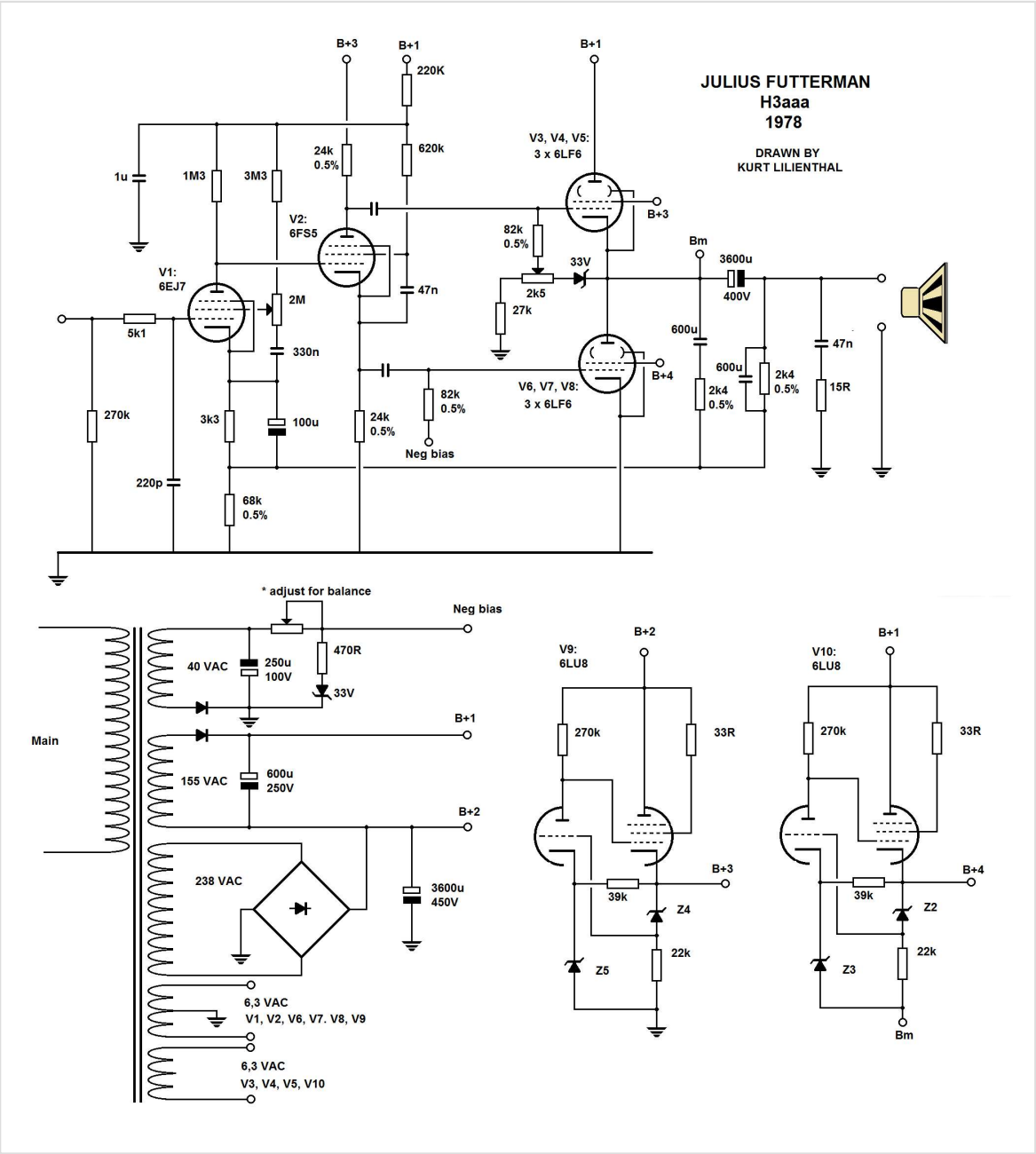
Lilienthal Engineering

Audio transformers, HiFi output transformers, Guitar output transformers, Special quality transformers, Line transformers, Input transformers, Interstage transformers, HF signal transformers.

100 amplifiers…..part 2, 1955-82

100 amplifiers, part 2. 1955 – 82.

These pages represents an ongoing process. I frequently add more as I find the time to dig deeper into the circuits and I keep finding more interesting schematics for us hungry schematic analyst's. Comments are always welcome, please write to me at: 100amplifiers at gmail.com. (If you happen to have some pictures of the amplifiers in this compendia, that you would like to share with us, please do not hesitate to contact me. Pix will be credited by your name)



Julius Futterman OTL, 6 x 6LF6 PP, 1954/56

It is impossible to get around Mr. Futterman in an analysis of the history of audio amplifiers. I fully understand why the thought of getting rid of the large and expensive output transformer emerged. Futterman's ideas and circuits were excellent, in particular considering the impossible task. The famous and best known amplifiers by Futterman were based upon pentodes as output tubes. The circuit above is actually another Williamson. Very high gain 6EJ7 pentode at the input and a concertino/split load phase splitter.But then it turns from Williamson to Futterman in that the output configuration are the so called "single end push pull". From a DC point of view the two output tubes (actually made of 2 x 3 6LF6's in parallel) are in series. But from a AC point of view they are in parallel – and that is the trick. In a conventional PP, the output tubes are AC vice in series and DC vice in parallel. The exact opposite operation. Having the output tubes in parallel rather than in series drops the matching load to 25% of the conventional. But even this is very far from the 16 Ohm speaker load, hence Futterman added further output tubes. 6LF6 was made for horizontal

deflection mode and it therefor a current strong and low ri pentode. Some 6-8 k Ohms – three of these in parallel makes about 2-3 k Ohm and again parallel with the other stack some 1 to 1,5k Ohms. There is still a loong way down to a regular speaker Ohms load and this is where the OTL designers plays their final card; lots and lots of global negative feedback and we now understand why Futterman wanted all that gain to begin with. The cathode of the lower tubes are grounded, hence fixed. But the cathode of the upper tube are riding on top of the plate at the lower tube. This means that upper drive should ad the AC swing of the lower tube in order to be balanced. In reality the lower tube works fine, but the upper produced the weirdest possible distortion signature – lots of constantly changing very high upper harmonics. Futterman partly solved it with the use of two HV supplies. The open loop distortion of single end PP amplifiers are dramatic, due to the just as dramatic unbalanced drive. Feedback is not a choice, tons of fb are mandatory. It is ironic that the unbalanced drive could have been solved by a two secondary winding transformer. But I guess that this would have ruined the concept OTL.

Futterman also used 12B4's in some circuits, and 6336's as far as I remember, but I don't think he ever made these on a commercial basis. Julius build all his amplifiers himself*, and sold directly to the customer. He was a genuine Joe…When a customer wanted a Futterman amplifier, he had to show up in person and pay an upfront of about 20% and wait 2 years for delivery. The Futterman designs are crazy difficult to adjust and no one, besides Futterman himself apparently learned to do the job.The final adjustments were carried out with the help of friends or the actual customer, as Julius Futterman himself had a hearing issue. In case of service or change of tubes, the customer had to sent the amplifier back to Futterman himself.

* Harvard Electronics; RCA, Westinghouse, Tech Instruments and others made Futterman's amplifiers on a license for a while. But rumours has it that Futterman constantly changed the circuits – small, but significant details in the design. Due to this and the difficulties in adjustment, hence stability, these companies cancelled the production. It have to be mentioned, that the amplifiers that were build by Julius himself , according to the saying are very reliable and stable.

Futterman was on a constant look for tubes better suitable for OTL. He changed output tubes every so often. Futterman had a dream of using FET's at the output as soon as such would be available as high power devices. Such power FET's became available about the time of Futterman's passing away. (1981) NYAL made Futterman's MOSCODE in the following years.

The original designs of Futterman were all class B. Due to the excessive global feedback they acted as Voltage output sources, just like solid state amplifiers and op-amps. This meant that the available power depended highly upon the impedance of the speakers. It is difficult to connect 8 Ohm speakers to Futterman's amplifiers with good results. From 16 Ohm and up, they do 4 times better and so on. The perfect match to the Futterman designs are electrostatic speakers, I am told.

OTL is a dead end in my opinion. My advice is that if you want to make an OTL – don't use tubes. Do as Futterman always dreamt of. Use FET's or similar transistor based output. It is a LOT easier, it is cheaper and it sounds better than tube OTL – at least in my opinion. I would personally prefer a genuine tube amplifier, but that is an endless (and uninteresting) discussion without winners or losers. Anyway, if you insist on making OTL designs, here is what I learned before I gave up.

1) Avoid all the cascode/series, so called parallel Push Pull. (The Futterman, Philips etc.) These circuits are notoriously asymmetric and the open loop distortion are extreme.

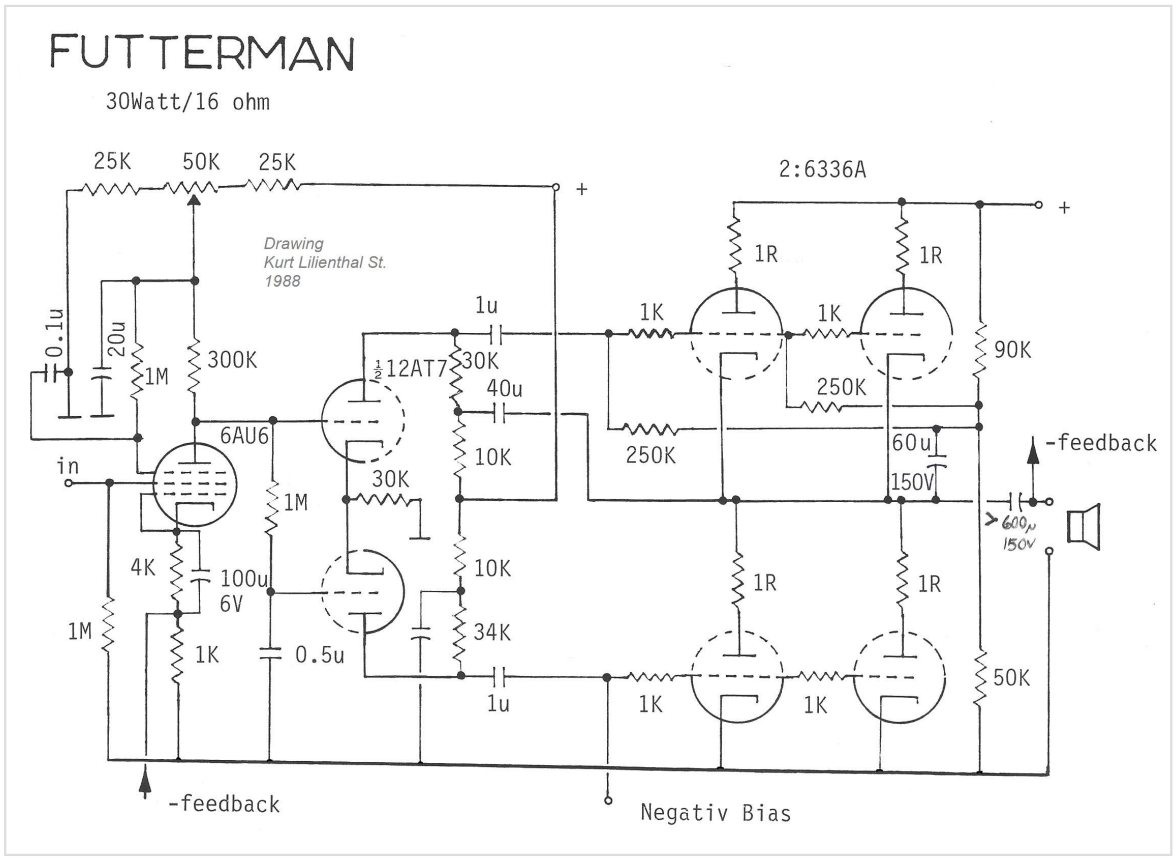
2) The best solution for Push Pull seems to be the Circlotron.. At the risks of frying your speaker – but that comes with any OTL, that does not swop the transformer to a large capacitor/electrolytic.

3) The obvious candidates for OTL operation are cathode followers, but do not ignore the potentials in genuine *anode/plate followers*, despite that these are very difficult to calculate. Perhaps the best solution are inverted power grid applications.(See **Stephie Bench**)

4) I suggest to go for current or power drive.(See my article “Power distortion” , 1998 or so. A copy may be found at the **PEARL** archive, Canada) In a current/power drive application the high ri of valves may even come in as an advantage.

Despite all this, I am a dedicated fan of Julius Futterman. I love his circuits and insisting design. I like the way he dealt with his passion and customers. Tremendous imagination and excellent ingenuity.
But after all, the end goal was audio, not clever engineering. And OTL amplifiers are a difficult specimen. Would good and poor at the same time be a suitable phrase ?
Sadly they ARE all better with a transformer exit…
Luxman, Philips, Stephens, Technics, RCA, Stephens, Coulter, National, Peterson Sinclair and many many others tried to walk the OTL path – with just as little success. I myself spend almost 10 years trying to get rid of that large, heavy and expensive OPT, before I realised just how good transformers really are and how much good they do in assisting the “valves and tubes”… . It is hardly ever the trannie that needs to be blamed – it is simply poor design (transformer and/or circuit). Valves does not maid good with 2 to 30 Ohm’s speakers. Period.
As much as I like Futterman’s designs, I am now at the total opposite side of the road. The more iron the better.(This was why I got in to the transformer business) Master Tapes is iron, vinyl is made through iron, PU’s are iron – Heck, even my speakers, guitars and the valves themselves depends upon iron.
Julius – you meant well and you did GOOD….you pushed the tubes to the limit of their capability, yet a Futterman amp never wears out the tubes.

Below is a circuit I had drawn many years ago, when I studied Futterman’s designs.Unfortunately I do no longer remember if it is an original design by Futterman or one of the countless Futterman based versions from my hand – or if it is indeed a Futterman version I have copied from someone else ? If you have info about this, please do not hesitate to contact me. The 16 Watts specification are rather optimistic, despite the 16 Ohms load. Never the less, it is a Futterman design and it looks nice.


