

THE SINGLE 300B AMPLIFIER: A MODEL 91 FOR 1992

BY JOE ROBERTS

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

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

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

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

Today, theater gear of the golden era, particularly Western Electric Mirrophonic

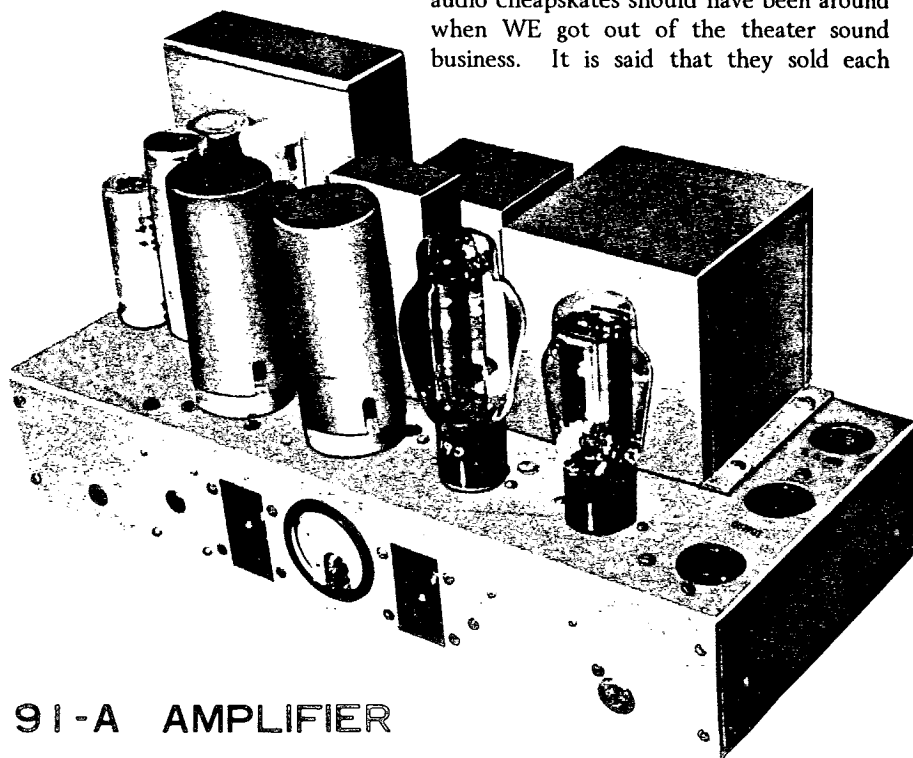
equipment, is revered by aficionados of vintage audio worldwide. A complete stereo set of WE amps and speakers would cost as much as a new car - if you could find it. It would cost many hundreds to ship. A large slice of the street price of Mirrophonic gear can be attributed to its status as rare, desirable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

Typical theater systems of the era employed very low power amps by today's measure and enormous super-efficient horn loaded speaker systems. Often these speakers used electrodynamic drivers since field coils provided higher flux for the bucks than permanent magnets in those days. Ten watts was

enough to fill a good sized movie house to impressive SPLs. Nowadays the equation is reversed; you need 100 watts to drive a one cubic foot mini monitor to acceptable living room levels. Anyway, it's clear that the efficient old methods were in sync with the laws of physics. Must be nice to have a theater sized listening room to indulge mother nature.

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

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



91-A AMPLIFIER

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

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

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

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

I first heard about WE from local audiophiles who were active in the early 50's. When anti-trust proceedings forced WE out of the sound equipment trade in the late 40's, surplus permanent magnet WE speakers dumped on the market were snatched up by "golden ear" types at bargain rates; you can see 'em in Harvey Radio ads from the early 50's. Electrodynamic WECO the-

ater speakers were also highly revered by early Hi-Fi experimenters. The first Klipschorns in 1948/9 used WE compression drivers, possibly obtained through surplus channels. Avery Fisher used electrodynamic WE theater speakers at home. Surely, Mr. Fisher could afford to choose the best.

