exalt in these kinds of indulgences. In this issue I would like to give you some engineering architectures to work with.

©AN'T TAME A CRAB: What to do about Crossovers

One of my biggest regrets is the amount of time I spent tweaking passive speaker crossovers. I began to spend equal amounts of time devising strategies to avoid using any crossover. Every time I successfully eliminated a choke or a cap from the amp load the music became more vivid, detailed and alive. Setting driver levels can also be a nightmare.

There is one solution which solves all your crossover problems at once. . . at the expense of a few extra amplifiers. If you want to go beyond the mundane in audio, I believe there is no easier way than to provide high quality loudspeakers with separate bandwidth-limited amplifiers for each driver. With this method, the drivers are connected directly to their own amplifier's output terminals and there are no additional parts, gain stages, or buffers.

Additionally, the amplifier can be specifically designed to meet the electrical, mechanical, and sonic needs of the driver. Going beyond simple interstage filters the drivers response can be adjusted by clever use of multiple time constants inherent in every amplifier design. Fortunately for us, the Edgar horns seem to require none of this type of skullduggery. *On to the BLISS. . .*

FINER THAN FROG'S HAIR: Speakers With Bowties

One reason horns became dinosaurs was the nastier aspect of "horn sound". Another drawback is that horns do not fit in well with most peoples' ideas of home decor. Taming horn resonances and making them "handsome" is still tricky as ever. We are trying to create a home speaker system that exceeds Wamm and has a touch of WAF. Okay I admit it: WAF is well down on the list of priorities for the BLISS. However, with the proper veneers, grill cloths, and marble colors it can be made quite attractive — see Raul Gil's setup for inspiration.

Figure #1 shows our steel spike, sand-filled horn, stone arrangement. No one will guess you have load bearing joist supports in the basement! This system is a bit heavy but it sings like Pavarotti.

BLUE ISLAND SYSTEM: Electronic Architectures

Figure #2 shows the schematic for the bass amp I have chosen to power the Altec 414s in the Petit Onken enclosures. A solid state amp could provide better bass transients and lower octave transparency but the low input impedance would require that I use an active filter with a buffered output to interface with my preamp which has a slightly high output impedance.

Fixed bias on the 2A3s would also reduce any subjective effect of softness in bass regions, but I prefer the overload characteristics of cathode bias. This 10 watt push-pull amp represents a compromise in some areas of bass performance but I think this amp will redeem itself in the smooth tonal transition at the 100 Hz turnover point.

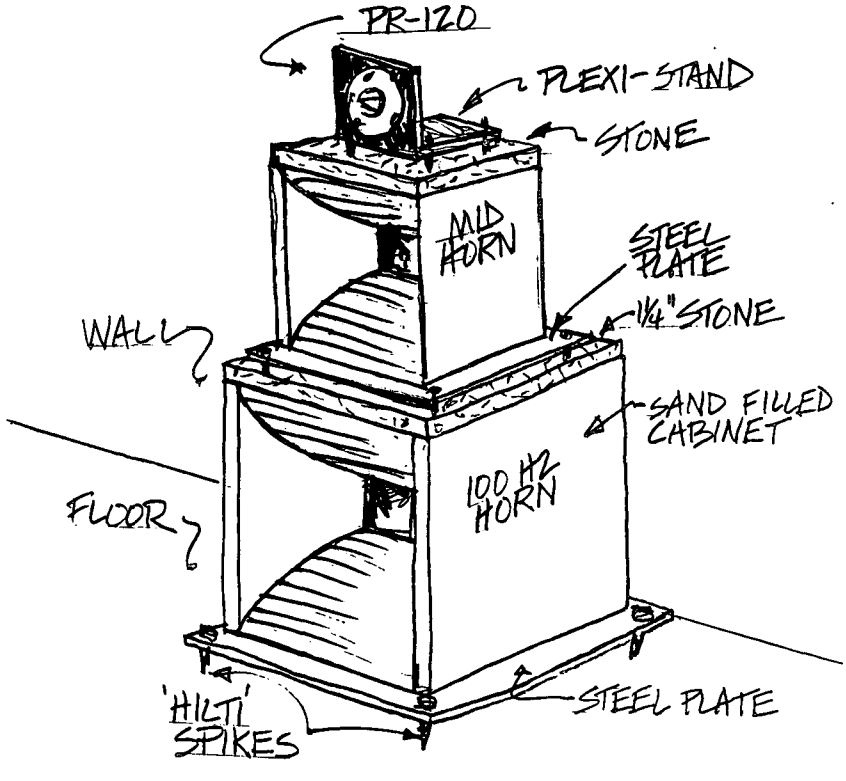


Figure 1 — Visualization of Blue Island System

Figure #3 shows my 300B Single amp with the 100 Hz-500 Hz bandpass filter installed. I really love the speed and vivid textures of the 300B single throughout the midband. This amp will power the soon to arrive Edgar 100 Hz horn. Bruce tells me his horn comes in at 110 dB/watt/meter!

The Edgar 100 Hz horns are approximately two feet on each side, designed to be used against a wall but away from the corners. The beauty here is the potential freedom from room boundary effects in a region typically sabotaged by cancellations and doubling just below middle C.

Having a dedicated amp makes bringing the level down to the 98 dB of the Onken easy and minutely adjustable. At 500 Hz, 1 dB level mismatches are certain to skew tonal balance. Precision stepped attenuators at the inputs of each amp will allow the BLISS to be tweaked to +/- 0.5 dB through the critical lower midrange.

Any amplifier with a direct coupled and a R-C coupled stage can be configured as a bandpass amp using a R-C network between the direct coupled stages for low pass and a coupling cap in the R-C stage chosen to yield the desired LF roloff point.

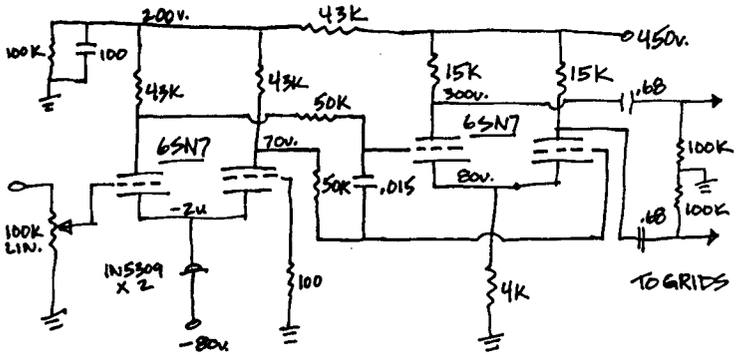


Fig. 1 - 2A3 Push-Pull Bass Amp
100 Hz low pass

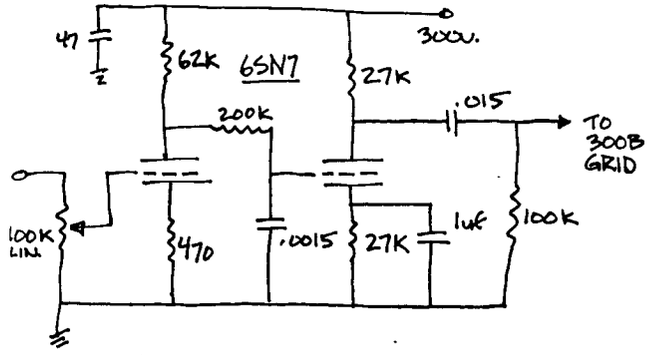


Fig. 2 - 300B Single 100 Hz Horn Amp
100 - 500 Hz Bandpass

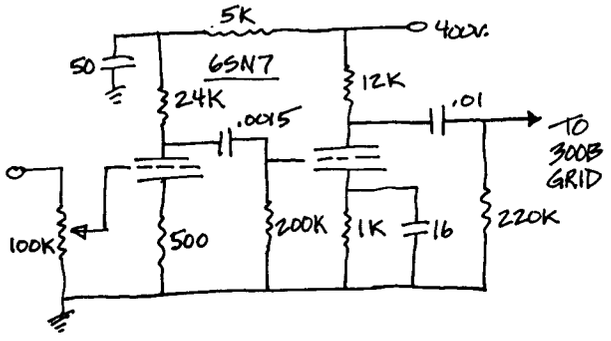


Fig. 3 - 300B Single 500 Hz
Midrange Horn Amp

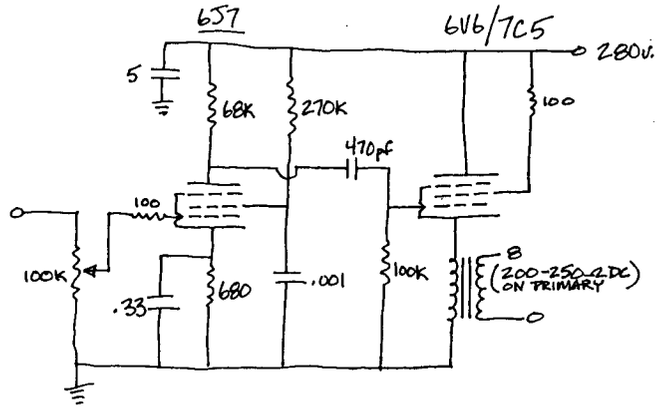
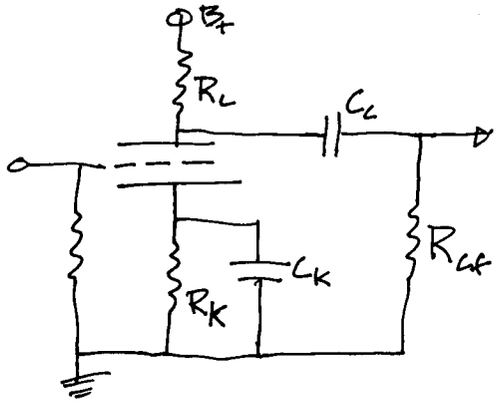


Fig. 4 - PR-120 Tweeter Amp



$$f_1 = \frac{1}{2\pi RC}$$

$$C_L = \frac{1.6 \times 10^6}{f_1 R_{CF}}$$

$$C_K = \frac{1.6 \times 10^6}{f_1 R_K}$$

f_1 = low frequency limit

Adjusting time constants for passive high-pass interstage filter networks

Reader Raul Gil and family perched on Raul's handcrafted full range Edgar horn system.

This creation is finished in rich maroon lacquer and birds-eye maple veneer, combining Deco Movie Palace style visual appeal with horn loading down to 40 Hz ! For constructional details on Edgar's *Monolith* bass horn, see *Speaker Builder, 1993:6.*

Figure #4 is the schematic for the amp I presently use with the Edgar mid-horn. It has only a 500 Hz high-pass filter. The D-54 is very well behaved outside its horn-loaded passband.

Figure #5 is a suggested schematic for a PR-120 tweeter amp. This design uses the 6J7 for low input capacitance and good RFI rejection. Tweeter resonances can have a very serious effect on midrange clarity. They can sabotage voice articulation and upper midrange tonal balance. This design uses three staggered poles to get the amp as far down by 2000 Hz as possible without severe phase shift or ringing. This is an untested design which, if implemented, should be examined on the scope looking closely for transient and phase anomalies outside the 5000-20,000 Hz passband.