FUTTERMAN
30Watt/16 ohm
25K
50K
25K
+
2:6336A
Drawing
Kurt Lilienthal St.
1988
0.1u
20u
1M
300K
1u
½12AT7
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40u
6AU6
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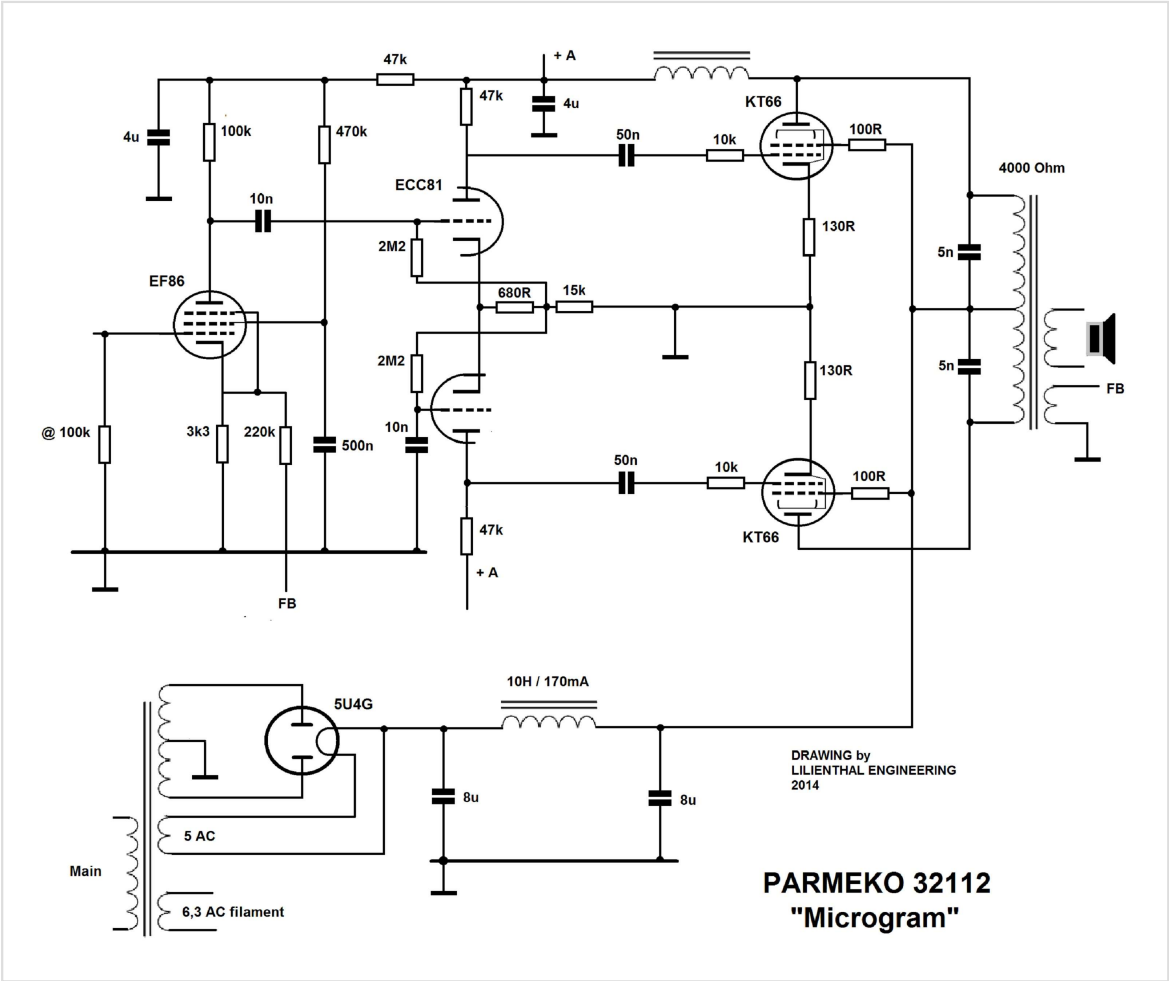
Negativ Bias

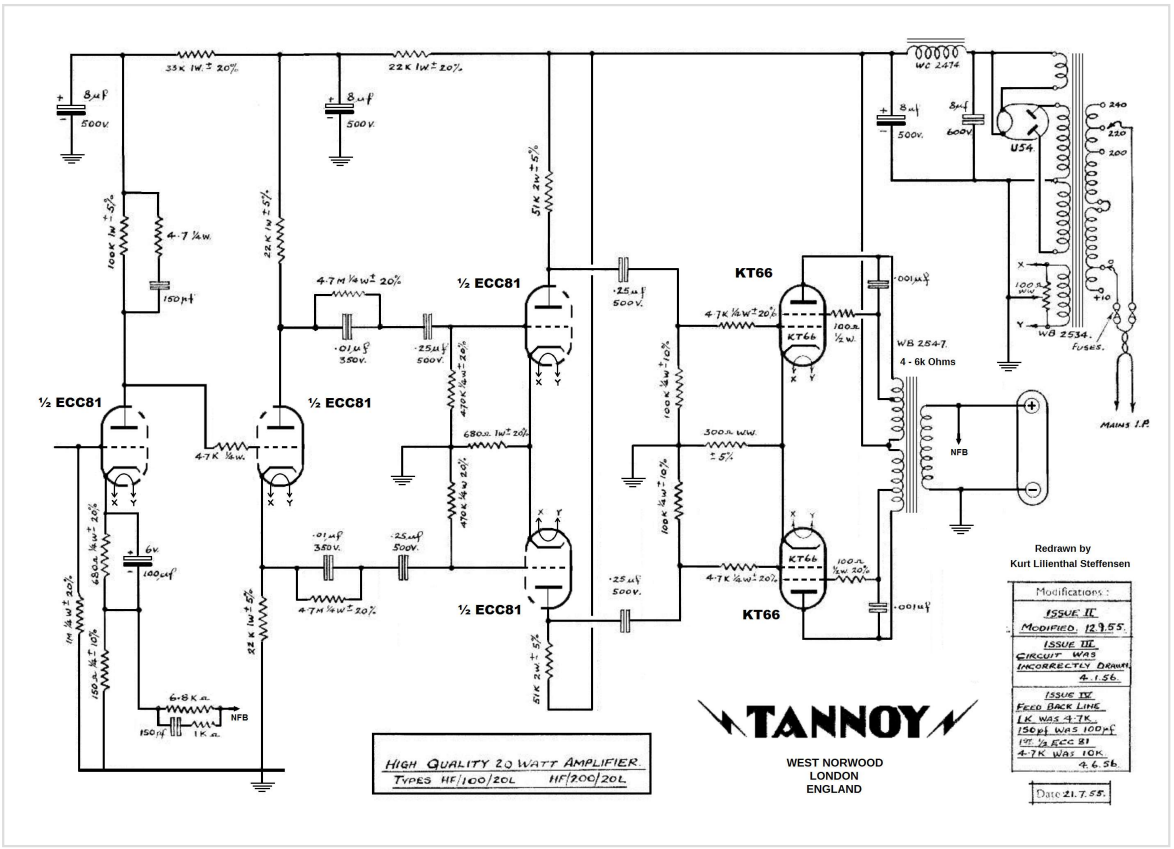


Parmeko 32112, KT66 PP, 1954-56

This British made PA amplifier is a beauty and school example of good build quality. In the schematic above I have stripped the amplifier of the entire preamplifier section and all garniture. This is what is left: The usual Mullard 5-20 circuit that most British manufacturers made during the 1950's and 60's. That is a little sad, as it is such a good looking amplifier. Well – nothing is ever perfect. At least Parmeco used an ECC81 driver instead of the lazy ECC83 that Mullard suggested. An easy modification would be to triode couple the EF86 valve and enlarge the feedback resistor to decrease the fb. Perhaps even remove it ?

Parmeko was a manufacture of transformers founded in 1927 as "Partridge and Mee". Parmeco are *still* in business today and *still* makes transformers and other electromagnetic components. In 1935 the company split in to two and changed the name to Parmeco. The other part of the former company would also continue to make transformers known as "Partridge"…….

Parmeco made some beautiful rack amplifiers for cinema during the 1930's, unfortunately I have not yet been able to track any schematics for these. Here are some pix though:https://www.google.dk/search?q=parmeco+amplifiers&rlz=1C1LENP_enDK543DK544&source=lnms&tbm=isch&sa=X&ei=-h_VVMPzEaT6ywOgwIK4Dg&ved=0CAgQ_AUoAQ&biw=1366&bih=612#imgdii=_

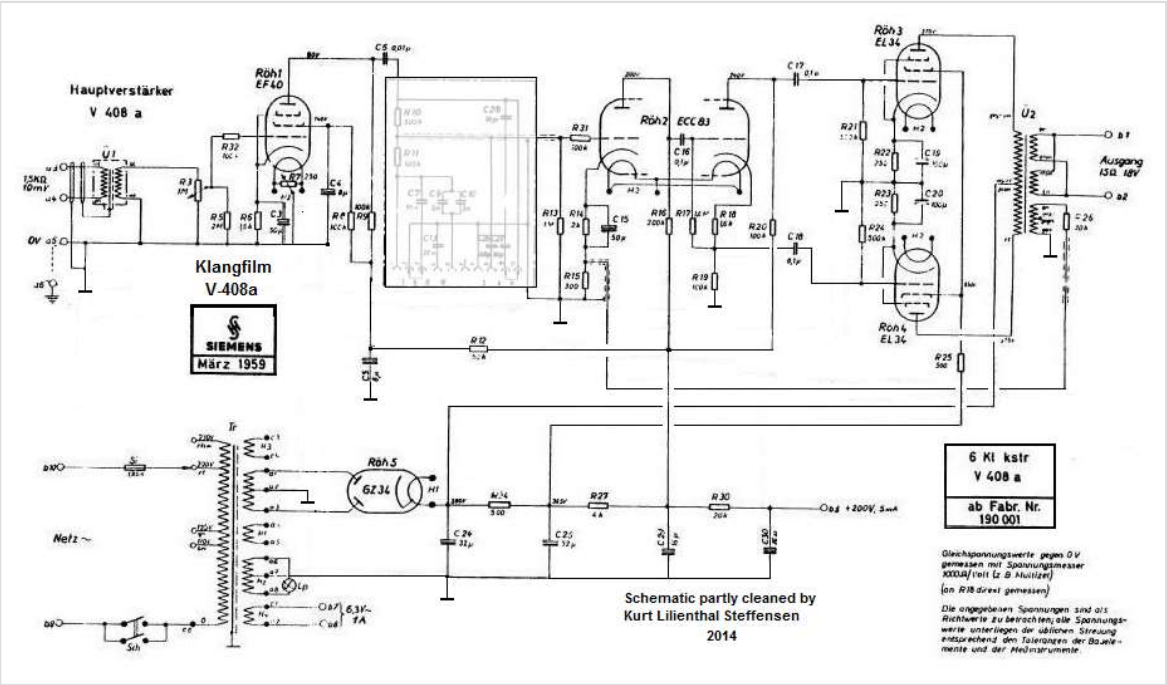


(Suggested by yours truly)

Tannoy HF/100/20L , KT66 , 1955

It is interesting that while most American HiFi companies based their designs upon the Williamson circuit, most British HiFi companies stock to the well known Mullard design. Parmeco 32112, LEAK and Radford are typical versions of the Mullard application note. The Tannoy here is an exception to that rule and indeed a very well designed one. Tannoy drives the KT66's gently at about 4-450V at the plates and they only demands some 20 Watts from the pair.

Looks good to me…..



(Suggested by Al Marcy)

Klangfilm kvl-408a, EL34, 1955

Boy – yes, we need some Klangfilm here. (Klang means “quality/merits of sound” in German and Danish) I regret the poor quality of the schematic, but it was the best I could find. I have cleaned the typical mess of wires, that German designers seemed to love back then.(Every damn piece of wire would be drawn at the diagram) I can not read the values of the components, but the design comes through well enough, I think. Klangfilm made a lot of fancy designs. Many of the pro Klangfilm EL34 gear was high Voltage class B, up to 800 Volts ! Mercy…

They even used the outstanding EL156’s and the weird RL12P35’s.(Caps and plate Voltage at the socket shield !)

Siemens, Klangfilm, AEg, Telefunken was the German pendent to US Western Electric and the British GEC, Marconi Osram.

In Denmark we had such companies as Ortofon, Bruel & Kjær, B&o, BoFa, Electro Mechano, MP Pedersen, Oxytron, Peerless, Vifa,

Amplidan, J. Schou, Jensen, Radiometer and a few others….Collected they may pass as the Danish Western Electric…Huh.?…

No.?

Right then, back to business…..If you happen to have such 408a in your possession you better mod that amp to something like – say..a Williamson design. ECC83 as phase splitter as well as driver..? Nah, I don’t think so.

How about a 12AU7 or 12AY7 as input and concertino, then 12AU7, 6CG7, 5687, 12BH7 or similar as driver…. GAH PLIIING.! And you are in Röhren himmel…….You might consider to bias the 34’s with some genuine German Volts for an active class A design. Plenty of free windings at the main trannie. Siemens made good quality iron, all worth the effort. This Klangfilm one might very well end up as your top amp.

It really looks wonderful. Here is a link to some pictures:

http://http//www.tube-classics.de/TC/Klangfilm/EurodynAmps/KLV408/KLV408.htm

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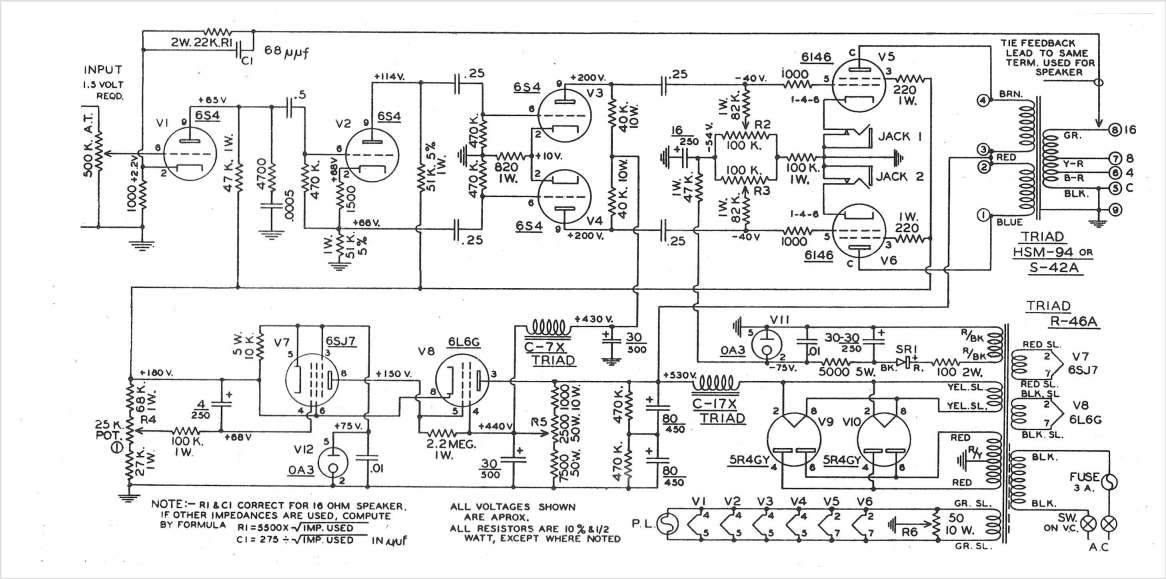
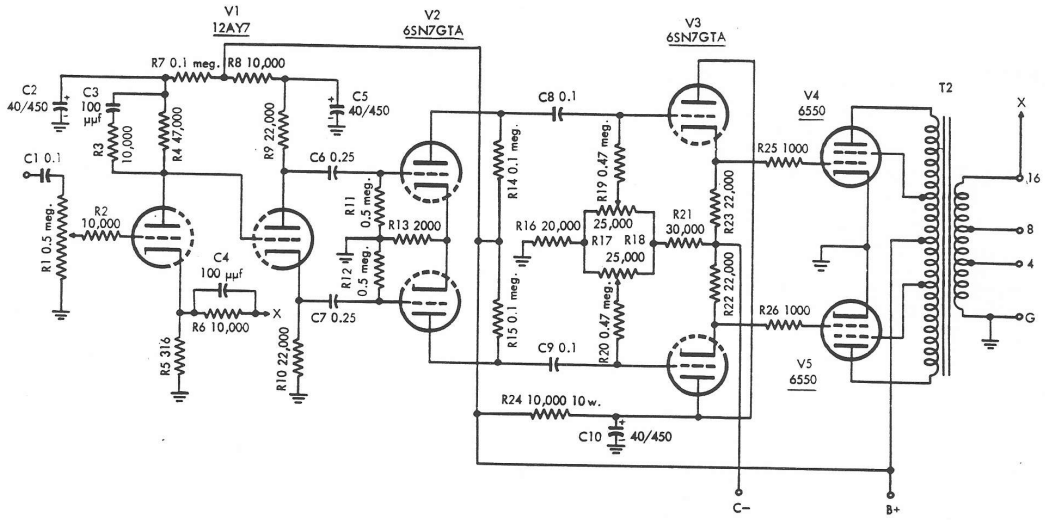