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

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

THE SINGLE 300B AMP

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

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

There is no direct substitute for this filamentary cathode tube. It is generally similar to the earlier RCA 50 in characteristics, with the exception of filament voltage, but

it is considerably improved in terms of mechanical construction and life characteristics. It is a real workhorse.

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

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

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

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

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

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

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

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

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

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

91s. Be thankful that the amp only uses one tube per side!

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

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

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

THE WECO 91

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

Setting up a WE 91 in your home audio system is not straightforward. Inputs and outputs use unusual 5 and 6 pin tube socket like connectors. The field coil of a monitor speaker in the projection booth served as a power supply choke (see schematic) in Mirrophonic installations. Since you're not using this speaker, you'll have to outboard a choke

(it won't fit underneath) and you need a high DC resistance inductor (maybe 1K ohms) to get the voltages right. Nowhere to put it. A real hassle.

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

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

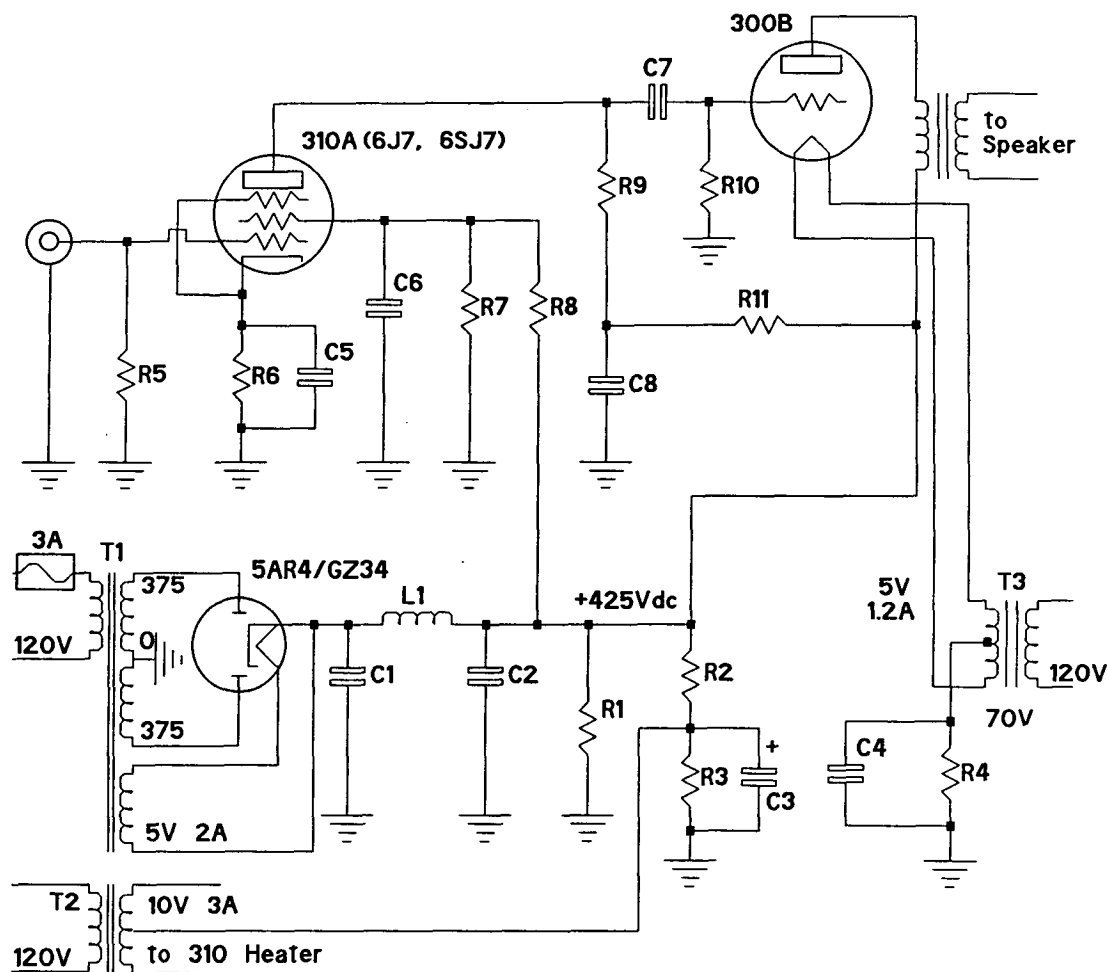
The heck with it I say. Let's just build one from scratch. Actually it is possible to recreate the 91 circuit in a more appropriate form with real RCA jacks and speaker terminals, using fresh parts, and including only the required voltage amp stage. The aural magic will still be there. In fact, in a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