BIRDS OF A FEATHER: THE PR-120

Dr. Edgar spent twelve years developing these horns and then he "casually" recommends the inexpensive Polydax PR-120 tweeter ($50) for use with them. Last issue, I was recommending the JBL 2405 as the best choice at a reasonable cost. Well, I take that back! Further listening has shown that this tweet is way out! I can't believe how good it really is. I have been listening to the new version, the PR-120i1, in the tri-amped system mentioned earlier and you can buy this unit with no reservations. Only the Sequerra Ribbon, the Plazma and the Onken OS-5000 have sounded better in my experience. Thank you, Dr. Edgar for your great taste. You can contact Bruce Edgar at POB 1515, Redondo Beach, CA 90278.

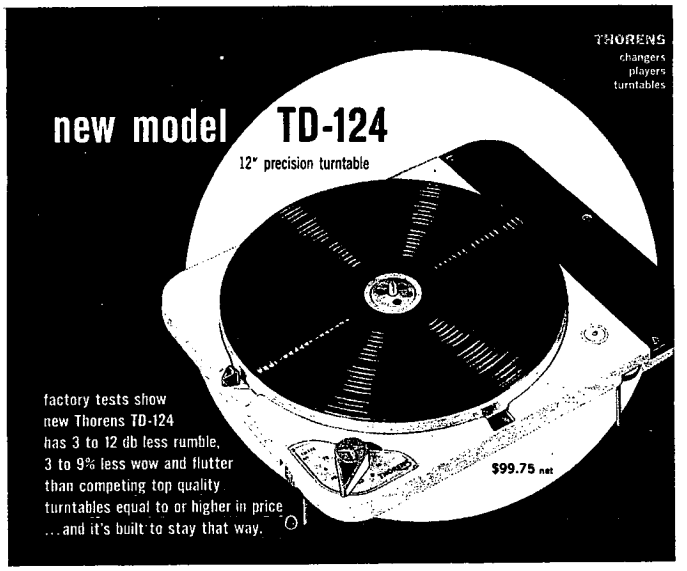
In my next installment I will go into the details of system setup, measuring, and wiring. In the spirit of shared discovery, I hope you will continue to do your own research on the edge of audio art. Remember, the High Fever boys still believe that there are AT LEAST 144 perfect ways to do anything.

THE MUSIC GOES ROUND AND COMES OUT HERE: The Thorens TD-124

Part of my "research" involves going around to NYC audio salons and harrassing the proprietors to let me "study" their systems. My purpose is to figure out "how it works". I do this to lonely audiophiles with original type systems too. The only thing I can say for sure I have learned is: when comparing the best to the best, analog front ends provide INSTANT goosebumps and visceral access to musical contrasts while digital sources seem to even everything out by generalizing on textural and coloristic details. The sensation of "something special and beautiful" or the effect of "tough and gritty", or the notion of "hard" in rock — these aspects seem to get lost in digital and show up in spades on analog. The serene, the nasty, the heroic, the hesitant, the shy, all come out very clearly in analog. These are some of the qualities we are designing the BLISS to elucidate.

I have always admired the audiophile who had the means and good taste to assemble a perfectly set up turntable/tonearm/cartridge combination. This is where the truly sophisticated music lover shows his character. He can assume the role of connoisseur and art collector by his selection, setup and maintenance of these components. This, to me, is where the "high end" was to be found. Unfortunately, entry level costs for front end connoisseurship are kinda steep for my blood. Undaunted, I have spent much of my adult life seeking high-end analog on a mid-fi budget.

After my cheapo late-70's Garrard with the free cartridge, I stepped up to a Dual 1219 with an ADC cartridge. Then came the Kenwood KD-600 which I loved for about 12 years. Then IVOR! He made me save my money for a LP-12, but when the time came to plunk down my cash, I wavered and swooned and bought an all out SOTA at the last minute.



Here's a new hi-fi turntable that works on an absolutely new principle—The Thorens "Roto-Drive," actually two turntables in one — *to give the lowest flutter, wow and rumble of any 12" turntable with equal or less moment of inertia*... Performance far exceeds broadcast standards for wow, flutter and rumble... exceeds that of turntables with hysteresis synchronous motors. What's more, the TD-124 gives you a truly outstanding combination of features. Check them!

* Continuously running, heavy 10-lb. rim-concentrated cast-iron lower table or fly wheel that—
  1. Provides high inertia (3 times as heavy as aluminum; outweighs 15" aluminum turntables).
  2. Completely shields pickup from strong hum fields.
* Light aluminum cover table with attractive mat that—
  1. Forms precision rotating surface.
  2. Allows fast starts and stops (⅓ rev. max.)
  3. Prevents attraction of pickup magnet to flywheel.
* Exclusive Thorens clutch instantly joins heavy and light tables, makes starts fast, makes cuing easy. Saves records; you can start turntable *after* you've placed stylus.
* Four speeds 16⅔, 33⅓, 45, 78.
* Built-in illuminated strobe disc for all speeds.
* Plus or minus 3% speed adjustment for all speeds.
* Built-in turntable level for easy leveling.
* Built-in knurled leveling screws accessible from top of unit.
* Easily detached, standard 12" arm mounting board. (16" board available as accessory.) You can change arms without leaving unsightly marks.
* Shock-mounted "Roto Drive" motor is completely vibration isolated by limp, extremely compliant belt drive, plus large idler.
* Easy to mount, only 2¾" clearance required below mounting board. Top surface requires 15 ½" x 12 ½" with 12" arm mounting board; 18" x 12 ¾" with 16" board. (NOTE: These are minimum dimensions; arms with rear overhang may require slight additional space allowance.)
* Comes with power line cord, shielded pickup cable and solder plate.
* May be used on 50 or 60 cycle alternating current. 100-120, 125-150, and 200-250 volts. Easy to change over.

HI-FI COMPONENTS • LIGHTERS • SPRING-POWERED SHAVERS • MUSIC BOXES — THORENS — SWISS MADE PRODUCTS NEW HYDE PARK, NEW YORK

Thorens TD-124 ad from 1959

For about a year it was my favorite possession, then I noticed that I spent most of my listening time looking for albums that "sounded good." I used to just play what I felt like listening to with no forethought about sonics.

Once I realized what I was doing, this search for sonics became even more of an obsession — one that excluded whole record labels and their artists from my listening repertoire. No more Columbia, Deutsche Gramophone, or Phillips! I knew this was bad, but I didn't know how to stop.

At first I thought the cheap MMT arm must be "dead". I bought a FT-3 looking for "life". Very little improved. So what the hell maybe it's my choice of cartridge. . . so I tried a few others. Still, the system seemed "off" and "sour" and "even". Adventure returned quickly, however, when a friend turned me on to the Thorens TD-124. We compared it to his Well-Tempered/Van Den Hul set up and it was no contest. I sold my SOTA instantly and started listening to ALL my records again.

The Thorens excelled at presenting weight, body and rhythm. These are qualities that I treasure and were lost in the SOTA and the Well-Tempered, but should I have bought a Linn in the first place? We know it is a rhythm master, but would it let me play records with no sonic forethought? Would it make me stop wondering if I was missing something? The Thorens is so old and clunky looking I always wonder if the NEW high end rigs would outclass it like the new preamps outclass the 7-C and SP-6. Then came John Atkinson and Corey Greenberg singing about the Linn and extolling the "good ol' soul" of the LP-12-Lingo-Cirkus. HOO HAW!!! MAN!!! HAHA-HAHAHA!!! MAN O MAN!!!

That was it! I begged and borrowed and got a Linn Valhalla and set it up exactly like the TD-124: identical Fletcher MDC-800 arms, identical Kimber KCAG Silver arm cables, Shure V-15-V, Adcom Crosscoil, and Stanton C-100 and 981LZS cartridges. I even made two mahogany arm boards to eliminate another variable.

Guess what? The Linn showed me why I have never heard a bad system with an LP-12 playing the records. The Linn is very, very transparent. It is transparent in a way that makes recorded performances seem extra holographic and pristine. This transparency takes over your listening space and impresses your friends. Its tempo keeping ability will also give you weeks of delight. But! But! I think the emperor is not fully dressed! Alas, he forgot his pants! The weight, body, and drive that gives a performance momentum and keeps the rhythm going is missing.

So what about the 124? It seems equal to the Linn in every area except noise floor and transparency. Plus it has a bit of "weight" that the Linn lacks. Now I was really getting frustrated. Even if I had lots of money I still didn't know what I wanted. Remember, I am a body-freak. One super rare quality that my big horn system with Thorens TD-124 has is that at very low SPLs it will still vibrate my chest and rumble my chair. Even at low levels you still can feel the bang of the kick-drum on your body! Try *that* on your system. With the Linn, most of this quality was missing. But, I love that transparency. The Thorens was thick and opaque by comparison.

This state of affairs gave me a high fever. I started changing and tinkering and trial and erroring till I made the Thorens transparent. I think I have excavated maybe 90% of the Linn's transparency out of the venerable old clunker. Try this: remove the aluminum platter cover and mat from the 124. Scrape off the rubber spacers from the platter itself. Next, replace these rubber spacers with dots of 'Blue-tac' and unfasten the three screws that hold the rubber mat on the platter cover. As you replace the cover on the platter, press firmly, making sure the cover is level and parallel to the heavy rotating platter. Add a gray felt Discwasher mat and reset your VTA and stylus pressure. That is all there is to it. All we are doing is changing the record/table interface. Isolating the platter cover reduced the noise floor and the felt mat imitates the Linn record platter interface which I maintain is a substantial part of the Linn sound.

While the LP-12 gives "high-Q" bass, the low bass performance of the TD-124 is a bit on the soft and wooly side — even after modification. Hence, the punchy bass of the Linn does not seem to be a result of the felt mat. In any case, the 124 with a felt mat seemed to subjectively lose a few Hz at the very bottom, but the leading edge of bass transients is clearly improved.

All in all, the Thorens shows itself to be a true contender for wannabe high end connoisseur types on a budget. I truly expect that with the addition of a high quality power supply and line voltage filtering this table could perform at the highest level. The 124 deserves the attention of some creative minds with musical souls.

reMUS

phono and line PREamplifier

Jan P. Lodstrom,
Stockholm, Sweden

A popular DIY preamplifier circuit from one of Sweden's leading tube freaks!

While we are waiting for a semiconductor good enough to match the sonic performance of the electron tube, I submit a tube-equipped preamplifier for your building pleasure. Because of its simplicity it is a reasonable project for the home constructor.

On the whole, this is a sensible circuit without frills or mysteries. It has been quite popular in Sweden among local do-it-yourselfers since the design was published in the Swedish magazine *Audio-Video* a few years ago. Builders are especially happy with the quality of the preamp for playing vinyl discs.