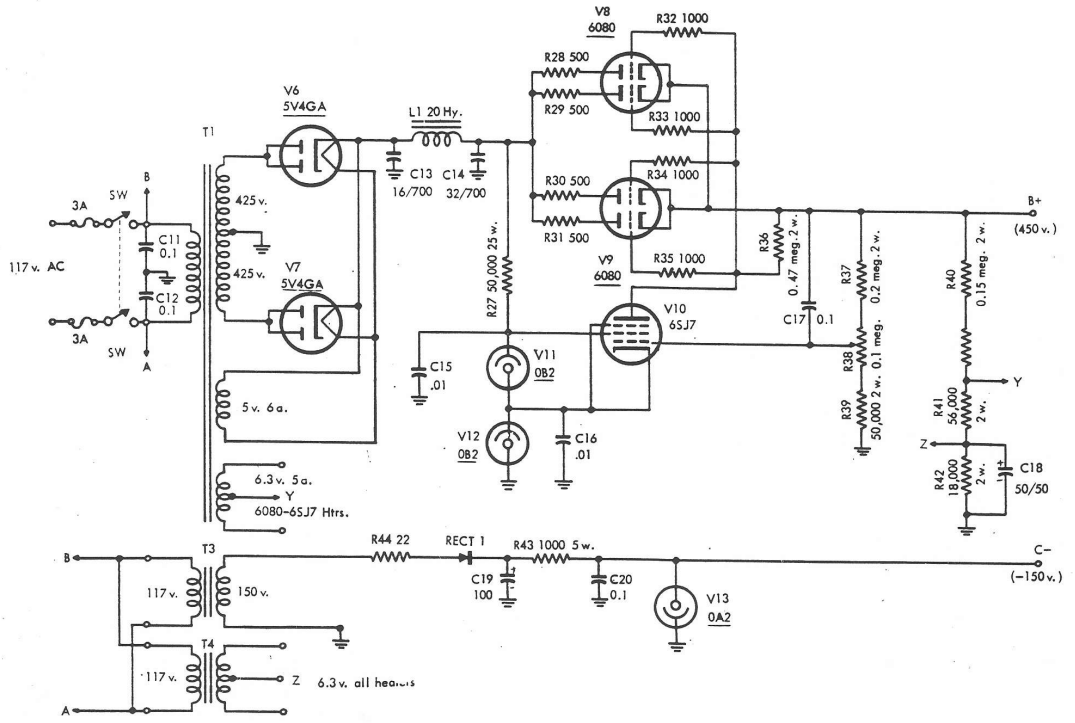
(Suggested by yours truly)

TRIAD kits HF-40, 6146 PP, 1955.

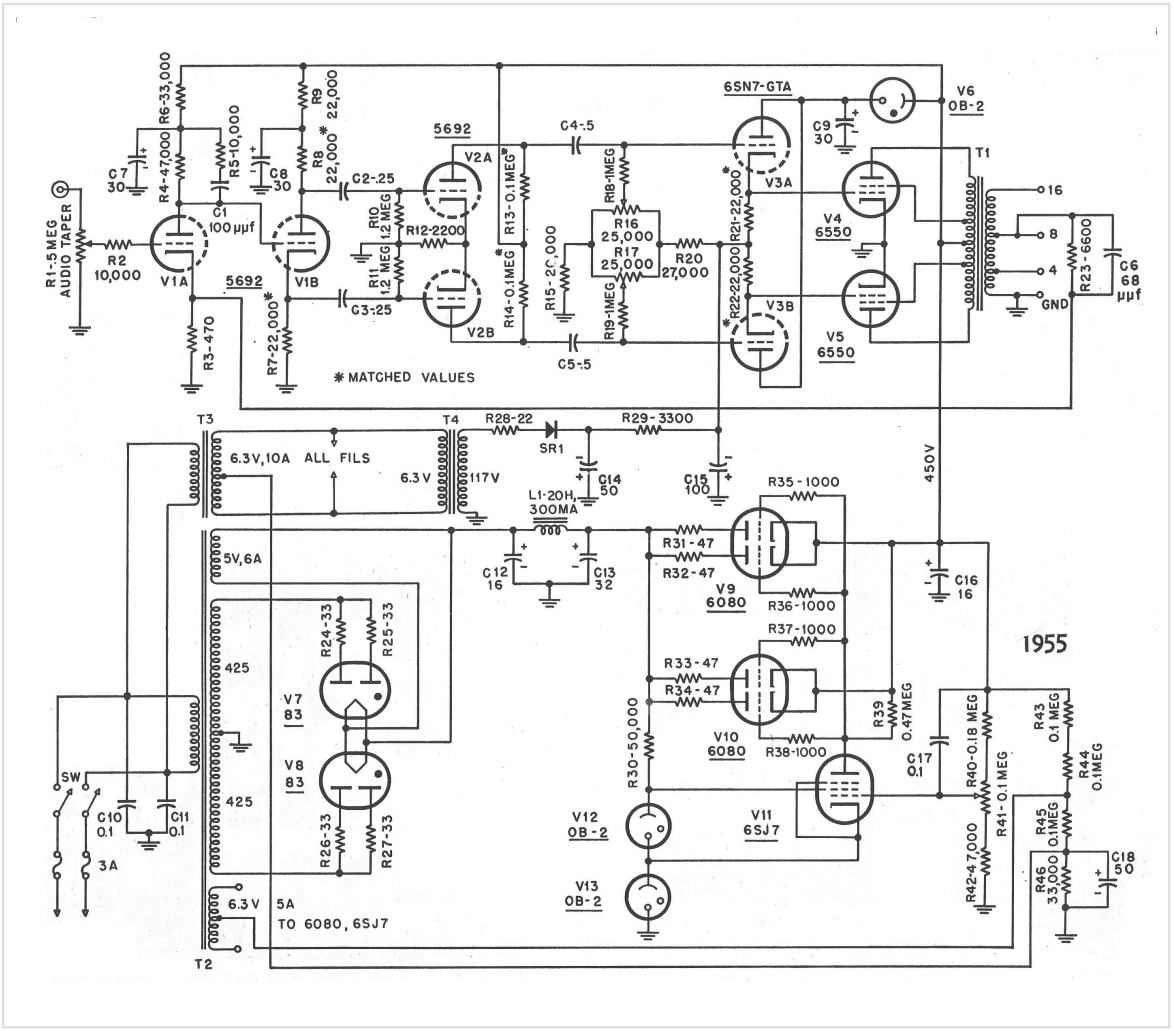
All though this is a Williamson design and the *physical* layout of the kit was stupid (much too small and tight) , it is indeed a very well designed amplifier. Partly Voltage regulated by means of an OA3, 6SJ7 and 6L6G. Two 5R4GY rectifiers and two smoothing chokes. Four 6S4 triodes and of course – TRIAD quality transformers and chokes.
Excellent kit and a design superior to most – certainly a lot better than the Dynaco kit's.
Should be said, though, that an almost identical circuit by Sarser and Sprinkle appeared in Audio magazine 3 years prior to this kit.



Schematic of 60-watt power amplifier, component values given. 40-watt unit is similar, but with one less 5V4GA and one less 6080 in power supply.



Schematic of separate power supply for 60-watt power amplifier. Values of all components are shown. V_{13} is actually located in amplifier chassis.



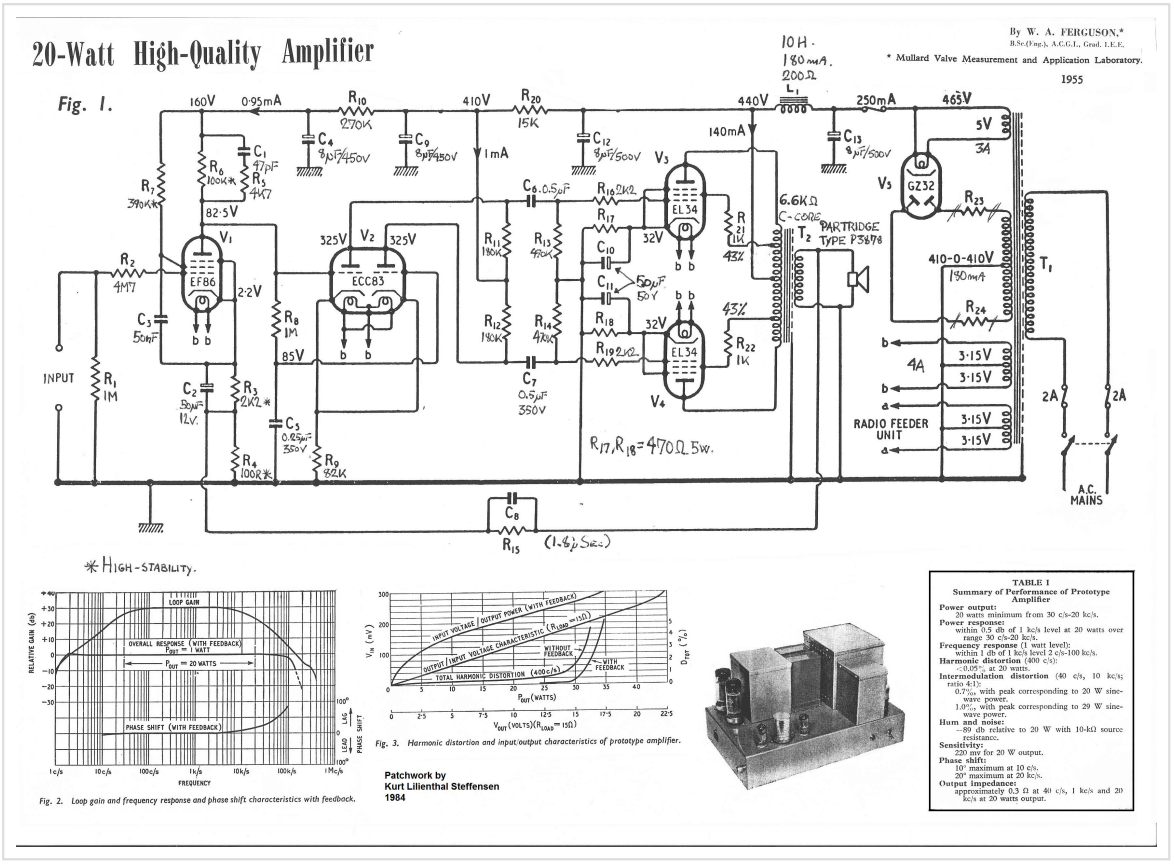
?? , 6550, 1955.

These circuits (possible by Kiebert) is a genuine adventure into good audio engineering.
Both amplifiers are improved Williamson designs and tightly regulated. I can't seem to remember from where I got these schematics, but it might have been from an 1955 "Audio" magazine.

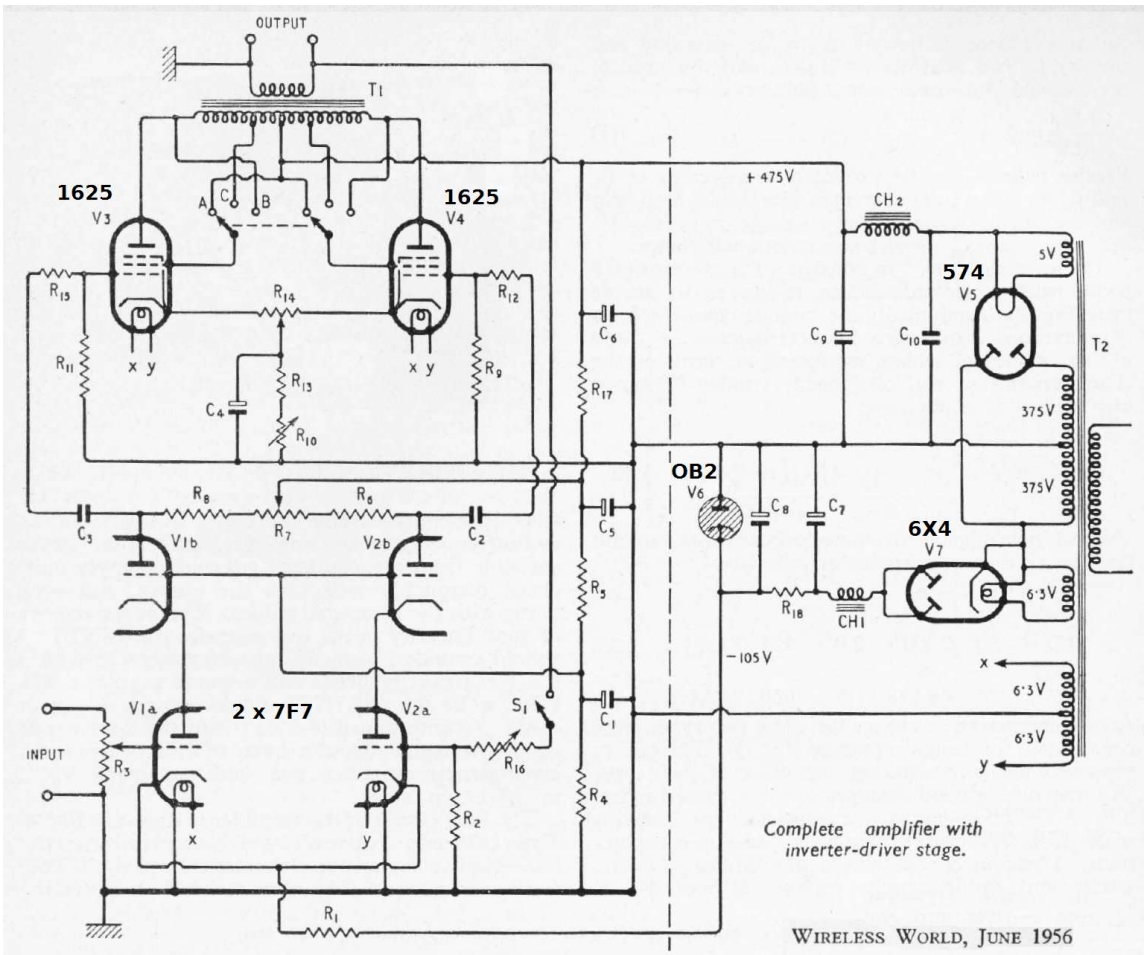
I will go much deeper into these circuits in my "Williamson" article , that will be published on these site later on. It is first class electronic design and I throw my hat to the ground in admiration…..

The Mullard, GEC, RCA, Philips and other 1950's app notes, Audio, Wireless World and many other magazines are an endless source of good schematics and knowledge about audio amplifiers and similar electronics. Much too much to be published here.
Amongst these we find the proto designs for many later famous amplifiers. Marantz 8B, Radford and Dynaco just to mention a few of whom based some of their amplifiers on a particular well known Mullard design. **"Mullard 520", "Mullard 5-20"** or simply**"Mullard 20 Watt high Quality Amplifier"** as Mullard called it themselves. It was designed by W.A. Ferguson. I know that I have often criticized this amplifier, but to be honest it is not really the design itself that flaws – it is the way Ferguson strapped the EF86 pentode and used the ECC83 as a longtail phase splitter as well as the driver. ECC83 is indeed a poor driver due to the high internal impedance. 180.000 Ohms of

plate resistance on top of that, as Ferguson suggest, does not do a lot of good here. But swop it to 5687, 12BH7 (or 6CG7 as Marantz did) triode strap that EF86 – back off the amount of feedback and you actually have yourself a rather decent “20 Watt high quality amplifier” anno 2015. High quality C-core output transformers, that goes without saying.