BUILDING YOUR CUSTOM 91

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

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

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



I/2/93 corrected version

R1 - 50K 25W wirewound
 R2 - 270K 2W
 R3 - 20K 2W
 R4 - 880 ohm 50 W. wirewound
 R5 - 220K 2W
 R6 - 1.2K 2W
 R7 - 30K 5W wirewound

R8 - 75K 5W wirewound
 R9 - 91K 2W
 R10 - 390K 2W
 R11 - 27K 10W wirewound
 All 2W resistors Allen Bradley composition type 5% tol. or "tweak" resistor of your choice.

C1-C2 - 15 mf 1000V oil cap (or 2 X 8 uf in parallel). Use 500V electrolytics if you insist on being conventional.
 C3 - 50mf 100V electrolytic
 C4 -C5 - 16 mf oil cap or film bypass cap of your choice @ 75VDC or greater.

C6 - film or oil cap 8 mf 200V
 C7 - .1mf 600V Vitamin Q
 C8 - 15 mf 1000V oil cap
 T1 - 375-0-375 V @ 125 ma; 5V @ 2A
 T2 - 10V @ 500ma CT
 T3 - 5V @ 1.2A CT
 L1 - 10 henry 125 ma choke

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

I heartily recommend auditioning various components in your homebrew projects. After all you're building it so look for a sound

that makes your ears happy. You will find that this amplifier is highly sensitive to parts swapping and it's a low parts count design so it's a good test bench for experimentation. The beauty of "rolling your own" is that you can optimize the aural character of your creation to fit your tastes and system balance.

You might feel inclined to go with the times and use the standard metal film resistors but I would recommend giving those forgotten ultramusical AB carbon composition re-

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

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

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

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

POWER SUPPLY

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

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

This is a pure class A design so the power supply doesn't have to cope with large peaks

in current demand. Thus here is an opportunity to go with quality over quantity in filter caps in good conscience. With two 15 mf caps and a 10 Henry choke, ripple is reduced to .03% or thereabouts. Use a bleeder resistor to improve regulation, prevent over-voltage at turn on, and provide a discharge path for the filter caps as a safety measure. A good oil cap will hold a dangerous charge for a long time!

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

THE 310A/B STAGE

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

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

You will want to use a shielded cable running up to the grid cap with the braid grounded to the chassis. A piece of interconnect will fit the bill. I put +40 volts on

the filament line through a voltage divider from B+ to avoid potential hum problems.

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

THE 300B STAGE

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

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

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

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

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

OUTPUT TRANSFORMERS

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

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

I am fortunate to have had the opportunity to hear several transformers on my single 300B amps. Most of my listening was done using WE 755s (8" full range 70-13,000 hz. response) in a slant front 2 cubic ft. cabinet, Thorens TD-124/SME3009/Grado MCZ, homebrew preamp playing Dinah Washington, Patsy Cline, 50's Jazz and other stuff I play for musical enjoyment. I realize

that this is a non standard reference system, but this ain't Sea Cliff, fellas.

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

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

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

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

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

Partridge TK4519 - The classic in the Japanese and Euro markets. Pricey to import and real difficult to find stateside since Par-

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

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

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

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

GENERAL CONCLUSIONS

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

Pro push pull

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

Anti push pull

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

Pro single ended

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

Anti Single ended

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

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

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

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

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

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

Another way in which the single triode differs from a good pentode amp is in the char-

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

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

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

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

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

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SINGLE 300B (Cont. from p. 11)

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

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

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

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

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