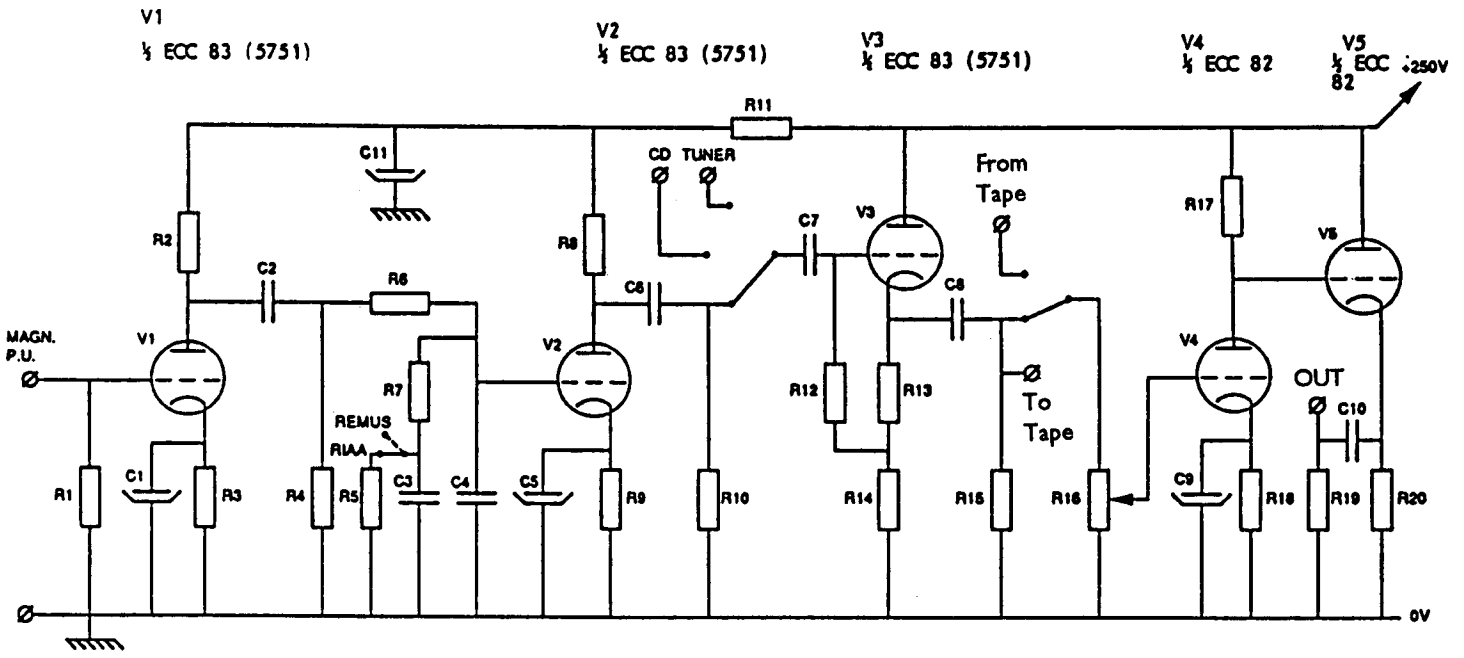
The preamp uses five tubes, each of which handles both channels. Two 12AX7s provide the phono amplification with RIAA equalization. A 12AT7 is used for an isolation stage and driver for the volume control and tape output. The line stage uses a 12AU7 as a voltage amplifier direct coupled to a 12AT7 cathode follower to provide a solid low impedance output.

The power supply is unregulated in the "official" version but some might want to employ some form of regulation. The simplest way would be shunt regulation with voltage regulator tubes such as one each OA2 and OB2 in series across the plate supply voltage. A supply voltage of about 320V would be required to ignite the tubes. Series regulation according to standard practice would also work well. The entire preamp circuit only draws about 10mA from the B+ supply.

The heaters should be fed by a DC source to minimize the risk of hum via cathode/heater leakage, especially in the input stage. Two schemes for providing DC to the heaters are pictured below. With a 10 VAC winding, C must be 10000 mF for acceptably low ripple. If you have a 12V winding on your transformer use a CRC (pi) filter where each C can be as low as 2200 mF and R would be between 5-10 ohms, 1 W. Adjust the value of R for 12V DC.

The value of the volume control can be any value between 25 K and 250 K, preferably logarithmic taper. I consider a balance control unnecessary. It is best to remove the cause of imbalance — speaker placement, unevenness of amplification in the tubes, or whatever it might be.

The better the quality of the tubes you use, the better your preamp will work. I call it the "REMUS", by the way, for "REproduced MUSic." As eager students of the specialist magazines, you probably know that there are several improved versions of the tubes used in this circuit. The industrial grade version of the ECC81/12AT7 is the 6201 and they are usually excellent. The fancy European goodies in the 12AT7 family are the E81CC and ECC801S. The latter version is especially highly recommended. The ECC82 and ECC83 have industrial numbers E82CC and so on. The US version of high quality 12AU7s are 5814A and 6189. For 12AX7, substitute 7025 or 5751.



Component values

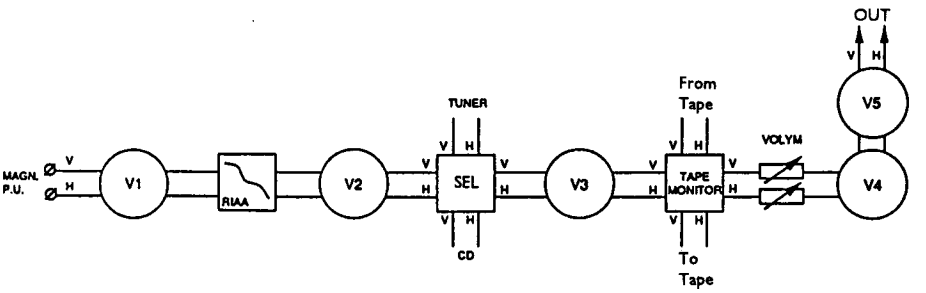
Note that only R11 and C11 are common to both channels.

R1	47 K	C1	47mF, 10V
R2	220 K	C2	0.1 mF
R3	2.2 K	C3	30 nF
R4	1 M	C4	10 nF
R5	240 K	C5	47 mF, 10V
R6	100 K	C6	33 nF
R7	10 K	C7	33 nF
R8	220 K	C8	1.5 mF, 150V
R9	2.2 K	C9	47 mF, 10V
R10	1 M	C10	3.3 mF, 150V
R11	4.7 K	C11	min 25mF, 300V
R12	470 K	* close tolerance polystyrene	
R13	560		
R14	33 K		
R15	1 M		
R16	25-250K log.taper		
R17	100 K		
R8	2.2 K		
R19	220 K		
R20	22K		

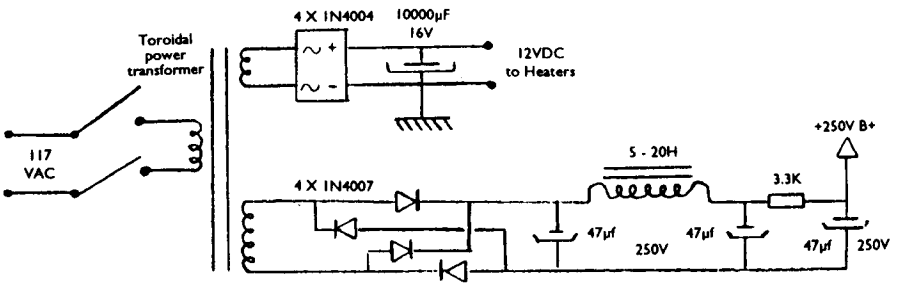
Transformer
Pri. 117V (or 220V)
Sec.1 190V 25mA
Sec.2 10V, 3A
Choke
5-20H, 10mA

The 5751 is not exactly equivalent to a 12AX7 but it is close enough and very good sounding.

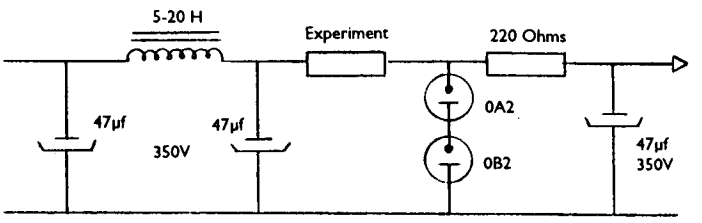
Some of you may wonder what the little switch marked REMUS-RIAA does. It is my feeling that some records benefit from a continuing rising amplitude characteristic below 40 cycles which is the normal pivot bass frequency for the RIAA curve. In the



Block Diagram of REMUS preamplifier



Power Supply



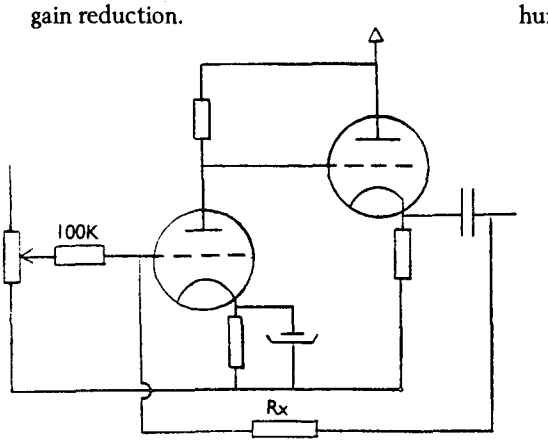
VR tube shunt regulation option

"REMUS" position, the pivot frequency is moved down to 15 c/s. In this lowest audible octave, most speaker systems have severe losses. If you have a reasonably good power amp that doesn't limit at 20 c/s, you will certainly get a boost, literally!

If you have difficulty finding a choke for the power supply, you can substitute a 470 or 500 ohm resistor for it. All resistors, except the one in the heater circuit, can be rated at one quarter watt. All non-electrolytic capacitors can be ordinary polyester or of finer quality as desired. Be sure to use polystyrene or polycarbonate capacitors of close (2% or better) tolerance in the RIAA section.

If you think the line stage is suspiciously simple, it is. Surprisingly it produces only about 0.1% THD, depending on the quality of the 12AU7. The amplification is tenfold (20 dB).

If this is too much for your needs, you might improve the situation by adding local feedback by including Rx in the line stage. Obviously, the lower the value of Rx, the lower the amplification. Typically, an amplification on the order of 4 or 5 times is what we want for line stages. Therefore, we must reduce gain by 6-8 dB. The value of Rx would be between 220-270 K. Note that a 100 K resistor is added between the wiper of the volume control and the grid of the 12AU7. Of course, noise, distortion and output impedance will be lower by an amount corresponding to the gain reduction.

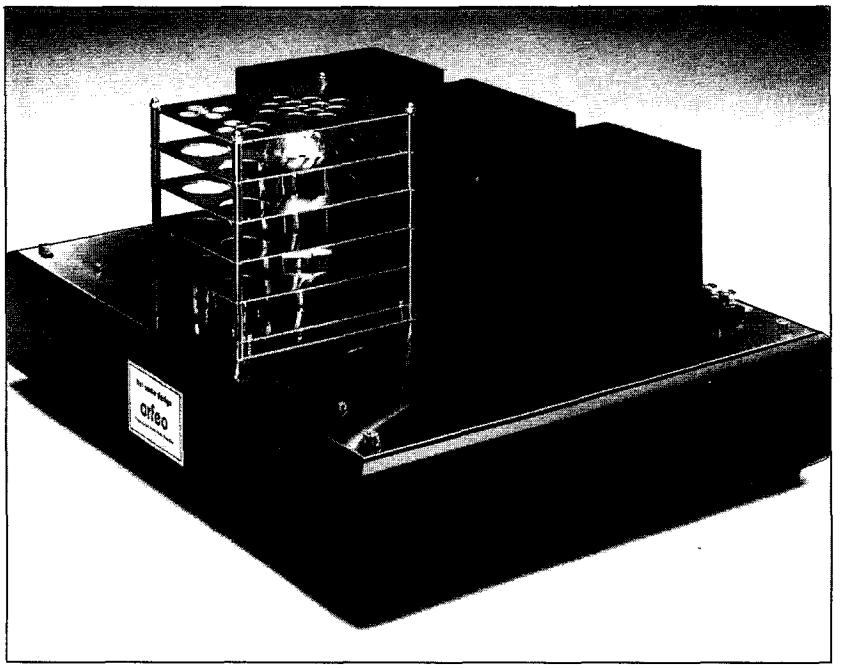


Adding feedback to reduce gain

I see that toroidal power transformers are now available in the States. Good! They are far superior to ordinary ones as far as stray magnetic fields are concerned. I can put a toroid on a chassis no longer than 10" and have no hum at all from the phono circuit at the other end of the chassis. If I can, you can too. Ordinary transformers are best located in a separate box along with all rectifiers and filter components. If only DC enters the preamplifier cabinet then how can it hum?