Mullard 5-20, EL34 PP, 1955



LIST OF PARTS

C_1, C_7	20μf, 450V electolytic	R_9, R_{11}	400kΩ, ¼ watt
C_2, C_3	0.1μf, 600V	R_{10}	200Ω rheostat, 10 watt (Output bias adjustment)
C_4	120μf, 150V electolytic	R_{12}, R_{15}	1kΩ, ¼ watt
C_5, C_6	40μf, 450V ,,	R_{13}	100Ω, 5 watt
C_8	40μf, 350V ,,	R_{14}	100Ω pot., 5 watt (Output cathode balance adjustment)
C_9	40μF, 450V ,,	R_{16}	1MΩ pot. (Feedback adjustment)
C_{10}	10μf, 600V	R_{17}	4.7kΩ, ¼ watt
Ch_1	5H, 300 ohm, 40mA choke	R_{18}	15kΩ, 10 watt
Ch_2	10H, 90 ohm, 200mA choke	S1	S.P.S.T. switch (Feedback disconnect)
R_1	50kΩ, 1 watt	T1	Output transformer—(See text)
R_2	68kΩ, ¼ watt	T2	Power transformer 375-0-375V, 200mA, heater as required
R_3	500kΩ (volume control)	V1, V2, 7 F7; V3, V4, 1625; V5, 574; V6, OB2; V7, 6X4.	
R_4	47kΩ, ½ watt } Cascode 2nd grid voltage		
R_5	100kΩ, 1 watt } divider		
R_6, R_8	220kΩ, 1 watt } Cascode load and balance		
R_7	50kΩ pot., ¼ watt } adjustment		

Hedge Cascode power amp. 1625 PP, 1956

The 1950's was an intriguing period from the point of view of innovation in audio. I think it is safe to say that during that time the technology of audio kind of matured and many circuits got refined. It was also a period of which engineers and manufactures dared to apply circuits that needed adjustment by the domestic users – in particular during the first half of the 1950's. Circuits such as adjustable damping and AC balance comes to mind. Another issue that describes this fascinating period was far better passive components. C-core transformers was invented providing output transformers that surpassed the old shell types by several octaves. Better reliable resistors and capacitors and so on. Still yet , had the engineers of those days been able to use modern passive components as of today, they would have partied all day long.

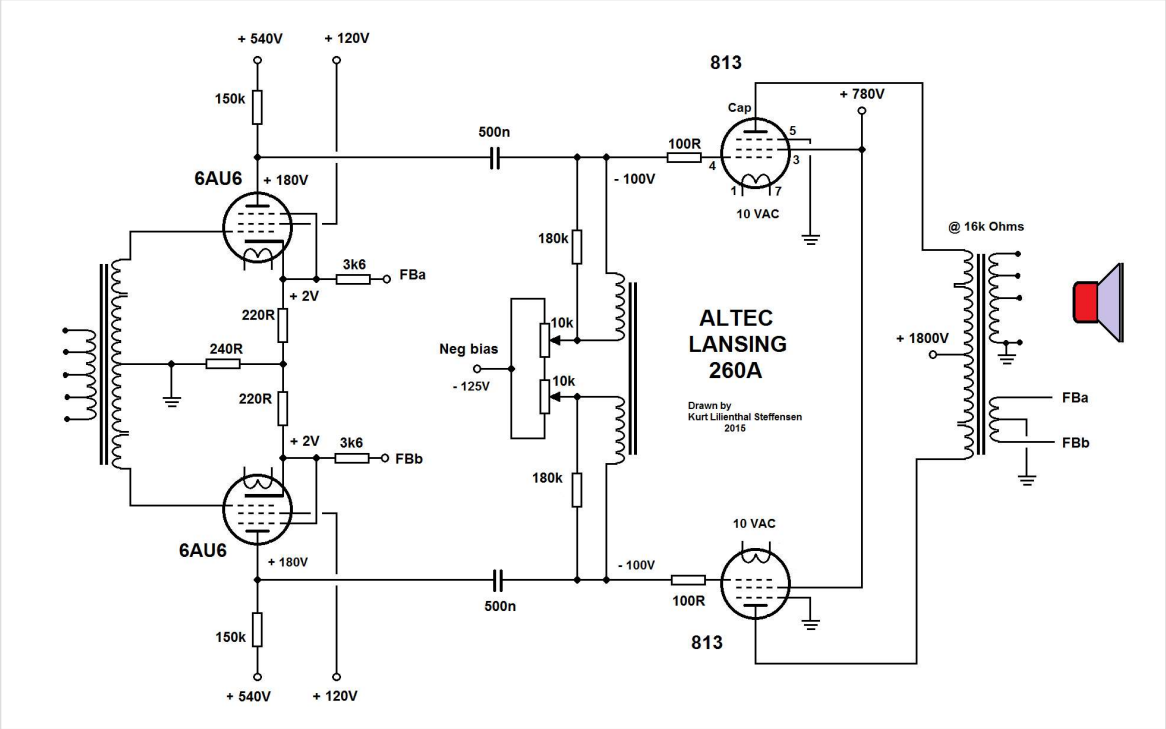
The above cascode long tail phase splitter amplifier and driver is a typical example of the skills and imagination carried out by the audio engineers of the 1950's. It was designed by L.B. Hedge and appeared in Wireless World , June 1950. There is nothing new in this circuit, but it is never the less interesting and great care would have been needed to tame the 7F7/6SL7 in that application. Apart from that valve nothing is component critical. The output valve may be any of the KT66/6L6/807 family – and this is a very large family indeed. Same goes for the rectifiers, just about any such will plug in here – even solid state. A thing that was impossible to obtain back then was good and large electrolytics. Hence it is not unusual to find paper/oil and metalized paper capacitors, the major compromise here being the relative small capacitance related to these. Good capacitors, potentiometers and transformers were extremely expensive in those good ol' days.

This is definitely a circuit worth for experiments. Any OPT suitable for 6L6G/KT66 will do.

Fisher 55A , EL34/6550 PP, 1954-55

This was the last amplifier in Fisher's 50 series. The circuit is similar to 50A and 50AZ , but the the pre amp section and the feedback scheme is very different.

Read vignette and schematic at Fisher 50A in part 1.



Suggested by Bill Perkins:

Altec 260A, 813 PP, (1956)

Now, we are talking…Look at this at this thing…1,2V RMS at the input terminals and you will have some 260 freaky Watts to feed your speaker !
(Take that , you 205D SE purist

This is really a “look and learn” thing. Stunningly simple for a high watt tube amp. Heck it would be even for a 10 Watt’er.

Iron input phase splitter (way to go) , 6AU6 PP choke load drive (Balanced to you geeks) and 813’s output. The original input transformer is a step up thing, but as we do not need that much gain for modern signals a 1:1 or 1:2 would be better. The driver choke could be just about any interstage with a midpoint (center tapped) and the secondary may be left unused or if possible split into two and incorporated at the primary in order to make an autotransformer. The output transformer is difficult to find. It should be a 12-16k Ohms primary and whatever output you prefer. If it has 0-4-8-16 Ohms taps, you can make the grounded midpoint from the 4 Ohm tap and use the 0 and 16 taps as the feedback to the 6AU6 cathodes. A little twisting with the 3k6 feedback resistor may be necessary.

You may wonder how they manage to drive them mighty 813’s from a pair of dwarfy 6AU6’s ? The answer is simple. 813’s needs very little drive power (Read: no grid current and high amplification) in order to deliver. You hardly need to tickle it at the grid and it gives away all it got. Thats how I like women as well.
2 x 3B28 and a 5R4 rectifier…He he…I like..

Well – here comes the down side..Weight 186 lbs….1800 plate Volts and 780V sg 2…! I use a little less Voltage in my Williamson 813PP design (to be found in the Williamson articles), and you might find some of the little tricks I use advantous if you wanna go into high Voltage transmitting tube audio.

A note of concern. I would not recommend playing with these transmitting tube designs unless you are 110% familiar with advanced high Voltage tube technology. No tube is worth sacrificing your health or life.

The original schematic as well as the PSU and many details can be found here in very good quality:http://www.pearl-hifi.com/06_Lit_Archive/07_Misc_Downloads/Altec_260A_Instr.pdf

Good pick, Bill.

CLASS A PUSH-PULL CIRCUIT

WITH 5-WATT RATING

The author holds that 5 watts is sufficient for high-quality reproduction in the average living room, and in a subsequent article will put forward evidence in support of this view.

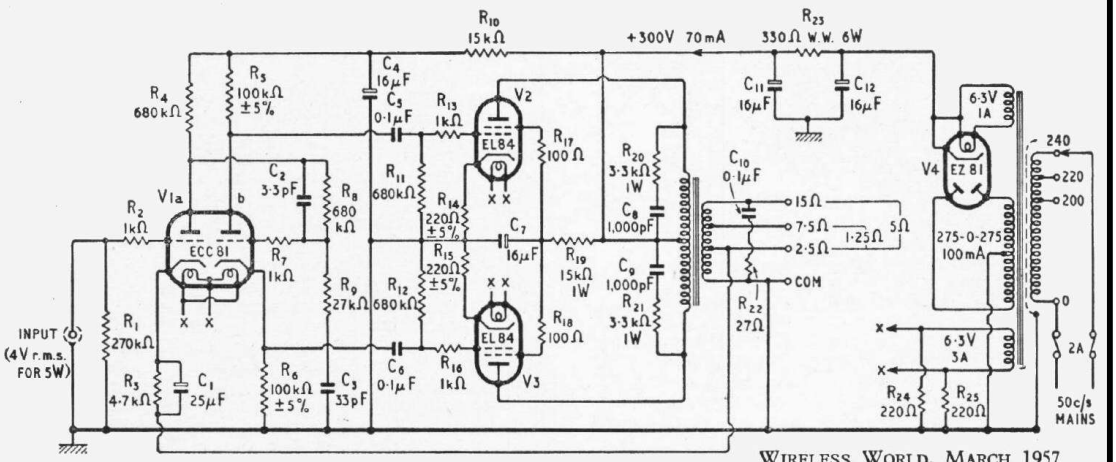
The amplifier is suitable for use with the author's gramophone and microphone pre-amplifier described in *Wireless World* for January and February 1955 or with a simplified pre-amplifier to be described later.

Output Stage.—The most expensive component in a high-quality amplifier is normally the output transformer, on which the outlay is sometimes over £5. The cost of an output transformer is dependent on many factors, but a very high ratio of shunt inductance to leakage inductance is always expensive because it necessarily involves dividing the windings into numerous interleaved sections.

In the present amplifier design, the output valves operate under pure class A conditions, and a clean high-frequency performance can consequently be obtained with quite a simple transformer, since there is no need for the leakage inductance between the two halves of the primary to be as low as is necessary under class AB or class B conditions.

By Peter Baxandall

Complete circuit of amplifier. All resistors ½ watt 20%, except where otherwise specified. All capacitors (other than electrolytic) 20%. Mullard ECC81 may be replaced by 12AT7, Osram B309 or Services type CV455. EL84 may be replaced by Osram N709, and EZ81 by Osram U709.



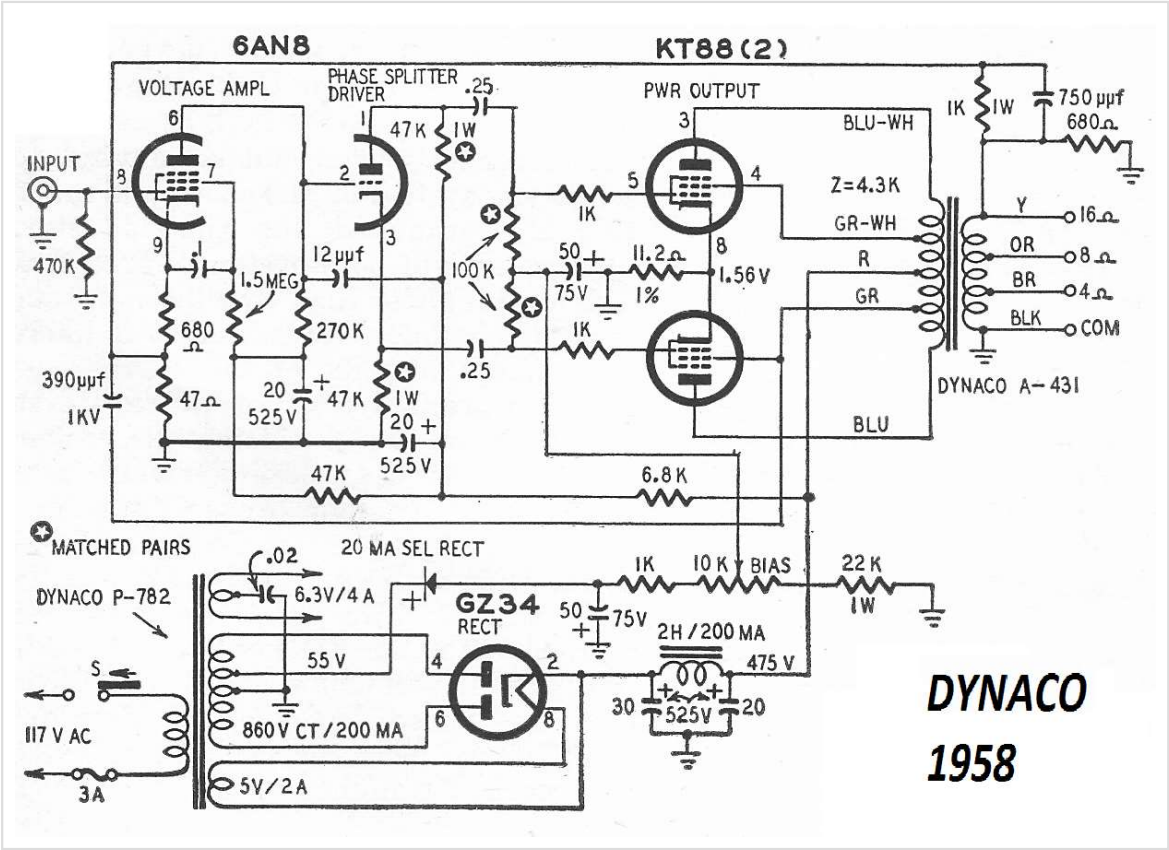
Baxandall 5W amplifier, EL84PP, 1957

This amplifier is a splendid exploration into minimalistic design. It was published in WW as an "inexpensive high quality amplifier". These were buzzwords at the time – we keep forgetting just how expensive parts were back then. Baxandall even ran it in class A in order to "remove some stress from the output transformer". A very different approach from nowadays.

The circuit is an abbreviated Williamson and much care had been implied in order to optimize the amplifier with as few components as possible. It is still a very good bid on a low cost high quality amplifier.

Yes – it IS the very Baxandall behind the tone controls we know as "Baxandalls".

A GREAT little small design.