Build your REMUS on a metal chassis with a metal cover for proper screening. Grounding is a science all of its own. My tip; use a ground rail, about one millimeter in thickness. Connect it to the chassis *only* at the cartridge input, then connect all signal grounds to it. This is a prerequisite for hum free operation.

Hoping that I haven't come across too scientific (fat chance), I wish you all the best of luck in constructing the REMUS.



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Desperately Seeking an Efficient Speaker

by Mike LaFevre and Peter Stillwell

Now that we have these great low powered single triode amplifiers, what the heck do we do for speakers?

After *Sound Practices #1* hit the streets, the MagneQuest hotline got lots of phone calls from people interested in using our transformers in the single ended 300B "91" circuit. Most of them wanted to know whether the relatively inefficient speakers they had would work well with this "hunk of an amplifier." Will eight watts drive my LS3-5As (or my Celestion 600s, or my JPWs, or my Vandersteens, etc.)?

The sad fact is that most of these adventurous souls have speakies that are just *terribly* inefficient by single triode standards. The majority of modern speaker systems need big horsepower to really come to life. This is not a problem if you are looking at the hundreds of medium to high powered amplifiers out there. It is only since the new wave of interest in low powered amplification arose that the scarcity of highly sensitive speakers became such a hot issue.

Although many of these inquiring souls would be pleasantly surprised at what eight watts can do, I usually recommended that they acquire a set of reasonably efficient speakers before building the fabled "91" if they want to achieve the best results. The hard part was to make an honest recommendation to them. Basically, the speaker market is way behind the times in terms of what the rapidly expanding base of triode listeners need.

Of course, I could have recommended some of the vintage drivers that were revered for overall performance capabilities and their suitability with the smaller single-ended amps and sent callers to the used market. But there were a lot more callers than there are old Altec 604s or whatever. Also, vintage speaker systems are usually anything but plug and play. You often have to build a proper cabinet to house the drivers and you may have to do some experimentation and modification to get those classics to do what you want them to do.

Many people understandably don't want to hassle with the recycled audio scene, objecting to buying raw drivers or complete speaker systems that they had never seen or heard from someone they don't know. They just want to go out and buy a new, finished pair of speakers. Nothing wrong with that.

Based on a perceived public need, I suggested to the editor that we try to assemble a small number of highly efficient speakers that are currently in production for the purposes of seeing if there is anything out there will run on, say, an amplifier with under ten watts output.

Years ago, efficient speakers ruled the roost. Amps were too low powered to allow speaker manufacturers to disregard the efficiency of their products. Then we got to the fork in the road that Herb Reichert so eloquently described in *SP#1*. The speakers shrank in size (and efficiency), and power became less and less expensive.

Then new tubes like the KT-88 and 6550 increased the power output of pentode amplifiers by 50%. The amplifier horsepower race was on and power handling displaced high sensitivity as the prime engineering challenge in loudspeaker design.

Now, we may have passed the peak of the horsepower race in amplifier design as some audiophiles are beginning to realize that less is more. Unfortunately, the result of decades of the bigger-amp-is-better mentality is that there are no contenders in the home speaker market that produce modern rivals of the beloved efficient speakers of yore: 604, 755, VOT, Paragon, Metregon, etc.

Actually, it should be possible to produce something just as efficient and much better than the aforementioned classics for audiophile applications in the average listening room. There are some very promising modern materials out there — horn tweeters and midranges with neodymium magnets, anyone? The art of speaker cabinetry has certainly come a long way since big Altec and JBL systems ruled the Earth.

I'm now a bit bemused that single-ended amplifiers are in the process of being "mainstreamed" by the high audio priests. The confessional booths at the audio temples are now jam packed. Editors and writers proclaim that they have seen the sin of their ways. Don't forget that just a fortnight ago, these same gurus held forth with utter disdain and disbelief that some kooky Japanese audiophiles might love three watt amplifiers with "antique" speakers. But the high end has gone full circle before.

In the meantime, there are a lot of disheartened ex-audiophiles out there sipping a Bud in front of their 52" color screens and groovin' to the hi-fi stereosonics of Top Gun. Who can blame them? There is no shortage of hype in this business and some of it has led in counterproductive directions.

For instance, the local tweak hi-fi industry has for decades completely ignored most of America's premier loudspeaker manufacturers. Companies like JBL, Gauss, Electro-voice, Altec, Jensen, Stephens and a few others that I've missed. All are or were manufacturers of solid, honest high grade equipment, much of which is very popular among overseas audiophiles. These companies, if they survived, flourished in markets other than hi fi, such as the pro-sound or sound-reinforcement fields. Thank God for all the gymnasiums.

There were survivors in other parts of the world: Lowther and Vitavox in England, TAD (a division of Pioneer...oops! not high end, sorry) from Japan. Additionally, there are some small companies and individuals in the U.S. and elsewhere that are committed to high-quality, high-efficiency drivers and speakers. In the U.S., Dr. Bruce Edgar is believed by many to really be at the cutting edge. Too bad he has been totally ignored by the high priests for so many years. Another fellow in Japan handbuilds really cool field coil speakers, at a reported cost of $2,500 each. This guy must be the ultimate craftsman — kudos!

Where does this leave us 40 years after the horsepower race began? Are there any speakers left in the marketplace that are efficient and worthy of consideration? To get our audition rolling, we secured four different sets of loudspeakers, all of which were appropriate for use with itsy-bitsy power amps.

The rules governing selection were simple: the speakers had to be currently manufactured in finished form (no kits this time around, folks); cost less than $2,000 a pair; and have good prospects for being favorably reviewed. It would also be a plus if two of us together could lift the speaker.

The field was narrowed from a list of 40+ speakers with efficiencies of 95 dB or higher, as identified through *Audio's* Annual Equipment Directory, to the following four products:

1 - **Audio Note AN-E:** A high-efficiency two way box speaker with an 8" paper cone woofer and a soft dome tweeter in a ported enclosure. Used by the manufacturer to demonstrate amps costing more than some small aircraft, so we figured it was worth a listen. We got the copper wired version, not the upscale silver-wired version.

2 - **pipe dream:** A Focal 7-incher in a tapered pipe enclosure, conceived by J.C. Morrison, noted Downtown guerrilla audio designer. Available from Fi in NYC as a custom-order product.

3 - **Klipsch Heresy** & 4 - **Klipsch La Scala** They might not be popular with snooty audio journalists but Klipsch never abandoned the quest for high efficiency. Let's give credit where it is due.

Our esteemed panel included a small core group of three or four people plus whoever else we could round up for a listen or two. The luminaries included my audio soulmate Jimmy Dobbs, who really hates "toy amps" and efficient speakers; Scott Stillwell, renowned speaker archeologist; his brother, Petey, who grooves on Porsches and Guzzi racing machines; Johnny Z, an accomplished luthier; Dr. Krause, a passionate audio explorer; and Jim Novak, crazed audiophile and amp builder. We were even blessed with the presence of the elusive editor of this publication at our first speaker-feast. And speaking of feasts, many thanks to Scott and Rosemary for the refreshments and warm environs in which to do our work.

We thought it was important to include a few highly experienced audiophiles with little or no direct experience of low-powered amps for balance and a touch of objectivity.

This "audition" was not set up as an official quasi-scientific review. We didn't even have a control system. Instead, we listened to a wide range of amplifiers and preamps always trying to keep things equal. For instance, when we played Mark Lyons' homespun 300B single ended, we made sure that we played it on all the speakers. What we were after was not an absolutely definitive in-depth analysis complete with a listing of all the sources and associated equipment employed. Rather, we wanted to gather impressions about the speakers that we might be able to pass on to the reader interested in the general issue of low-power applications. For additional insight, participants were encouraged to take a pair of speakers home with them to audition more carefully with equipment they knew well.

Klipsch La Scala

So let's let the cat out of the bag. After our first "group" meeting, I asked everyone which of the speakers they enjoyed the most. Which would you like to take home with you? The unanimous favorite was the Klipsch *La Scala.*

Frankly, we were all surprised. We too had fallen victim to the folklore and false stereotyping that the big Klipsches would suffer from driver-to-driver discontinuity and "horniness" (also referred to as "honkiness"). After nearly seven hours of auditions on the first day, the *La Scalas* were everyone's first choice. And each time — every time — after that, at all our meetings, no matter the size, no matter who participated, the consensus remained: the *La Scalas* brought home the gold.

The *La Scalas* played with a sense of ease, composure, and grandeur that had two local *TAS*-subscribing audiophile club members picking their jaws up from the floor. Just put Mercury's CD of "Also Sprach Zarathustra" on the smallest amp in the house (in this case, a two-watt, type 45, direct-coupled single ended designed and built by Gordon Rankin) and help your dearest friends through their ecstatic recovery. The *La Scalas* played this demanding piece with the utmost grace, control, and verve. Ever hear a two watter slam on a *La Scala?*

I'm sure you're all thinking that Mikey has finally gone off the deep end, so this would be a good time to call on another member of our elite group of auditioners to report our findings.

Again, we can't claim that these are scientific results derived under perfectly controlled circumstances. But they are accurate, at least to our ears. With that behind us, let me pass the gauntlet to Peter Stillwell, who was organized enough to take notes while the rest of us were busy munching on snacks and catching smokes out on the patio...

Listing at almost $2,000 a pair, the Klipsch *La Scalas* are the most expensive, beefiest (at 123 lbs. apiece) and efficient (at 104 dB) entries in our survey. Excellently finished in black, the *LS* are reasonably grand in physical proportions, measuring 35½"H X 23¾"W X 24½"D.

A three-way, horn-loaded system, the *La Scala* employs a 15" woofer and mid and high horns with all wiring easily accessed via the open crossover. The cabinet is somewhat resonant due to the large surface, despite overall high build quality with most joints being glued and screwed. They are highly placement-sensitive. We settled on placing them as "near cornerhorns", which gave "rock-solid imaging anywhere in the room" and softened a slight forwardness in the horns.

Everyone agreed that the *La Scalas* sound "large, open and effortless" and deliver a "movie theater-like recreation." Detailing and imaging are, with proper placement, extremely accurate, making the *LS* evocative of actually "being there". We had some concerns about time alignment of the tweeter and potential megaphonesque "horn honkiness" which turned out to be totally unfounded.

La Scala!

The *La Scala* worked with a variety of material, ranging from Bach to rock. The bass response is the only area of some controversy. Scott thought that the bass was open, akin to an Altec VOT sound, whereas John Z and Jimmy Dobbs preferred the more controlled, "tighter" bass of the Heresy. This likely stems from the larger, more resonant cabinet of the big Klipsch. Scott opined that, of all the speakers, "The big Klipsch are the most livable." Mike said, "These *La Scalas* free you from the power monkey. You could take a walkman with fresh batteries and run 'em!" These speakers allow you to pick an amplifier based on its inherent sonic beauty, without regard for power specifications.

Klipsch Heresy

Klipsch *Heresy*, at a retail of $800 the pair, give the most bang for your buck. They are 96 dB efficient. "Not efficient enough for the pee-wee single ended amps, you really need 100 plus dB efficiency for the two- to five-watt amps," according to Mike. But there's plenty of oomph on the 300B based amps for all but the most cavernous listening rooms. The *Heresy* drivers, 12" woofer, mid and high horns, are packed tightly into attractive, oak-finished cabinets with wedge shaped stands. The factory stands are inadequate and, based on our experiments, not high enough. The horns really need to be at ear level. Placed about two feet from each wall in a corner on tall spiked stands, they provide detailed and room-filling sound.

John Z preferred the *Heresy:* "Bass response is more slamming, the detail on the upper end is good, maybe even better than the *La Scala.*" We agreed that they didn't sound as open, refined, or airy as the *La Scala*, but opinions varied regarding the top end. I found the Heresy to be a little too hot, "in my face" and a little ragged in the midrange. Damping the horns might have a civilizing effect but we didn't want to go wild with loaned speakers.

These same "rough" qualities, however, made them the best rock 'n' roll speakers of the bunch. For example, they seemed totally "at home" on well-produced Clapton material. Indeed, the *Heresies* are very involving. Like dating a very sexy, aggressive and cerebral college woman: exciting, but in need of a little maturational claying and crossover work.

Audio Note

The Audio Note *AN-E*, built in Great Britain, list for $1,500 per pair and are 93 dB efficient. They are "traditional" in appearance with oak finish and black grill cloth. A nice, simple two-way speaker, the *AN* crossover is very good. The smoothness of transition from the 1" dome tweeter to the 8" woofer is impressive. One listener noted that "you pick up some notes throughout the range that are represented more truly" than with the horns. The bass is rich but undifferentiated, lacking distinct reproduction of various notes on some jazz material.

Imaging and detailing are accurate and natural sounding, but the *AN-E* sound stage, although deep, lacks the big presentation of the *La Scala*. This "smooth, creamy, nice" sound would doubtless appeal to many but left our panel of inebriated hedonists feeling "emotionally uninvolved."

We found the *AN-E* to be very sensitive to placement relative to the floor and walls and somewhat picky about amps and cables. We also found that the *AN-E* worked much better with an eight watt 300B SE than with the flea-power single 45 amp. Overall, it is a speaker that will benefit from the kind of careful system matching and setup that we were unable to furnish in the context of our auditioning session.

The *AN-E* provides a quietly satisfying, natural, and cerebral sound one can live with. But in the end, it's the sort of sound that leaves you longing for a weekend tryst with the brazen *Heresy*.

Morrison Pipe Dream

The *pipe dream* is a tapered pipe using a single Focal 7V313 per side. J.C. designed these as *midrange* speakers to be used from 100 Hz to 10 KHz in conjunction with a woofer and tweeter. A number of independent-minded listeners have taken to listening to them as stand-alone full range transducers. Don Garber at *Fi* loves them and he uses them as stand-alones in his home system with a 2A3 SE amp. A few of our contacts in the NY area recommended them highly so we got a pair in for the listening session.

The *pipe dream* resides in 7"W X 12"D X 44"H cabinets superbly crafted in relatively thin Baltic birch plywood. The speaker is mounted at the top of the tower-like cabinet, giving the whole assembly a high center of gravity. A "zobel network" tames the powerful 7" Focal driver — probably the most expensive raw driver tested here. They are visually engaging and cost $1,200 a pair.

These single-driver speakers are descended from a proud tradition: many purists single cone full range speakers such as Lowther, Hartley, and WE 755. Comparisons with the legendary WE 755 are expected, but both drivers suffer many of the same flaws. That doesn't mean that they are unlovable, just that it takes someone special to overlook the lack of top and bottom end in full range service in appreciation of other satisfying sonic qualities.

In fairness, it should be mentioned that neither the Audio Notes nor the *pipe dream* are the kind of speakers that will wow a roomful of well-fed audiophiles after they have been blasting Klipsch *La Scalas* for a couple of hours. The *pipe dream* is a subtle, intimate kind of speaker that excels in smoothness, coherence, and other "low profile" performance criteria. This is true also of the *AN-E*. They are both competent at what they set out to do, but they ain't horns and they don't have the kind of "slam and dazzle" that goes over big for a crowd of rowdy audiophiles primed to rock and roll.

Conclusion

Our little band of speaker reviewers listened intently to four pairs of loudspeakers during several sessions over several months' time. In the end and with this parting breath, I turn to my philosophical training. Want to call this a speaker review? Sure, go ahead. But we don't pretend to dictate purchasing policy here.

The best speaker to use with your single ended? We're still looking. Keep your ears open and your preconceived notions (probably acquired in hand-me-down fashion) under tight rein.

Could there be other modern-day treasures out there? Of course, two great classics are still available. First there are the famous Klipschorns at about $4,000 a pair. A quick thought experiment: how much higher in price would the Klipschorns be if they were made by some yuppie-driven "high-end" company? If you like them, get them while they're still available at this great price. And don't forget that Altec still offers the VOT in assembled form for a mere $4,300. Audition these: the new 515s are reputed to be better than their vintage counterparts by many. Don't get sucked into the religion of pure nostalgia practiced by some antiqueophiles. Use your ears and your own aesthetic judgment and share your thoughts, impressions, and findings with us through *Sound Practices.*

Some 40 years ago, Paul Klipsch argued that what the world needed was a good five-watt amp. Nowadays, my sense is that what the world needs are more great speakers to choose from optimized for the current generation of single ended amps. In the meantime, we advise you to test drive some high-efficiency speakers for yourself.

Editor's note: "Mike, this article makes it sound like you think the *La Scala*s are the best speakers in the world."

"Well, they're way better than we thought they would be and it could be one of the best $2000 speakers in the world — for single-endeds, anyway. If some yuppie high end company was making these they would cost $10,000 a pair."

Mike, ever the man of the people, owner of a two watt single 45 amp, adopted a pair of *La Scalas* for his home system. He reports good results with unauthorized tweaks like plasticlay damping on the midrange and tweeter horns and removing the protective circuitry, no longer needed with his three watt amplifier. Mike heard that a major improvement can be had by locating the crossover in an outboard box and filling the cavity holding the midrange and tweeter with sand. He thinks the Klipsch has great untapped tweak potential.

Although the *La Scala* did sound surprisingly good, part of that may have been the weight of old stereotypes falling. Even a horn lover like me didn't expect a middle of the line *Klipsch* to sound so convincing. As for their performance, with solid state gear or anything besides small triode amps, who knows? Maybe there are good sonic reasons after all as to why Klipsch speakers fell from grace sometime back in the Seventies. A pair of *La Scalas* on a GAS Son Of Ampzilla *might* provide the most painful experience you ever had.

Aside from the fact that the most popular speaker in this modest survey was a decades old design that is wrongly maligned by audiophile snobs, what struck me most about this project is how few contenders there are out there. I'd like to see a dozen competitors for the *La Scala* in terms of price *and* performance.

I can't understand why ambitious speaker designers aren't rushing to market with new and exciting high-efficiency designs. After all, business in triode amps is reported to be quite healthy and the resulting unmet demand for efficient speakers holds great opportunities for fast-moving, forward thinking loudspeaker manufacturers. Even in the experimenter underground, where manufacturing economics and practicality aren't the main drivers, progress in speakers lags developments in electronics by a large margin. Let's get on the stick and come up with some speakers!

Manufacturers' Comments

pipe dream

Fairly accurate review. I never did care much for Canal Street boom and sizzle anyway. However, I did get an irate late-night call from a usually friendly neighbor not long ago threatening to call the police. Bach organ music — it's not called the *pipe dream* for nothing — powered by the above mentioned 2A3. There are a couple of changes from the review model though. The Zobel filter is out. And there's considerably less stuffing — just enough to contain the back wave bounce. I was thinking to myself that that it was sounding a bit proper with the mods and then a certain party dubbed them the "Christian Temperance Monitors." Now they're back to their original state. George Jones sounds like there's sour mash in his veins and the opening shots of Beethoven's 7th are right there in my living room.

Don Garber, *Fi*

Klipsch

Over the better part of the last two decades, I've had the opportunity to listen to a multitude of hi fi systems, a lot of them using Klipsch loudspeakers, including my own. People are funny about Klipsch. It seems everyone has strong opinions about Klipsch. Why is this?

Over the years, I've developed some highly unscientific but usually repeatable conclusions about who likes Klipsch and who doesn't. If we rank people from 1 through 10 based on their knowledge, love, and interest in music and hi fi equipment, Klipsch does very vell with the ones through sevens, poorly with the eights and nines, and then great with the tens. Let me explain.

Ones through Sevens: These are the folks who are not highly schooled in the art and science of audio equipment. They might be normal people who only listen to AM radio in the car or they might be world class musicians. All they know is what they hear and Klipsch sounds good to them. They are not educated in the black arts of hi fi. They don't know the jargon associated with our stuff and they neither know nor care what soundstaging, depth of image, detail, or the big A, Accuracy, are. They just know that a guitar sounds like a guitar, or a piano sounds like a piano. It just simply sounds right.

Eights and Nines: These guys (I'm not being sexist, most of the eights and nines *are* males) are the troublemakers for Klipsch. We should all remember the fable of the Emperor's New Clothes. This is the one where the head guy was sold a bill of goods by his tailor, who led the Emperor to believe that he had those really hip new set of "threads," when in reality he was sportin' nothin but his own base level equipment. It took a purely honest voice (a child) to point out the truth and the Emperor became the laughing stock of the Empire.

This fable reminds me of this group of hi fi devotees that I refer to as "audio lemmings." They know just enough to be dangerous. Most of them read the audio periodicals, some of them work at audio stores. The trouble happens when they begin to read (and believe) advertising or, even worse yet, reviews of products. They go on to discuss the merits of particular products among themselves, often hever having heard the product in question. This hearsay evidence has killed many fine audio products in our lifetimes. Klipsch is often a victim of these sometimes accidentally ruthless characters.

Tens: Once again, Klipsch falls back in favor with these folks, who tend to be truly educated individuals. Engineers, designers, and others with a true appreciation and often passion for the concepts encoded in Klipsch design philosophy. They may or may not personally like the sound put forth by a Klipsch speaker (which doesn't really matter, by the way) but they respect the product for attempting to attain a stated reputable design goal, based on and designed to work within the laws of physics.

In summary, my opinion on evaluating speaker systems or any other component is very simple: *Listen to it*, preferably in your system, in your listening room. a.) If it sounds good to YOU, that means it is good for you and your system. It means nothing else; b.) If it does not sound good to YOU, don't put it in your system. It means nothing else.

This may seem overly simple and maybe it is, but I think this attitude toward "evaluating" audio components is much more sound than investing in a piece of equipment based on someone else's ears, system, room, and subjective opinions.

Mike Dyer,
Klipsch and Associates

Audio Note
Thank you for this interesting listening survey. I am pleased to note that your listeners found that the *AN-E* had a very "true" sound within certain ranges. The main design goal of the *AN-E* was to provide a quality high efficiency speaker at a reasonable price. It is our experience that they certainly do benefit from careful system matching and setup, but this is true of many, perhaps most, loudspeakers.

I am not surprised that your panel found the horns more *impressive*. A good horn system can give any dynamic speaker a difficult mark to beat in certain areas. What is needed here is a discussion of technology, manufacturing economics, and current trends in the loudspeaker market. I feel that we are at a crossroads right now with many interesting prospects for the future. I propose to write an essay of several thousand words on the subject. Is there time and space?