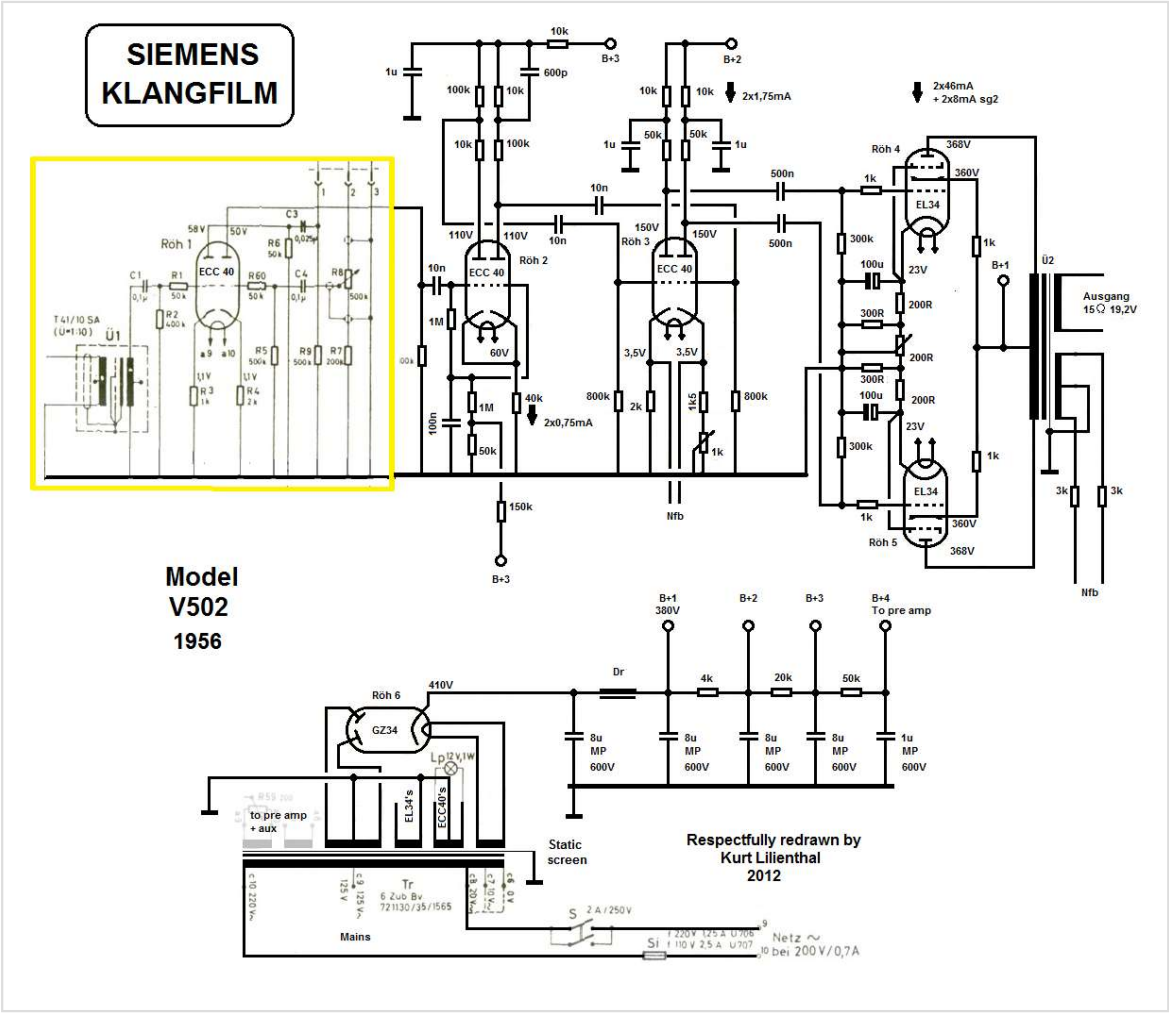
Dynaco kits, 1955 to 1968.

Well known classics and good OPT iron.
These Dynaco circuits by Hafler and Laurent were almost one to one copies of Williamson, Mullard and GEC designs, but in my opinion the Dynaco copies are generally not very good engineering. The main transformers and the smoothing choke in the ST-70 are quite underrated, even more so when they were exported to the 50Hz mains supplied Europe. It is a deep mystery to me that the staff of “Absolute Sound” elected the ST-70 as one of the top 10 amplifiers of all times ! It is most certainly the best selling tube kit ever – some 300.000 were made according to Dynaco themselves. It was quite affordable and easy to build, but in my ears they do not sound as a good tube amplifier. It is harsh and rigid. It modulates the signal in a weird way and distorts the transients.

They are relatively easy to modify though.But you need to dump the entire small signal section and the low quality PCB that came with it. Elsewhere on this site I will you show two possible circuits based on the ST70 hardware.

It is also worth to visite the site of Patrick Turner in Australia. Lots of high class info and stuff. He even sells transformers. Here is a link to the Dynaco modifications of P. Turner:

http://www.turneraudio.com.au/dynacost70mods.htm



(Suggested by yours truly)

Siemens Klangfilm V502, EL34 PP, 1956

This is a very high quality amplifier made by the Klangfilm department of Siemens, Germany. Klangfilm dates back to the 1920's and was once owned by the AEG company that also held Telefunken. I have several valves marked "KLANGFILM" , but I am not sure if these were indeed produced by Klangfilm. Might as well had been AEG, Siemens or Telefunken. Anyway Klangfilm produced professional amplifiers and similar gear for PA-service and broadcast. Cinema and theatre was their main market.

The V502 is a master stroke. The EL34's are driven quite conservatively in class AB service with some 370 Volts at the anodes and a gentle bias of about 46mA. This equals a plate dissipation of approximately 16 Watt's + 2,7 Watts at the sg2, all in all about half of which EL34 accepts. A pair of original Telefunken 34's lasts a very long time in this rack mountable amplifier. It is clearly made for long and stable service. The ECC40's are configured for similar low current and Voltage. No PSU electrolytics to dry out here, they are all MP (Metallized Paper). These and paper in oil capacitors were rather common at the time. The on/off switch are made of a regular twin switch, but here connected in parallel for double reliability. Better safe than sorry.

In the schematic I have left out the tone controls in the pre-amplifier and the networks feeding the in build meter for user service adjustments. The preamplifier is way too sensitive for modern domestic use. If you own one or two of these amps, and you happen to be a dedicated vinyl fan, I would suggest to convert the pre-amplifier section in to a RIAA amp. The input transformer is of usual good Siemens quality and it will provide you with a sweet and delicate sound quality. The build quality is the usual Siemens, Klangfilm, Telefunken. This means *high* with care for the detail. It looks pretty darn good, I only regret that Siemens/Klangfilm never potted their transformers. (Neither did Telefunken or Philips) Sometimes a shield of mu-metal was strapped around the winding side, which is quite an efficient solution, although it does not look as good.

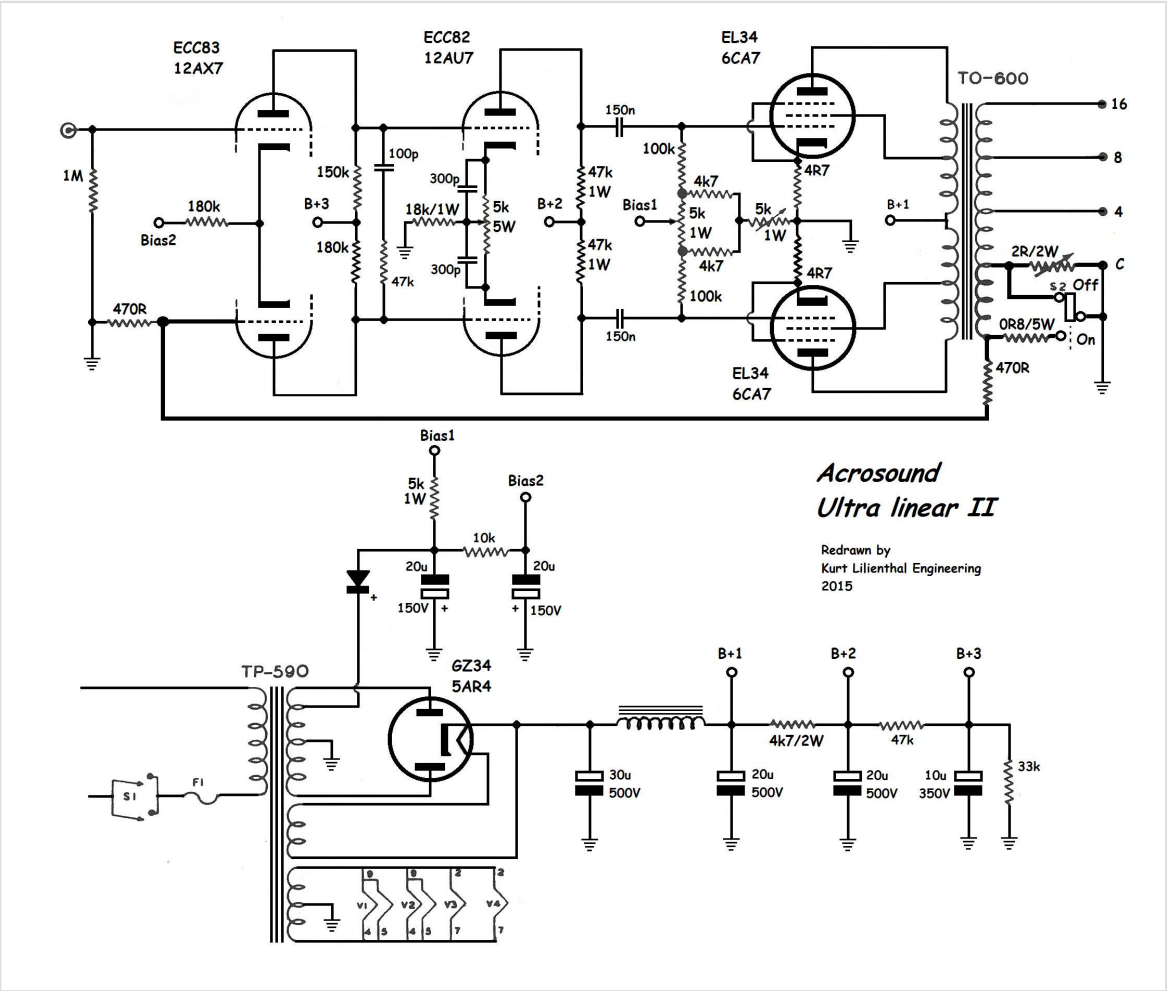
Right, lets talk about the power amplifier. The OPT only has two secondary windings, one is fixed for 12-16 Ohms speakers, the other is a balanced feedback winding that we will discuss later in more detail. I like the idea of a single speaker output winding as it avoids the usual leakage losses in unused windings (0-4-8-16), sadly this one is dedicated to 15 Ohms speakers only. The EI core laminates is of high quality CRGOSS, however the copper DC resistance is on the high side. 260 Ohms per half primary winding. It might have been on purpose to provide an extra safety margin in case of runaway of the 34's. On the other hand it was not unusual that the copper resistance was quite high in the output transformers of former times. But too high copper resistance adds to distortion and negative dynamic regulation – Losses – and should be avoided if possible.

The advantage of a separate feedback windings is that it does not force the amplifier into instability in case of capacitive loading from crossovers, cables and such. Here the winding is further balanced to provide balanced fb to the balanced driver – this is the only proper way to apply fb to a balanced stage. No global fb used in this amplifier !

The input stage is balanced as well and splitting the signal in form of the well known long tail. But these Klangfilm guys does not rely upon the best that may be achieved by a grounded common tail, they used a negative Voltage in order to implement a high resistance. This is almost as good as a modern CCS Fet/transistor. The remaining unbalance are not "recovered" by means of fb, but simply by the elegant and simple resistor network at the plates. Thus the DC balanced are maintained and the output differs in magnitude by outputs taken at various points. Excellent and simple solutions to a number of problems in one stroke. Many contemporary designers would favour by studying this old circuit.

The driver and pre-röhre is the trusty old ECC40. This excellent twin triode are quite similar to E80CC, but equipped with a rim-lock base.

The Klangfilm V502 is admirable good audio engineering. Hats off guys….



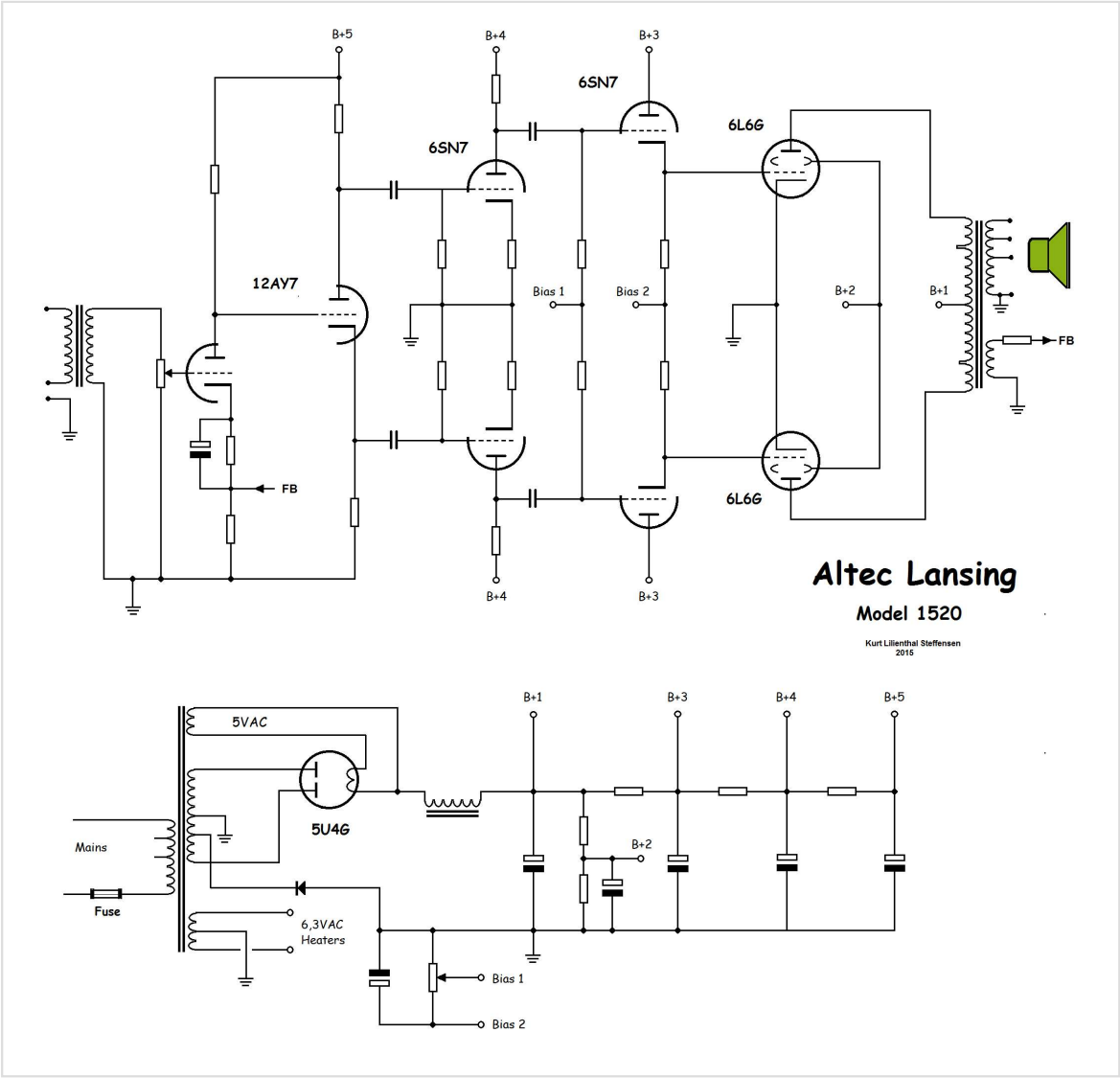
(Suggested by JC Morrison:)

Acro Sound UL-II, 1954-58 ?

Acro Sound company was founded by Hafler and Keroes. Apart from their good transformers, they also made some really nice amplifiers.

The UL-2 are an all balanced/differential construction. It allows adjustable “power damping”. This was a feature that was rather common in the 1950’s, but sadly it passed out – possible due to the difficulties with the adjustment.

Excellent design.



(Suggested by Bill Perkins:)

Altec 1520,6L6GC PP , (Late 1950's ?)