Peter Qvortrup
Audio Note,UK

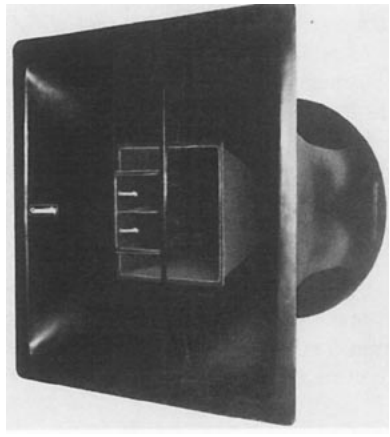
ed.— Whoa! I know this is your favorite topic but the essay will have to wait for #6. Anyway, we're just getting started with this discussion.

Contemporary Pro Horn Systems — interesting, huh?

One theme which frequently emerges in discussions of high efficiency speakers is professional audio. Back when relatively small amps were the way it was in hi-fi, there was considerable overlap between the professional market and the top end of home audio loudspeaker markets. The same JBL, EV, and Altec components used in furniture cabinets were installed in utility cabinets for commercial installations. A good speaker back then was a good speaker — for home, theater, *or* gymnasium use.

Somewhere along the line, audiophiles and audiophile loudspeaker manufacturers decided that they were doing something different from, loftier than, and totally incompatible with the pro sound market. Pros think audiophile gear is wimpy while many audiophiles consider pro gear to be durable but unrefined. In some cases, these assertions are true but solid build, reliability, and the "professional" label do not necessarily exclude audiophile-grade performance.

COMMUNITY LEVIATHAN II



Imagine. . . an enormous listening room with a built in loading dock. . . a trailer backs up and a union crew offloads the amazing *Leviathan II* from Community Light and Sound, Inc. WOW! A pair of these six-foot square triaxes powered by a couple pairs of nice 300B amps, wouldn't that be special? At 108 dB 1m/1W, low power is not an issue!

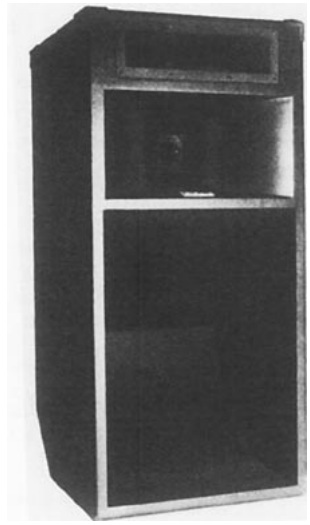
The low end of this modest horn system consists of six 15-inch low frequency drivers coupled to a colossal sandwich-core fiberglass horn. The mouth of the LF horn is 72" by 72" with a flare rate of 32 Hz. A Community M4 driver works into a PC1452M horn between 250-1200 Hz and a pair of Community's newly developed MH 2.8 carbon fiber diaphragm HF drivers coupled to a PC464 horn handle the top end.

Overall, the unit measures 84" deep. The sensitivity of the system is 108 dB 1W/1M and it is rated for a maximum continuous level of 136 dB! Power handling capability is 1200 W continuous/ 2400 W program, so you won't blow them out with your 300B amps. Price TBA, but figure on spending all of the change you saved up for that Wilson WATT/Puppy system!

Sure, a lot of pro electronics is deservedly suspect from the viewpoint of the kind of listener who would have a small tube amp in the rack. However, many serious audiophiles in the US and abroad use pro loudspeakers in their home systems. You just wouldn't know about it from reading *Stereophile*. In Japan and Europe, quality pro speakers from makers like TAD, Gauss, Vitavox and, yes, Altec and JBL, are highly popular among top audiomaniacs. One reason you don't see more is that this stuff ain't cheap. You could get a very decent pair of small speakers for the price of a pair of TAD tweeters. Even for upper rank audiophile speakers, the costs of using some of the better pro parts would be prohibitive.

With the current resurgence of interest in horn loudspeakers for home use maybe it would be worthwhile to raid the contemporary professional market for good parts, useful insights, and inspiration. Let's look beyond the old classics like the Altec VOTs (which are far from perfect for hi-fi in stock configuration) and discover what progress has been made in pro speakers over the last few decades. No doubt there are some very worthy contenders out there among high end 'working' speakers. Here are a few to ponder.

EASTERN ACOUSTICS WORKS CF-350



This classic three way horn system is still available on special order from Eastern Acoustics Works in Framingham, MA. It uses a 15" cone in a wooden bent bass horn, a cone-driven mid horn outfitted with a phase plug from 350-3500 Hz, and a N481 1" compression driver tweeter on a constant horizontal horn. Sensitivity is rated at the promising figure of 105 dB/ 1W@1m and it is capable of 130 dB max output. Measuring a manageable 22.5 W X 48.5 H X 23.75 D, the CF-350 will easily fit in the space vacated by your IRS V.

Our pro sound guru says "Very natural mids, sweet extended highs, and tight moderately extended bass. Worth checking out." Costs less than a pair of B&W 801s or current production Quad ESLs with the advantage that you can rent them out for weekend sound reinforcement jobs!

SINGLE-ENDED AMPLIFIERS, FEEDBACK AND HORNS: SOME HISTORY

by Dr. Tom Hodgson

I was intrigued by the article on the WE 300B single-ended (SE) amplifier in *SP* #1. Your list of pros and cons for SE versus push-pull (PP) led me to reconsider why SE might be better, particularly with regard to the operation of the output tube into the output transformer (OT) and the value of the resulting voltage distortion. This is worst at low frequencies where the OT primary inductance is usually lowest.

I am a committed tube "freak", never having found musical satisfaction from transistors, for reasons as yet unexplained. My gut feeling on SE, at first, was that a SE output tube and OT ought to be more linear than a PP design. Since the OT carries DC current in the SE case, the silicon-iron core must be air-gapped to prevent saturation. Typical measured BH curves with sinusoidal voltage drive for a) an ungapped and b) an air-gapped OT are shown in Fig. 1a, b.

Note that the magnetization force H axis is ten times bigger for the ungapped case. Modern OT iron saturates at a flux density B of order 18 kilogauss, so if the tube DC current "biases" the iron to 8-10 kilogauss and the music signal swings +/- 3 kilogauss, then it is obvious that the SE design must be more linear, all very simple! Now OT design and the physics of magnetization are not for the faint-hearted. That which follows is by no means an OT design thesis. But I needed further insight into my simple view of SE.

Having grown up in England through WWII and the ensuing golden era of British tube design and recording practices, I turned to searching the pages of the *Wireless World* magazine starting with the year 1920 onwards. It was, at first, a weekly publication. I was an avid reader from WWII on, when it became a monthly periodical. A bonus of such a search was that I might perhaps trace the history of SE and PP and the ensuing use of negative feedback with chronological correctness.

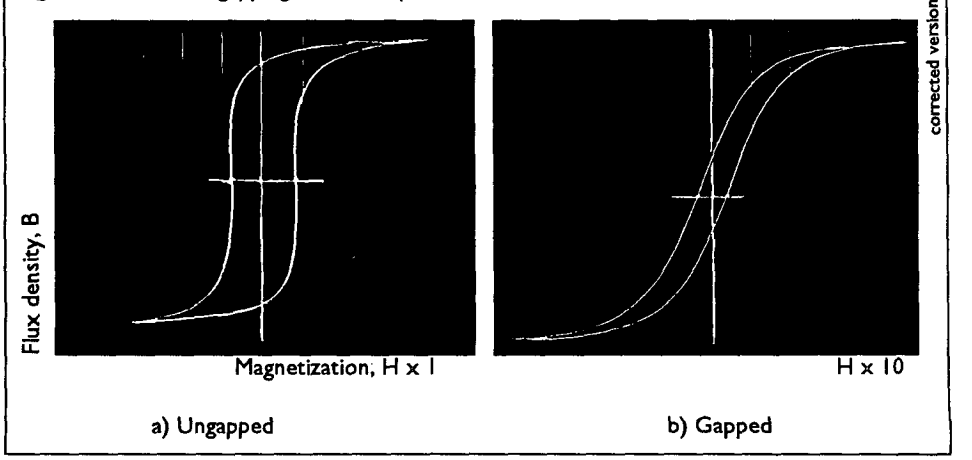
The first constructional article for a quality 4W PP amplifier using a pair of PX4 triodes appeared in the May 11, 1934 issue authored by W. I. Cocking, subtitled "Constructing Distortionless Equipment". The PX4 was a Marconi triode of 2.5W output in SE class A and cost $4 (which was about one-third of the then weekly working wage). The more powerful DA60 12W triode cost $20. I was quite surprised by this article since during the 'thirties the *Wireless World* mainly covered SE radio-receiver output stages and a few transformer winding articles with no mention of air-gaps, although M. G. Scroggie of Mullard gave a graphical method for choke design in the June 1, 1932 issue based on the 1927 Hanna method. However, I discovered the mother lode in the June 22 and 29, July 6 and 13, 1939 issues, namely the article "Distortion in Transformer Cores" by Dr. N. Partridge. This article and his more academic 1942 version in the British Inst. of Radio Engineers are both referenced in the *Radiotron Designer's Handbook, 4th ed.* I learned that Partridge's work appears in most subsequent transformer texts, for example, Sturley's *Radio Receiver Design*, Vol. II (the only text I know that actually designs an SE OT) and the modern day Grossners' *Transformers for Electronic Circuits.* The latter should be easily accessible.

Partridge used both theoretical and experimental analyses to calculate transformer distortion. The output tube may be viewed as an AC voltage source, E, with source resistance Rp driving current, I, into the primary inductance, Lp. (The winding resistance R_{DC} could be included in series with Rp). The loaded transformer would have a load R_0 reflected into the primary circuit from the secondary, see fig. 2.

Before one can easily see why this circuit can produce voltage distortion it is necessary to view the BH loop in more detail. When a sinusoidal voltage is applied to a silicon-iron OT core the resulting hysteresis loop is as in fig. 3.

The sinusoidal distortionless voltage source E drives the current through the source resistance Rp into the impedance Z of the primary inductance Lp. The flux Φ = (flux density B) x (core area A), and B is determined from the BH curve for a given magnetizing force $H = 0.4\pi NI/l$, where N is the number of primary turns and l is the length of the iron magnetic path. It is crucial to think in terms of H or the amp turns NI first rather than B. The unloaded secondary voltage is proportional to the time rate of change of the flux, Φ. Note, however, that $B = \Phi/A$ is a very nonlinear function of H. The core saturates at a value designated B_{max} and also there are two values of B for a

Fig. 1 - Effect of air-gapping on BH loop



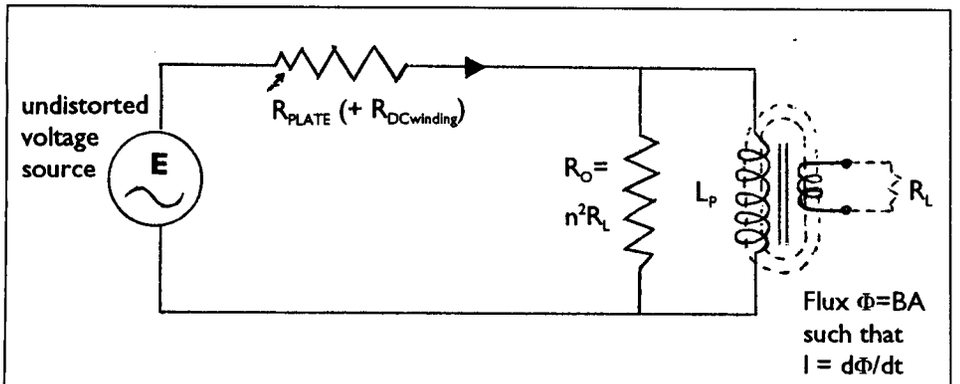


Fig. 2 — Simplified model of output transformer, referred to the primary as analysed by Partridge. Note that L depends on E, and I, and H, and B, and thus μ !

given current I or H, depending on whether the sine wave is increasing or decreasing. If there is a small sinusoidal ripple in the positive peak, say, of the sine-wave it will produce a so-called minor loop in the BH curve, see again fig. 3.