Improved WIlliamson. Unfortuneately I have not been able to find a proper copy of the schematic. It was not possible for me to read the components values with any certainty, but that does not matter much as it is pretty straight forward and easy to understand. Please, contact me if you have a copy of the schematic good enough to read the components. Trannie input 12AY7, 6SN7, 6SN7 cathode driver to 6L6GC out….

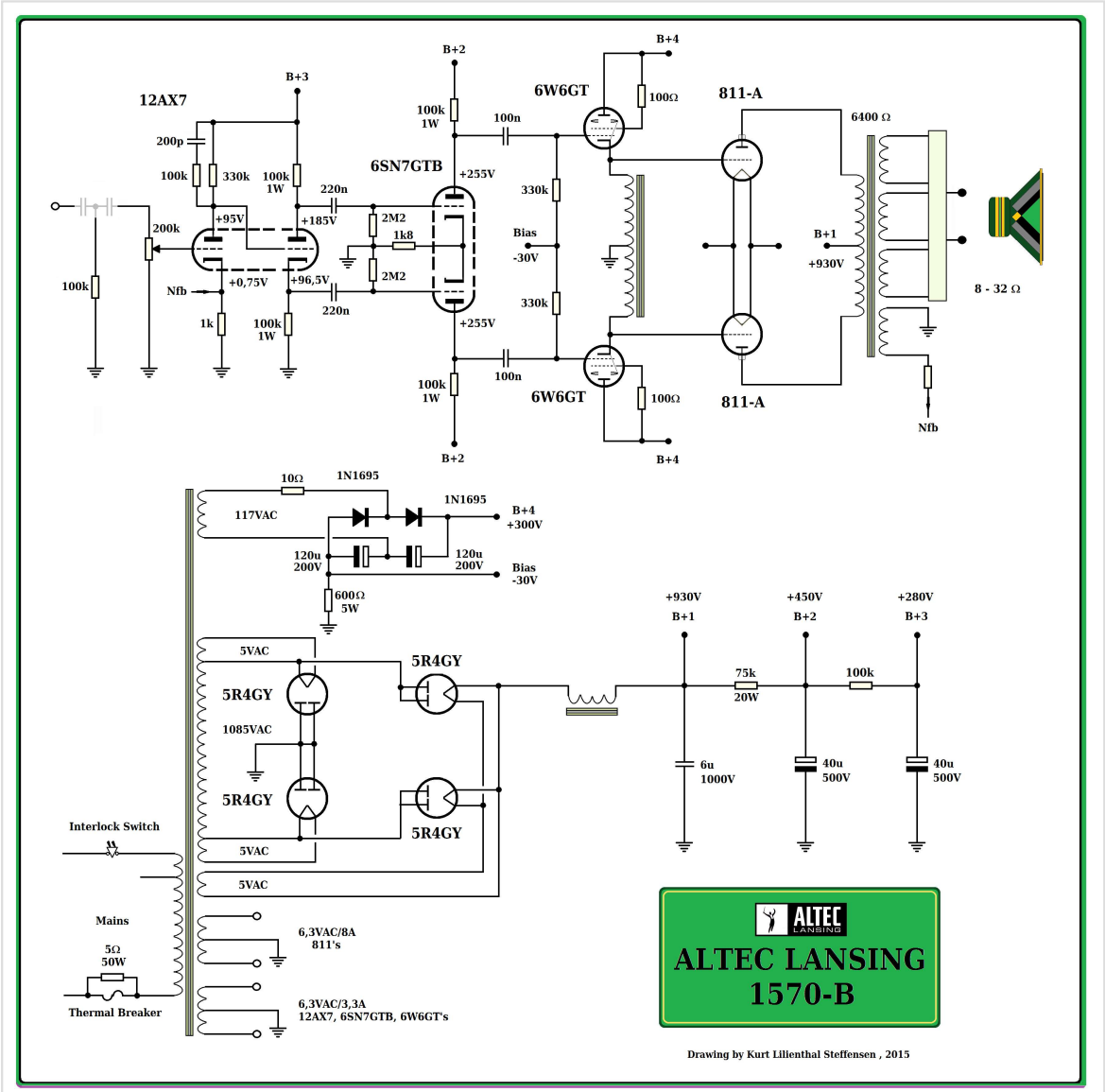
Nice – really nice…It differs from the traditional Williamson in that the power tubes are driven by a cathode follower and that it uses active bias. The 12AY7 is a good choice as input tube. I also like that all stages are properly isolated from another by means of individual Voltage dropping resistors/electrolytics. Do also note that the PSU is a choke input. This demands a choke capable of handling the excessive AC Voltages, but provides considerable better regulation and lower ripples. Do notice that at turn on, the PSU capacitors will be exposed to the full AC peak from main B+ windings and has to be rated to handle this.

The gain is high for modern use, though. I suggest to remove the input transformer and add 10 Ohms/1W resistors at the cathodes of the 6L6's in order to be able to measure the bias. I always use such resistors and strongly recommend this as a common practice. Apart from proving a neat

measuring point, such resistance slightly improves the linearity due to cathode regeneration and adds some protection against runaway.

My guess is that the 6L6's are ran at about 350 Volts, sg2 270V and that they sought for high power. That means that OPT is about 6-7k Ohm and the current per 6L6 is 44mA + 2-3mA sg2.

I really love the Altec amps, in fact I prefer them to Western Electric's. But that is just this viking speaking.



Altec Lansing 1570B, 811-A PP, 1958

This is yet another adorable power amplifier from the labs of Altec. It is a Williamson design with an exclusive choke loaded driver. The 811-A's runs in class B, which means that not only does they need a reasonable high Voltage swing it is also necessary that they are driven from a low impedance current capable source. Hence the choke load.

The rest of the amplifier is pretty conventional, although of good and intelligent engineering. It is clearly made for high power and continuous use. The Voltage for the driver amplifier is taken from a separate winding, using a Voltage doubler. The 600R resistor in the current loop provides the negative bias of -30V, by means of the grounding technique.

The total gain of the amplifier is about 72 db. This sounds like a lot, but it has to be seen in the light of the output of close to 200 W. The input sensitivity fits a modern signal source very well.: 1.0 volt rms for the rated output Power Output of 175 watts at less than 5% THD from 65 Hz to 20,000 kHz. At 165 watts the THD is less than 3%. from 70 Hz to 10,000 kHz. At “low” levels the frequency response is 10 Hz to 50 kHz ± 1.0 db, according to the specifications. It came with an optional input transformer.

The output Impedance is declared to be less than 10% of the nominal load impedance. Noise Level: Output noise -25 dbm: 77 db below rated output.

As far as I can tell this Altec had no fuse. Instead it is equipped with a thermal bimetal circuit breaker. This has the advantage that in case of overheating the 5 Ohm resistor would be in series with the power transformer and the amplifier would keep on playing, although at lower level. It was mounted with an interlock switch as well, in case someone would try to tamper with it with the power on.

Dimensions of the green monster: 10 1/2″ H, 19″ W, 13 1/2″ D . Weight: 59 lbs

The Williamson input stage is DC-coupled, which often means a relative low plate Voltage for first tube. This goes for the 1570 as well. The plate resistor of 330k makes that lazy 12AX7 more sleepy than it has to be. It would make good sense from a sonic point of view to change it to 5751, 6972 or 12AY7. The 330k should be divided, so that only some 47-100k loads the input. Remember to insure that the phase splitter (second stage) , are strapped to fit the plate Voltage for bias !

The 6SN7 makes a fine differential amplifier, but you may consider to strap it with a long tail or CCS at the cathodes. You might also consider to change the 100k plate resistors to a more reasonable 47k or so, for a higher roll off. (Better pulse response)

The driver is fine as it is, no need to change anything here. Just about any small power pentode/tetrode/triode will do the job as long as the correct bias is taken care of. 6W6G is a fine little power tube, 6V6G, 6Y6G, 6K6GT, 6F5GT, 5881 or 5932 would be fine here as well.

Due to the nature of the 811 and the circuit as such is is not possible to adjust this amplifier into AB – not even AB2. The 811’s are biased at 0 Volts and thats it.

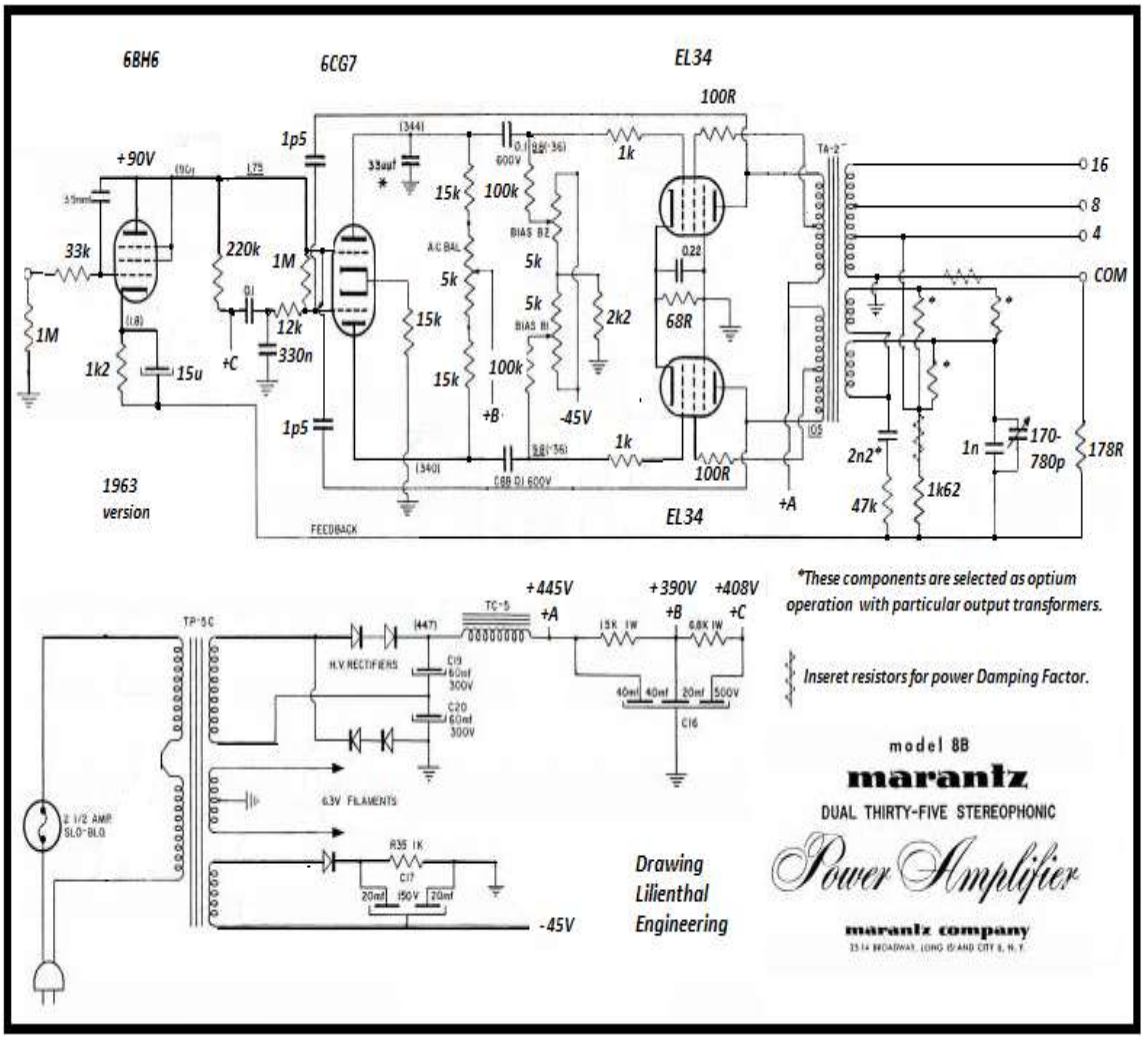
I do not know how much current the power transformer may deliver at continuous service (I have no 1570 at hand), but it looks like it might be capable of some 150-200mA ? If so it is possible to modify it for a pair of 211’s in class AB. Now THAT would make this amplifier a true monster with regards to sound as well. You would need an additional transformer to deliver 10 VAC at some 7

Amperes (or two of 3,5 A) As there is no easy way to obtain a negative bias for the 211's a common cathode resistor would be needed. You might also consider a pair of 211H's (Plate caps). These are not quite the same as 211, but might be an even better solution in this circuit. In both cases adjust the bias for class AB2, that will ease the continuous current demand and still allow some 20-40 W class A. By using a separater transformer for the 211 filament, we will lift some 50 Watts of burden off the shoulders of the mains transformer. I think it is a plausible modification.

The 1570 PSU is a nice choke loaded breed, which insures good regulation. It strikes me however as a little weird that Altec chose to use a bridge of four 5R4's for an amplifier in class B service. The Voltage drop over these are quite dramatic, in particular for a class B amplifier. This *will* compress the signal. That might not be a bad thing for many public address applications, but it will modulate the signal as well and that is never good. The small 6uF paper in oil capacitor wont be of much help here.

The plate to plate copper resistance of the OPT is quite low – only 96 Ohms. This is in particular low considering the relative high impedance of 6400 Ohms. Nice job, Peerless.

Hats off to the engineers from Altec Lansing.



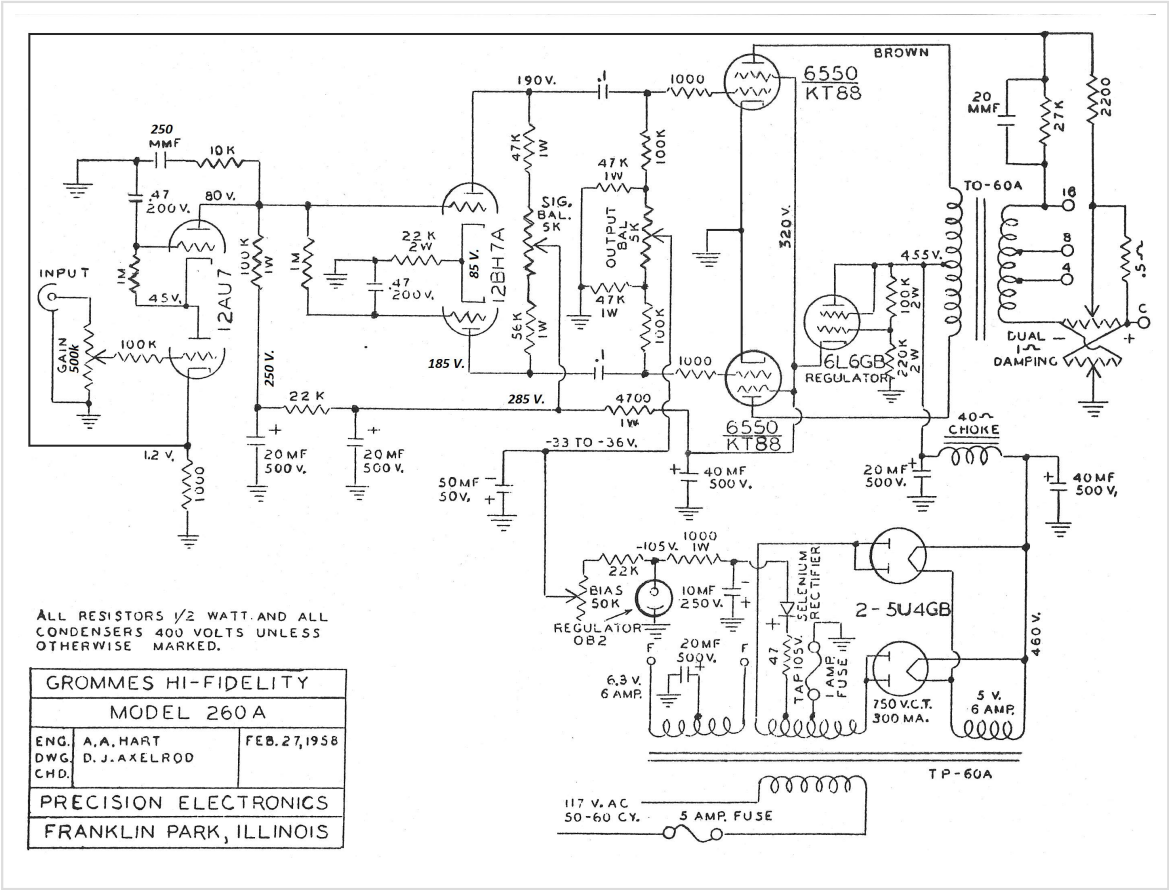
Marantz 8B, 6CA7/EL34 PP, 1956

Two versions was made of the famous 8B, one with a paralleled 12AX7 input and another with a 6BH6 pentode.

Some prefers it converted in to Williamson design. (Easy to do) It is similar to the Mullard “20 Watt Quality amplifier” aka 520 that was published a year or two previous to the Marantz 8B. The Marantz was however a better design, not least due to the 6CG7 driver. (Mullard used an ECC83) . A few years later Dynaco came up with an “improved Mullard 30 Watt” , using the better driver circuit from Marantz.

The models 2,5 and 8 are almost identical circuits.

Cool looking classic……Good sounding classic.



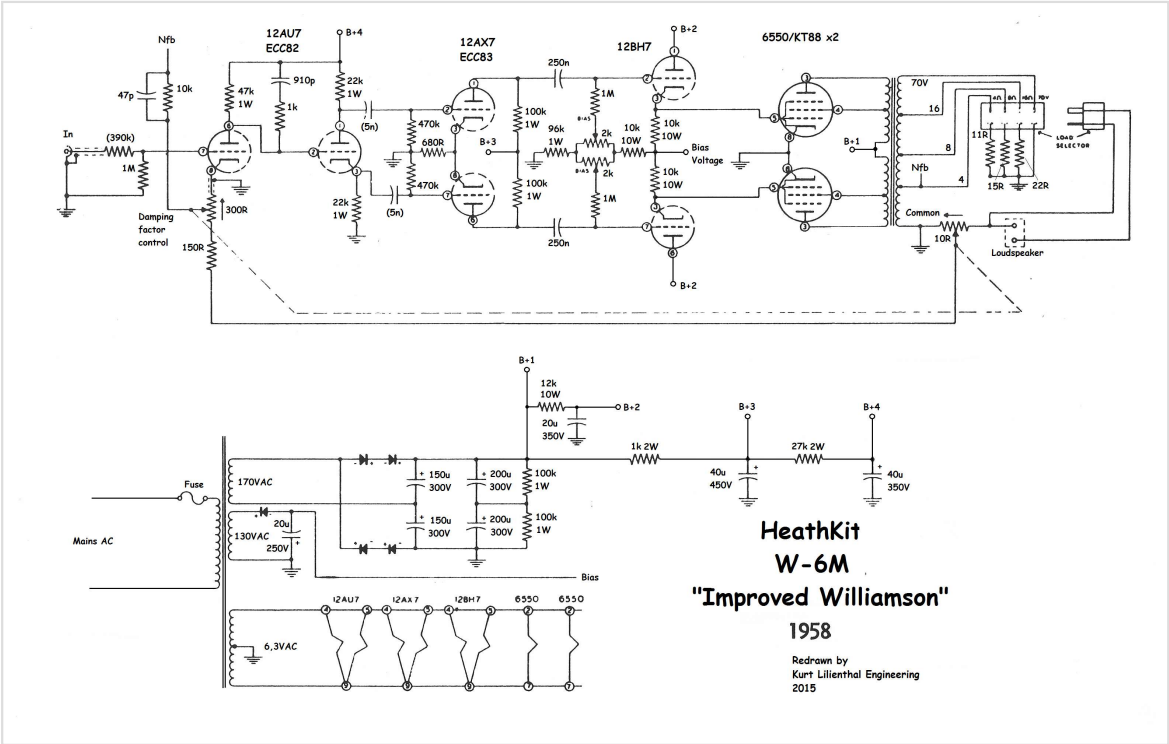
Suggested by yours truly:

Grommes 260A, KT88 PP, 1958

12AU7 cascode, 12BH7 driver phase splitter, OB2 regulated bias, 6L6GB regulated sg2 and two paralleled 5U5G's. Variable feedback damping. Stunning good engineering.

I like most of the 1950's Grommes designs, that I have seen. There is always a funny and original detail or two to be found in these amplifiers.

Grommes was established in 1946 and are apparently still in business as "Grommes Precision" producing solid state devices for the pro market. A reissue of the 260A amplifier was announced around 2004, but I don't know if it was successful ?



Heathkit W-6M-70, 6550 PP, 1958

Heathkit made a number of Williamson designs.This one called “Improved Williamson” is a 6550/KT88 power with 12BH7 cathode driver. Solid State rectifiers.

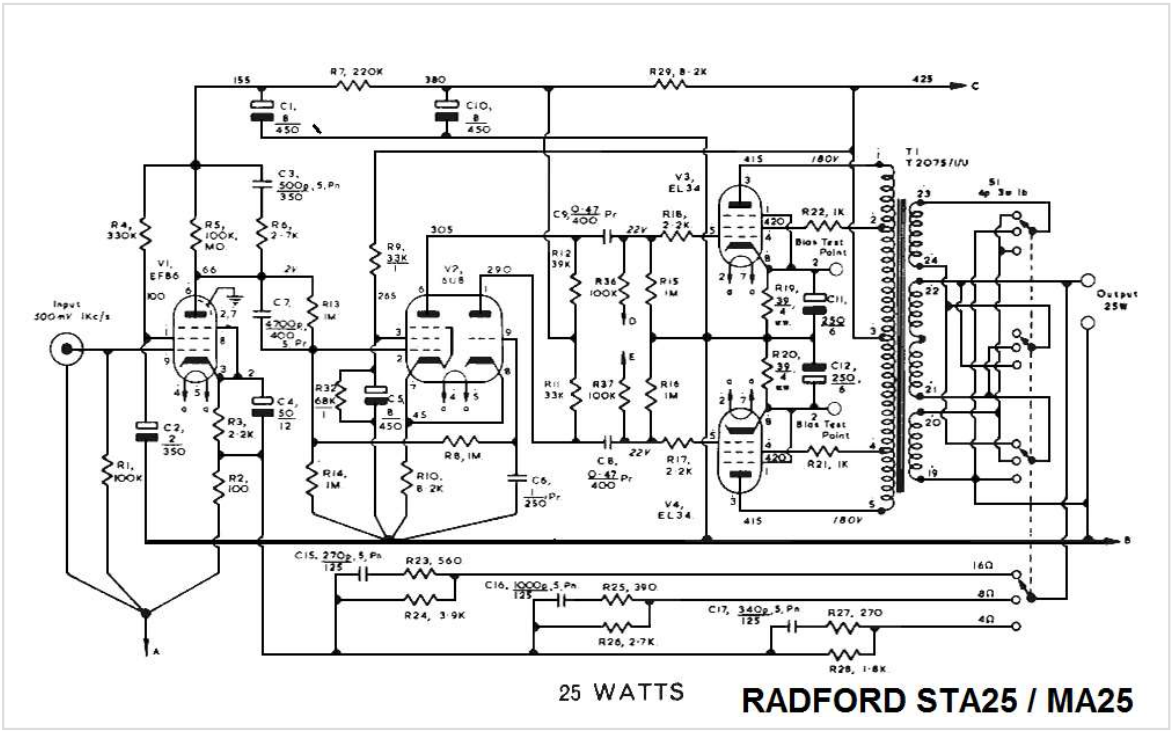
I sincerely believe that Heathkit must have a place in this company. Whom has not at some point been in contact with a Heathkit product ? My first oscilloscope was a Heathkit. Heath company’s first kit was an aeroplane !

I will go deeper into the story of Heath when I find the time.

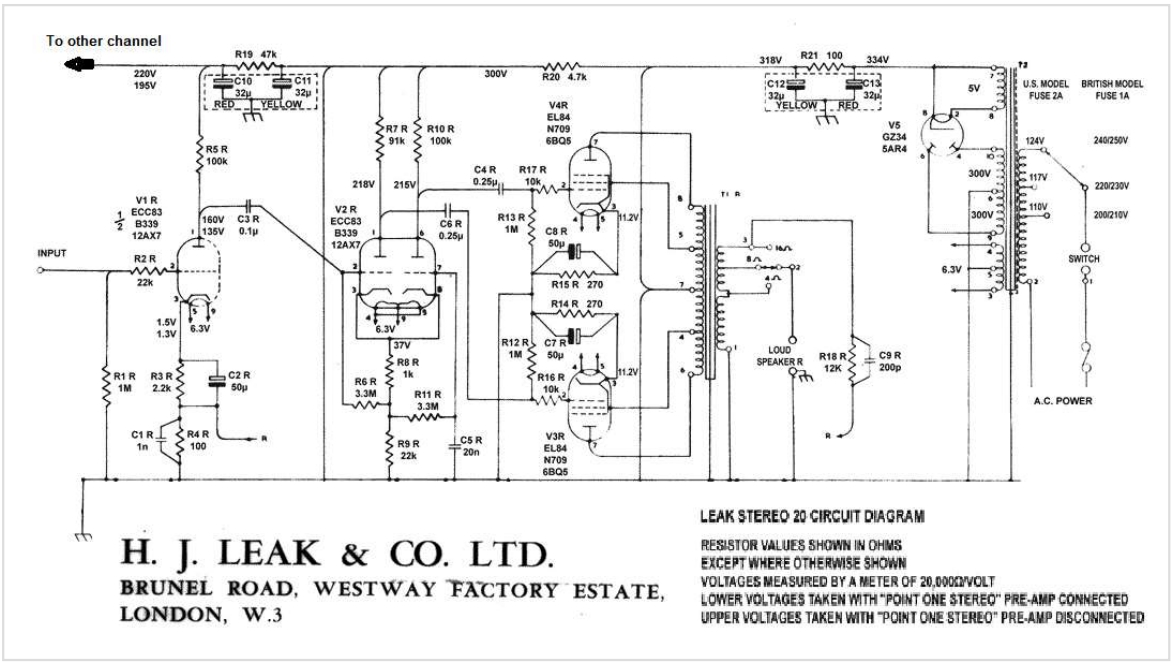
Their amplifiers might not be top of the hat, but most of them were actually quite good and often the iron was some of the best they were able to produce at the time. With a little modifcare – your Heath may become top hat….(There is several other Heath schematics in my Williamson article series, yet to be published)

The W-6M is indeed a very good Williamson.

RADFORD

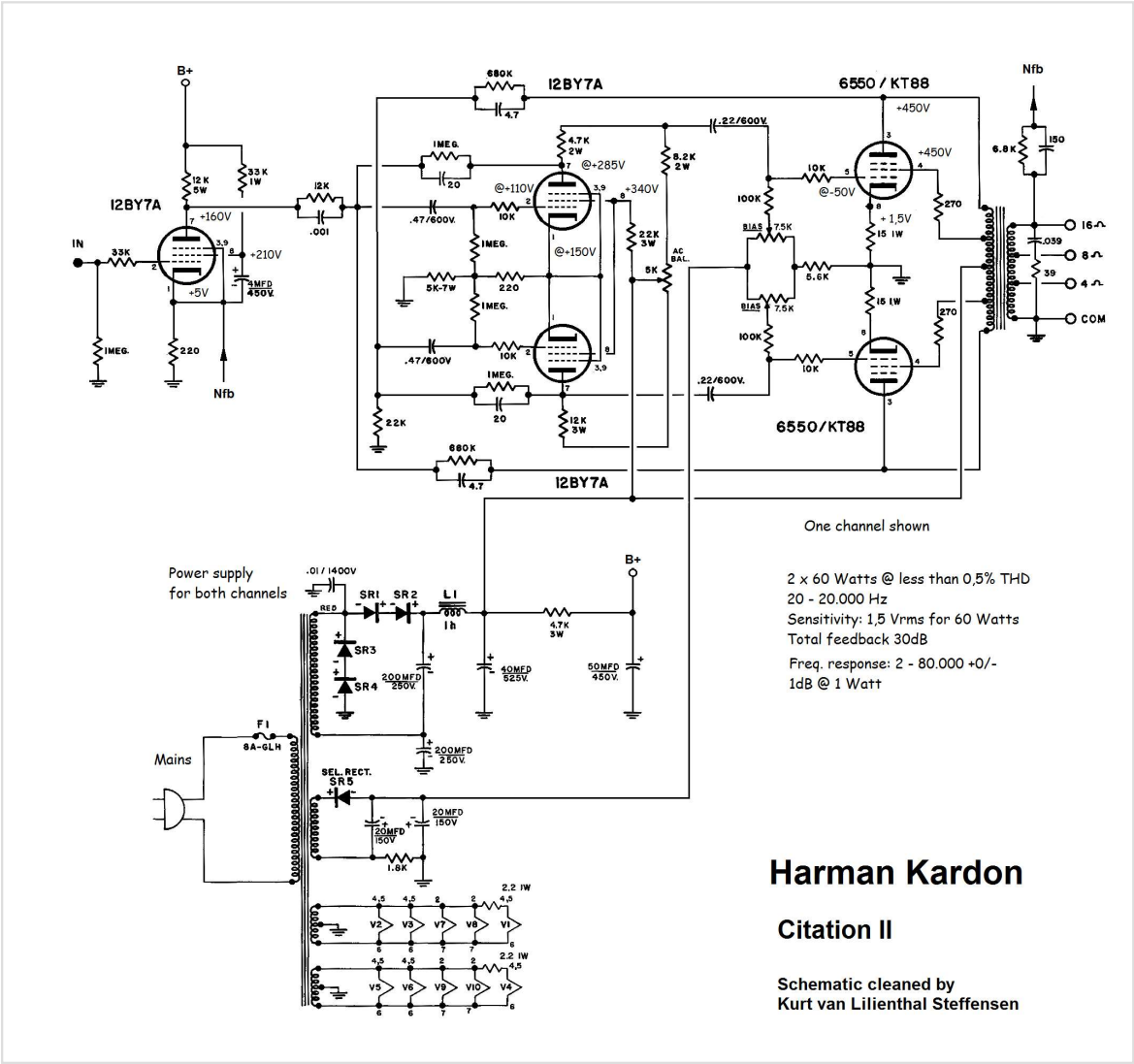


LEAK



The Mullard “520” circuit sadly made school in England. Sad because it is a rubbish circuit. It may be that it measured good for the time, but it really does not sound particularly good, very few managed to tame that 520 circuit.(Marantz being one of them) In USA the school was Williamson. This is also a British circuit, but it sounds a lot better. The simple cure for the RADFORD’s, LOWTHER’s is to modify them to WIlliamson. The LEAK ST-20 as shown above would gain

tremendously from a change to ECC82 or similar and less feedback. (The plate and cathode resistor has to be changed as well – that goes without saying) It is possible to keep the input ECC83 and maintain a high level of feedback. Directly from the shelf the small LEAK's sounds best. (Less worse ?)….But after a nice Williamson modification the big ones tends to "win".