How, historically, have scientists coped with this very difficult problem of determining B? Even the great acoustician Lord Rayleigh in 1886 looked at this problem. He approximated the loop by the dotted curve, using two back-to-back parabolae. More simply, if the dotted curve is assumed to be a straight line through the origin, we have the so-called quasi-linear magnetics. The relation between B and H is written B = μH, with μ called the permeability of the OT iron. For the quasi-linear case it is constant, being the slope B/H of the line (until saturation). Actually, as fig. 3 shows, it depends on I, and H, and B.

Like most transformer texts, I have delayed giving a formula for the inductance Lp. It can be written $L = 0.4\pi NI = 0.4\pi N^2A\mu/l \times 10^8$ (cgs units), but note that the difficulty of the non-linearity is disguised. What is the value of μ for the iron, and so the value of Lp? In the absence of DC current, μ might be 2000 as compared with μ = 1 for air. This explains why the BH curve tilts over to the right so much in fig. 1b, its slope μ = B/H is relatively smaller. The magnetic "resistance" or reluctance to flux crossing the air gap is high, so that the magnetizing force or (DC) current must be higher to drive the flux across the gap.

With the above background one can now understand Partridge's elegant description of OT distortion. The driving current, I, produces a flux Φ, and hence a voltage across the primary inductance Lp (and secondary) which varies with I (or H), with μ also varying. So I is distorted, B is distorted as well as the output secondary voltage, and the voltage across Rp will be distorted by an amount opposite in sign to that across Lp (remember the voltage source is taken as distortionless). Because the BH curve is symmetrical about the H axis, the harmonics (h) will be odd multiples of the fundamental source frequency (f). Partridge measured these distortion current ratios I_h/I_f and called them the current distortion factor pertinent to the particular iron used, in his case 3½% Silicon-Iron, and varying with B, or I, or H. He plotted it against B_{peak}, see fig. 4. He called this "intrinsic" distortion because it depended on the OT, its iron, and B.

He also showed that these measurements would also closely describe the loaded OT if the secondary load resistance is reflected into the primary circuit multiplied by the turns ratio squared = R_0, see fig. 2. The distorted resistive part of the voltage distortion now appears across Rp and R_0 in parallel, = R'.

His final result is that: % harmonic voltage distortion = $\left(\frac{Ih}{If}\right).\left(\frac{R'}{Xp}\right)$ where Xp is the impedance of the primary inductance at the fundamental frequency f (=2πfLp). Partridge expanded on this formula in his 1942 papers, but my simpler interpretation follows his 1939 articles.

Let's take a simple PP example similar to one taken by Partridge to demonstrate this result. Say a 2 x KT66 pentode stage is

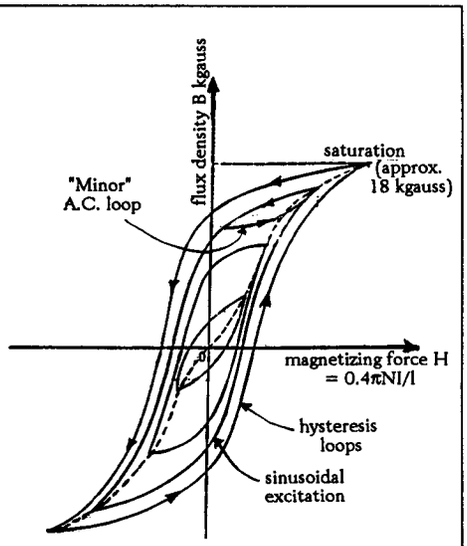


Fig.3 — The BH curve for OT iron

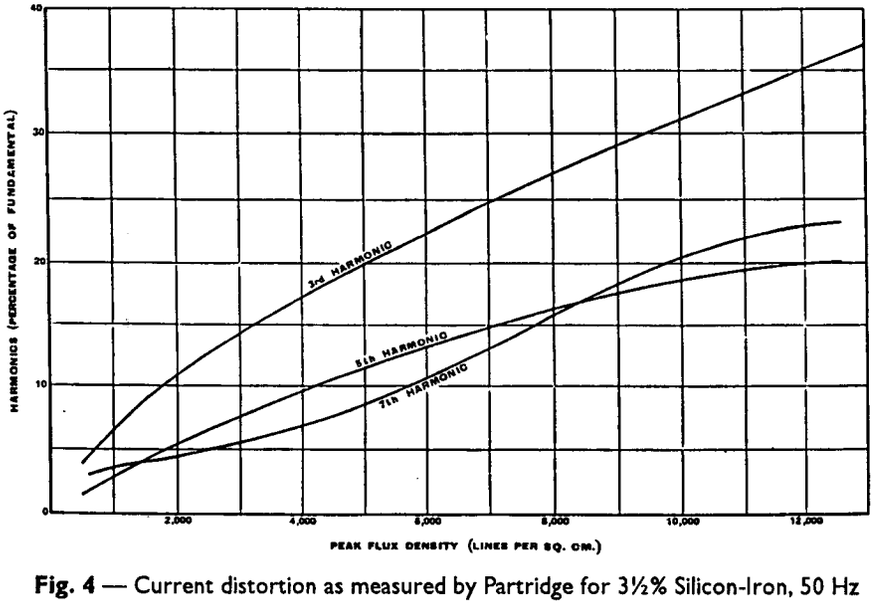


Fig. 4 — Current distortion as measured by Partridge for 3½% Silicon-Iron, 50 Hz

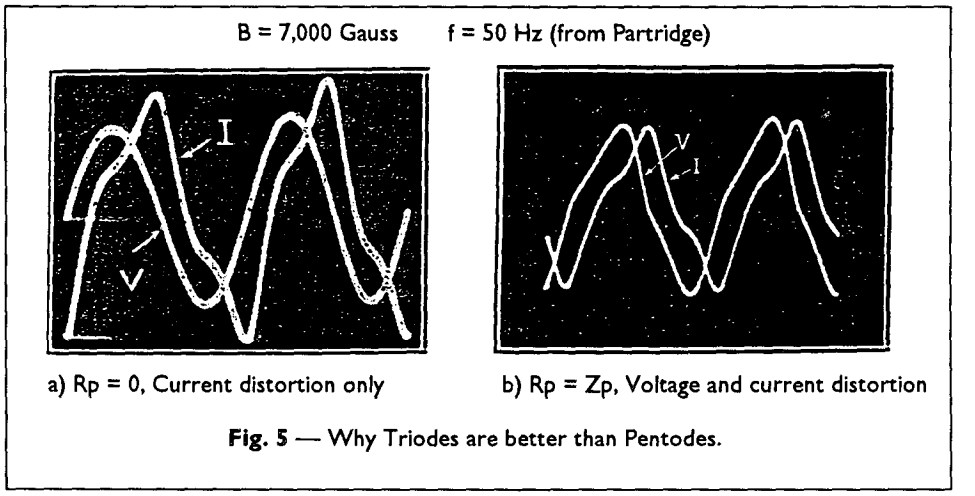
used, with 2Rp = 50k ohms and plate to plate load resistance of 5k ohms. If B_{peak} = 3000 lines/cm^2 (gauss) at full output and the impedance of the primary OT inductance is 20k ohms at f = 50Hz, then from fig. 4 the third harmonic current distortion is 14%, giving a voltage distortion = (14%) x $\frac{5kohms}{20kohms}$ = 3.5% in the absence of feedback. The advantage of triodes over pentodes is immediately seen from Partridge's equations. Say one used WE 300Bs and also the same OT is used (an oversimplified approach). A WE 300B has Rp = 700 ohms, so voltage distortion is (14%) x $\frac{2x700}{20kohms}$ = 1% ! in the absence of feedback. This, I feel, is a most revealing calculation in favor of triode output stages.

Partridge demonstrated this point elegantly with experimental measurements. If Rp = 0 there is no voltage distortion, see fig. 5a ! A typical current and distorted voltage for Rp $\neq$ 0 is shown in fig. 5b.

To me, the interesting part of Partridge's work now appeared in his fourth weekly article. He advocated the use of large air-gaps in OTs for PP designs (I calculated some 5 mils, besides the usual 1-2 mils inherently present in EI laminated cores). Now this is precisely the procedure for coping with the skewed BH loop resulting from the DC current present and loss of primary inductance in the SE case, read on.

Now what does an air-gap, size a, do? A simple view is to think in terms of H or amp-turns/inch. Then the total magnetizing force or amp-turns to maintain the flux is H_{total} (l + a) = H_{iron} l + H_{air}a, where H_{air} = numerical value of B since μ = 1 for air. The iron is still working at the same condition as before, so the distorted current I_h is the same. But now H_{total}, and so I_f is much larger, say 4 to 5 times. So the current distortion I_h/I_f has dropped by this factor. But, regrettably, as the BH curve has tilted, see fig. 1b, so has the effective permeability (known as the AC incremental permeability $\Delta \mu$) dropped by the same amount. So the value of $2\pi fLp$ = Zp has dropped by this same amount also, as has R_0/Xp! So the voltage distortion is the same!! I call this fact that Partridge pursued air gaps, even though he knew that voltage distortion does not change with air gapping, the Partridge Paradox, and is the reason why I wrote this note.

Partridge saw this result as no great disaster, believing it was better to know you had an "intrinsically" more linear OT. Now one adjusted R_0/Xp, accordingly, presumably choosing triode output tubes as well as winding big OTs within the restraints of HF response. (Remember that at that time 15 KHz was regarded as adequate for musical reproduction and I detect from certain *SP* articles that some still believe this to be the case!) So his final PP OT was wound with far more primary inductance than necessary for good LF response before gapping.



a) Rp = 0, Current distortion only

b) Rp = Zp, Voltage and current distortion

Fig. 5 — Why Triodes are better than Pentodes.

The same is true of course for the SE OT with unbalanced DC present. Thus, *for a given OT*, SE operation does not straightforwardly reduce the voltage distortion. There is an additional complication in that the BH loop is now a minor loop (like in fig. 3) around the DC bias point, which is taken around a flux density on the order of 8 to 10 kilogauss. The slope of the minor loop is the average incremental permeability $\Delta \mu$) and depends on the air gap. So there is an optimum air gap size for maximum primary inductance.

In summary, Partridge suggested keeping the current distortion factor low, then design a good output tube-transformer combination, preferably from a big OT. Now, I know this will prove controversial to some. That's why OT design is an art, better left to professionals. (This is a plug for Mike LaFevre of MagneQuest who has patiently listened to my theories of the history of OT development.) In case Partridge's result may appear to you to be quite obvious, be careful how you might use a toroidal OT with a strip-wound core, for instance. The BH curve would now be very steep sided like the loop for the ungapped case in fig. 1a. Unless the DC current is carefully balanced in a PP stage with a typical toroidal OT, the BH curve will be skewed and *asymmetrical* about the H axis. This results in large (30-40%) second harmonic distortion at bass frequencies, producing a dark and murky bass sound with a dulled treble.

A fitting conclusion for me in trying to trace Partridge's work would have been to have had the opportunity to discuss it with Dr. Partridge himself. I must thank Dr. G. A. V. Sowter (now 93 years old and a colleague of Dr. Partridge) for giving me the sad news that Dr. Partridge was the victim of a WWII V1 rocket bomb in 1944. But his conception of the output tube-OT relationship leads me to make a remark on negative feedback (NFB) and its place in Tube-OT history.

For tube power amplifiers, the publication of the four-stage PP triode Williamson amplifier by Williamson in the April 1947 *Wireless World* proclaimed the use of NFB as a means to reduce the 3rd harmonic distortion from the OT, the triodes' second harmonic being canceled as a result of the PP design. The advantages of tetrodes over triodes (from a power point of view) quickly followed in Baxendall's Jan. 1948 *Wireless World* article. But to quote, "to reduce non-linearity distortion to a given level, it is of course necessary to apply considerably more NFB with tetrodes and pentodes than with triodes" — 3rd harmonic problems again, now from the pentodes as well as the OT.

Now could this be the plus for SE designs? Is it the 2nd harmonic (in small quantities) from the class A operated triode and the DC biased OT that enhances the musical sound? The golden era produced articles on 2nd harmonic distortion and the modern disaster of slew-rate limiting was also mentioned.

I have always viewed NFB, in its usual electronics application, as a way of making a circuit more independent of its active components. The op amp plus two external resistors with high open-loop gain (ßA) such that the closed loop gain is the ratio of the two resistors is an example, with its corresponding large decrease in the output driving resistance.

One theme came across to me in reading well over two hundred articles from the golden era, namely the relative economies of the designs. Box speakers with low efficiency required higher power (pentode) amplifiers. But just looking at OT advertisements in the 1954 *Wireless World*, I came across excellent C-core OTs by the Gardner, Gilson, Parmeko, Partridge, and Sowter companies, typically costing $18 to $20 each. Harold Leak's TL12 12W KT-66 PP mono amplifier and preamplifier cost $120 at the time. I know of only one British amplifier which used a C-core OT and that was the Lowther, costing $130 per monoblock — the stereo LP was yet to arrive. The C-core is, I feel, a partial answer to the Partridge Paradox and the use of big OTs. Economics didn't permit big, air-gapped OTs for commercially produced amplifiers, but I see no reason why hobbyists today shouldn't use superior OT design.

One cannot discuss low power amplifiers like SE without mentioning horn loudspeakers. They are not only very efficient, but their inherent acoustical loading at bass frequencies help zero feedback SE design where its output driving resistance is likely to be high compared with the golden era NFB PP designs.

Following comments in *SP#4*, I too have always enjoyed my Klipsch corner horns and I have admired Paul Klipsch for the way in which he produced a relatively smooth midrange horn by experimental determination of the termination conditions at the horn mouth. This is a difficult problem for horn theory. As an acoustician myself, I can say it is not easy to solve the acoustic wave equation for sound radiation for spherical waves, say with termination in another coordinate system, like rectangular. Classical horn theory carefully avoids this problem. It can be done today on high-speed digital computers (see one suggested method by E. Geddes, *Journal of the AES*, July/Aug. 1987). It is still better, with simple designs, to resort to experiment. I came across a great construction article for a short midrange horn for a 6" diameter driver in the June 1939 *Wireless World*, correctly designed by choosing the exit area first. Edgar has championed the use of the short midrange horn with non-compression, larger than usual, drivers. I am looking forward to listening to a pair of this type of horn with a pair of original Lowther PM6 drivers shortly.

To conclude, what have I (re)discovered? The golden era people certainly knew what they were doing as regards musical reproduction, and I haven't even mentioned the two hundred or so U.S. articles I have collected. I have listened to the Model 91-style 300B circuit presented in *SP #1*, as well as a parallel 300B SE design and a 845 SE design. It is said the wavefront seems to reach one more coherently, some say the silence is darker or the low level resolution is better. I still think the Leak TL12 PP KT66 triode-connected 12W monoblocks are difficult to beat but, as yet, I have not been in a position to do direct comparisons. Now if I could only find a cure for that CD treble!

I am open to correspondence and suggestions on the reasons for the musical sound of single-ended triodes (as are the pages of this magazine—*ed.*) Dialogue on the subject is sorely needed. I hope I have pointed you in the right direction with the preceding discussion, but before you question my humble description of Partridge's work, try to read him first.

AUDIO NOTE UK OUTPUT TRANSFORMERS

SINGLE-ENDED CIRCUITS:
EL84/6V6, 20W, 2K6, 4/8 , 100mA PSE, $120.
300B/2A3, 25W, 2K5, 4/8/16, 90mA SE, $140.
EL34/KT88, 30W, 1K5, 4/8, 180mA PSE, $135.
EL34/KT88, 20W, 3K, 4/8, 130mA SE, $145.
6L6G, 30W, 3K, 4/8, 140mA PSE, $150.
KT66/5881/807, 30W, 3K, 4/8, 140mA PSE, $150.
211/845, 50W, 10K, 4/8, 150mA SE, $225.
300B/2A3, 50W, 1K25, 4/8, 180mA PSE, $235.
845, 50W, 2K5, 4/8, 180mA PSE, $265.
211, 75W, 5K, 4/8, 240mA PSE, $290.

PUSH-PULL CIRCUITS:
EL84/6V6 PP, 15W, 8K, 4/8, $60.
EL34/6L6/KT66/5881 PP, 25W, 6K, 4/8, $65.
300B/2A3/6B4G PP, 30W, 5K, 4/8, $100.
KT88/6550 PP, 50W, 6K6, 4/8, $95.
KT88/6550/EL34 PP-UL, 60W, 4K3, 4/8/16, $100!
KT88/6550/EL34 PPP-UL, 100W, 2K2, 4/8/16, $200.
EL34/KT66/5881 PPP, 50W, 3K, 4/8, $110.
845 PP, 50W, 6K8, 4/8, $215.

POWER TRANSFORMERS:
D.I.Y. ONGAKU, $175.
STEREO SE 300B AMP, $150.

SE=SINGLE-ENDED, PSE=PARALLEL SINGLE-ENDED,
PP=PUSH-PULL, PPP=PARALLEL PUSH-PULL,
UL=43% ULTRALINEAR TAPS FOR DYNA/ACRO
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W.A.F.

by Joyce

THE ART OF THE DEAL

When friends call they often ask, "So what kind of system are you listening to these days?" Recently I've been a little hesitant to answer. I wonder, shall I make them terribly envious as I describe the wonderful system we had last week, or must I stick with the facts as they stand? "A boom box," I end up answering honestly, because the truth is that we are currently listening to a $69 Hitachi boom box. Invariably, our friends respond in shock, "But I thought you guys had a world-class system." That's right, I'm thinking, world-class system, which means that right now our system is all over the world. "Our system," I explain, "is currently in transit."

Audio equipment, I've discovered, is always in transit. Even when it's sitting solidly, right there in your living room, seemingly immobile on its sharp little tippy-toes, it's actually already on its way somewhere else. It doesn't matter if it's perfectly matched to your system, or if you've been listening to it for years. Whether it's solid state or vacuum tube, single-ended or push-pull, the one thing all audio has in common is that it's *on the move*.

It took me a while to catch on, but now that I'm aware of it, a lot of audio behavior makes more sense than it ever did before. Realizing that, for the rest of your married life, your audio system will be in a constant state of flux is an important step in understanding your audiophile mate, and the hobby in general. (It may also explain why I can never seem to get a hang of our system, but you've already heard *that* story).

Before living with an audiophile, I naively thought that audio equipment was principally intended for listening to music. I now know that there are plenty of other fun things one can do with it. Chief among these is setting up a Complicated Audio Deal. Take a good look at your husband the next time he's in front of the stereo. It may seem like he's innocently listening to music as he happily taps his fingers on the couch, but believe me, what he's really doing is mentally working out the details of the intricate audio deal he's just thought up.

All you can do is watch and wait. Is he about to sell the turntable or is it the speakers that are going? Did he get your favorite amp tied up in another impossible trade or is he just about to lend the tuner to someone in Massachusetts?

If your goal is to get rid of a particular component in your current audio system, all you really have to do is wait. (Complain a little, too, it helps speed what is a natural process). Remember, whatever it is may be here disgracing your living room right now, but it's *just in transit*. Seek comfort in the fact that before too long, at least temporarily, someone else's wife will be stuck with it.

If, on the other hand, you should for any reason wish to hold on to a component, I can tell you now, you're going to have to fight for its life. We have this REL Precedent FM tuner that I've grown very fond of. It's a cool piece of equipment, the kind guys just have to look at once and they're already thinking up a way to make a deal for it. I've had to rescue it several times from the "greatest audio trade ever." My husband's friends don't understand, "Is it because the REL looks so cool with the rest of your system, or is it because of that super smooth tuning knob, or is it ..." "Because," I mutter, so low they can't hear me, "I know how to use it and it hasn't electrocuted me yet."

Since change is such an integral part of the audio hobby, it's often only when our system essentially consists of 300 yards of speaker cable and a tuner that I realize something is wrong. I sometimes think the audio deals my man works out are so complicated, so full of logistical intricacies and nuances, that not even he can fully comprehend them. This, I suspect, is how we wound up listening to a boom box. "How can it be, " I ask, "that we have all this great equipment and yet we rarely have a complete system to play?"

Let's see, if I can remember this correctly: our favorite amps are currently "out on loan" to a friend. We have his amps, which need to be fixed, and when his amps get fixed, we can get our amps back. The way I interpret all this is, our amps aren't really out on loan, they are being *held hostage*. Try explaining it like this to a guy and he'll look at you like you're crazy. "They're *on loan*," he'll insist. Mind you, this has been going on for two years now — I know I'll never see those amps again.

Since audiophiles are usually eager to lend each other stuff, your understanding of their ways can be often put to good use. For instance, we all know that true audiomaniacs cannot resist the urge to improve on or "tweak" equipment, whether it belongs to them or not. So the next time your husband builds a truly awful amp, encourage him to lend it to the most out-of-control modifier you know. He'll either break it beyond repair or tweak it up until it sounds so good he'll never part with it, either way it's out of your life for good.

The rest of our system is being "traded" or "upgraded," which are both euphemisms for "gone". For many audiophiles, trading is a compulsive behavior and cannot be helped. It is also highly contagious, which is why the average audio trade eventually winds up involving at least four or five people in a frenzy of exchange. I don't pretend to understand the laws of this wild bartering, but I can tell you there's rarely such a thing as a simple, two-way trade in audio. They inevitably get complicated, so don't be surprised to find that the amount of time a certain piece of equipment actually stays in your system is often less than the time it took to set up the deal in the first place. Just learn never to throw away any boxes.

Now you'd think I'd despair as I sit here listening to my boom box, but all this audio wheeling and dealing makes me hopeful of someday actually finding that world class system. I just know it's out there. I imagine a guy in New Jersey has the speakers, and right now he's adding just a little more damping material to the box. The nearly perfect amp is making the tweak rounds somewhere in the midwest and, along the way, someone will put in a part that will make all the world of difference. And in Spain, a mad scientist type is auditioning various rare and wondrous caps in my future preamp.

My perfect, world-class audio system is already in motion and all the parts are coming together beautifully. Before long, UPS will be delivering it right to my door. With all that speaker cable in-house and my trusty REL tuner, you might say I'm ready for it. And this time, with any luck, I'm going to figure out a way to bolt it down to the floor before I let it out of my sight.