Suggested by JC Morrison and myself:

Harman Kardon Citation II, 6550 PP, 1959

Heavy and..hmm…heavy…..At the schematic above I have removed the meter and its associated network and I only show one channel. The three 12BY7's are actually small power pentodes, but it is a good idea to use them as Voltage amplifiers as the sensitivity they offer is high. Granted they would sound better strapped as triodes – but that may be a matter of taste and preferences, I guess. There is a lot of mixed feedback in this Citation II. Mixed fb never sound good in my experience, but in this Cit.II the causes for the fb made this way is mainly due to the phase-splitter. I don't mind the Schmidt or long tail phase splitters.They can be pretty good. If balance in these is of main concern then there is principally two ways of dealing with that. Compensated by passive components or compensated by means of balanced feedback. We can tell from the circuit as well as the matched resistors, that the Harman Kardon engineers was indeed worried about the

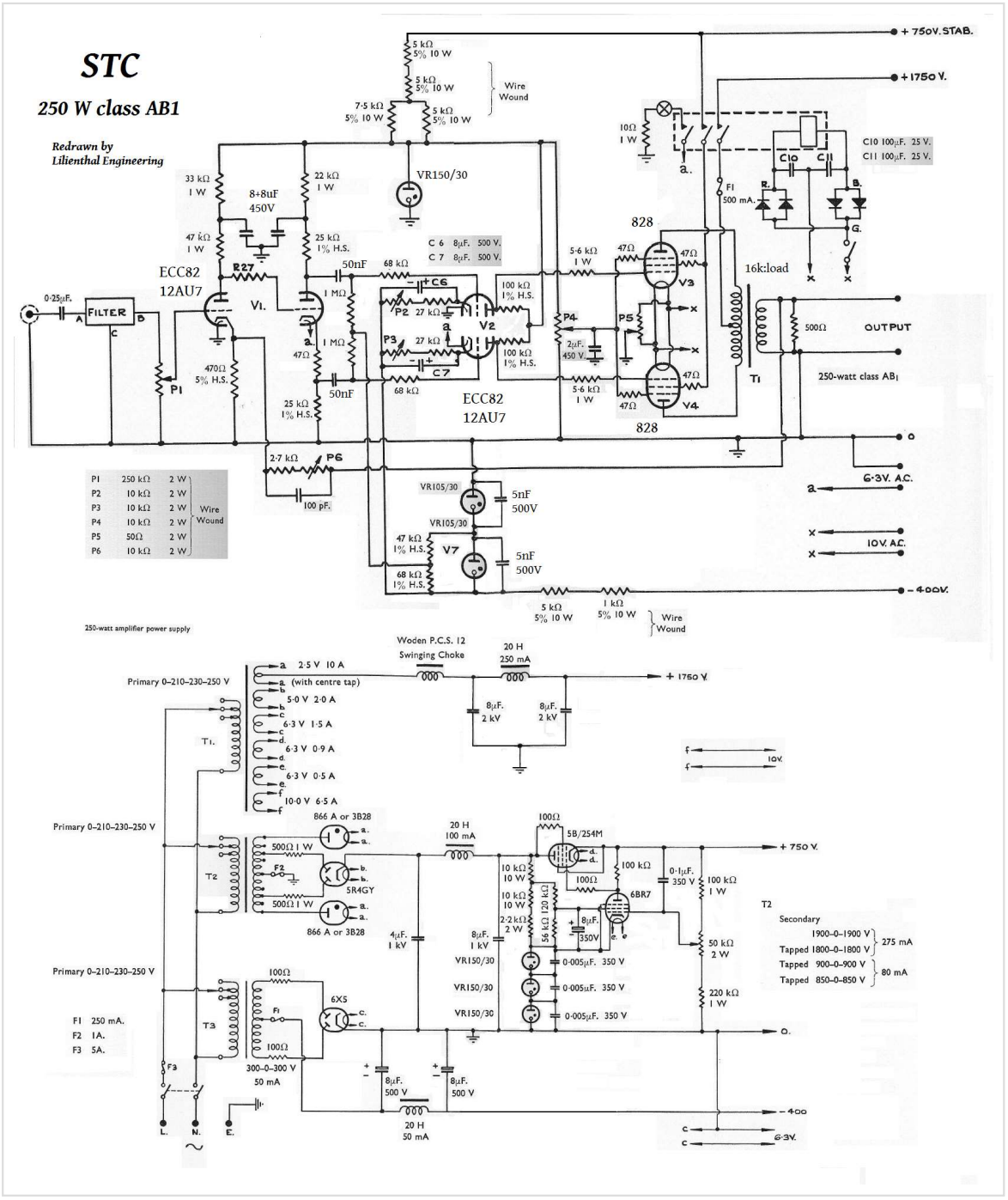
unbalance. HK uses both methods and further creates a fb loop within the global fb loop. Single point fb , however, is a compromise as the Schmidt/long tail phase splitter is a balanced/differential circuit. Single point fb feeds both phases at the same amplitude back to one phase input, thus introducing an unpleasant complex distortion. HK solved the puzzle by feeding the signals back from both of the primary sides of the output transformer to the opposite phase inputs at the phase-splitter. Now, that would be perfectly alright, had they not decided to use global fb as well. Having a fb loop within a fb loop is good if we wants to make a sinewave generator, but it is not good for complex signals such as music. Add to that the sg2 feedback via the so called “ultra linear” coupling, the fb to sg2 at the input pentode as well as the local cathode fb here and we have a chaotic mess of 5 fb points in total. There is also a total of *seven filters* in that simple circuit, due to the complex fb scheme. A good way to deal with that phase splitter and fb is the way Klangfilm did in their V502 model. (To be found elsewhere on this site)

H K could also have grounded the 4 Ohms tap and returned the signals from the 0 and 16 Ohms taps and that way included the secondary in the fb.

I modified one of these beasts some 25 years ago.
I can’t remember exactly what I did to it, but it was a struggle because I wanted an SRPP input stage and to keep the schmidt phase-splitter somehow.
Stupid of me….I should have converted it into a Williamson or triode input ferro phase splitter and triode drivers.
Designed by Stewart Hegeman….Outstanding crazy good OPT made by Freed, New York.
If you have one of these and wants to modify it, it is very well worth the effort due to the high quality of the Freed transformers. I would suggest one of these alternatives:

1) Triode couple all 12BY7’s and disconnect the global fb from the secondary side to the input 12BY7. It is a matter of taste and need for gain if you would choose to decouple the input cathode resistor – but at least you should try it. Cut the number of fb loops and discard as many of the filter compensations as possible. A little experimentation are needed. It is always a good idea to make a start from open loop state. (All fb loops off)

2) Simply convert the whole mess to a Williamson design. There is no need to swop the 12BY7 drivers – simply triode strap these. Change the input to a twin triode a la Kiebert and you are there. Add as little fb as possible – noise and hum may be an issue here. Further reduction of ripple noise may be provided by a small choke (10-20mA , 5-20H) replacing the 4k7 PSU resistor.

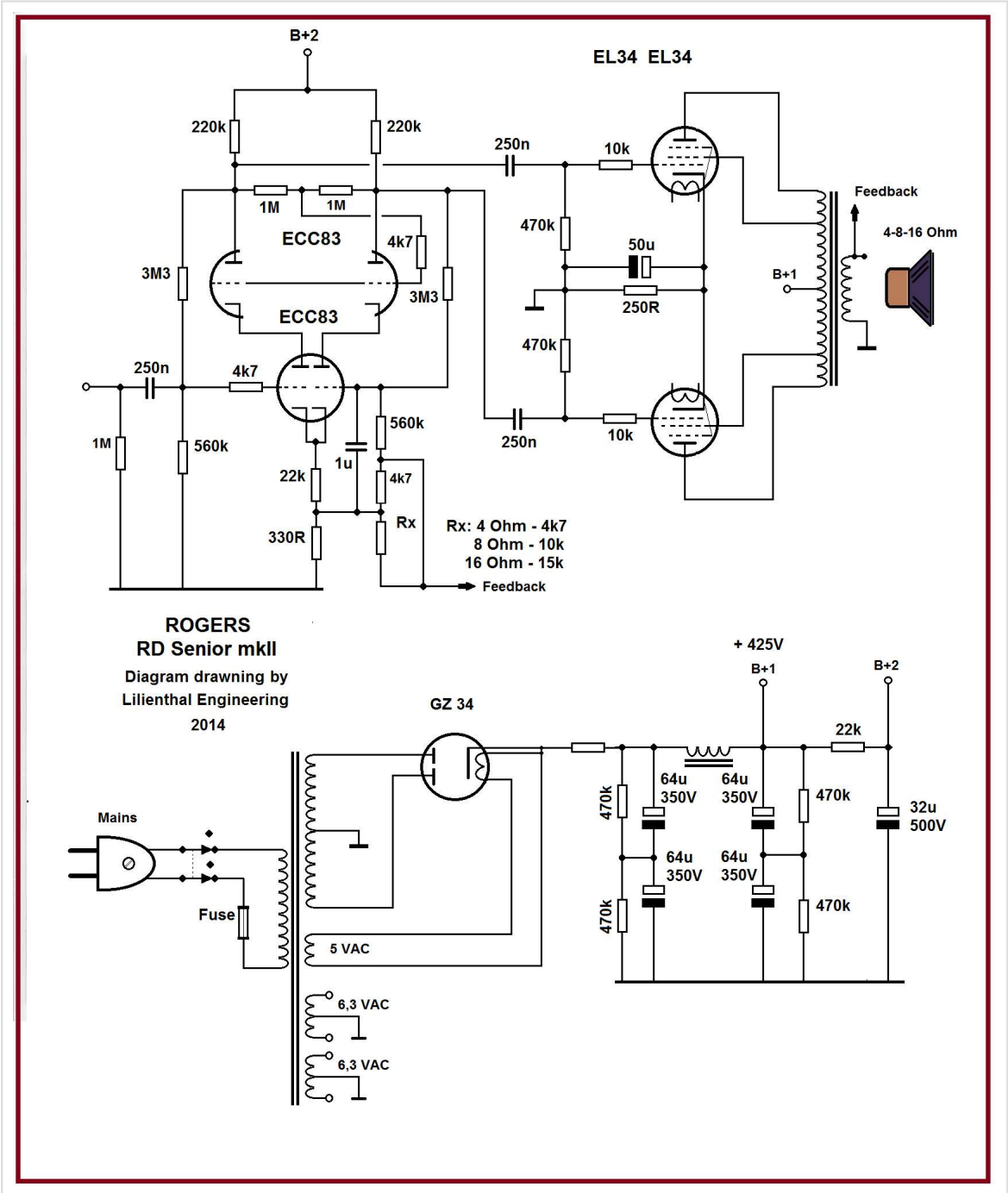


STC , 250W , 828 PP, ?

This STC made in England are candy to us fans of regulated Voltage. It is a genuine Williamson design, but “faster” ECC82’s are chosen over the older octal versions. Look at all that regulation and pay attention to the regulated direct coupled driver. Excellent engineering. The 828 beam power output tubes are regulated with an overwhelming 750 Volts to the sg2’s and by means of a swinging choke and yet another smoothing choke feeding some scary 1750 Volts to the plates. Respect, gentlemen – it is not often – if ever – we have seen a regulated high Voltage high power amplifier. 4 rectifiers, 4 chokes, 5 Voltage reference/regulators and a full regulated PSU in one single mono amp !

Unfortuneately I have little info about this rare amplifier, I would guess it was made between 1955 and 1965 , but it might as well have been a little earlier as ECC82 was introduced in 1951.

I do lift my hat to this 250 Watt class AB circuit.



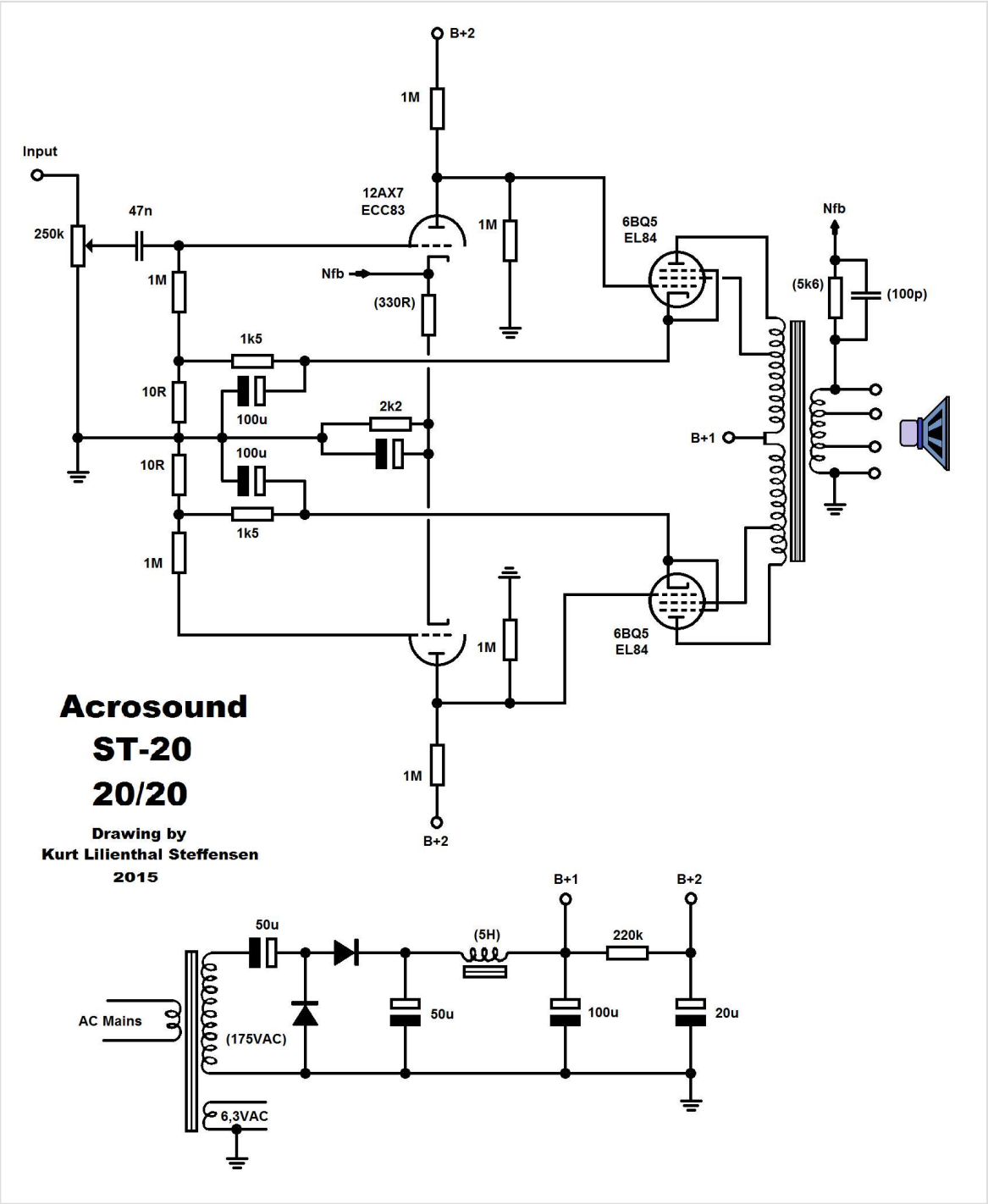
Rogers Senior mkIII, ca 1959

As the model name indicates this was the third generation in this Senior series from the British Rogers. Only two stages, all signal conditioning is carried out by the cascoded Schmidt phase

splitter. Quite nice. Apart from this the design is conventional, so lets concentrate on that Schmidt cascode and the unusual feedback scheme.

The Schmidt phase splitter is a differential amplifier, but one side of it is partly “driven” by the feedback from the OPT. ACtually it is split to the grid and the cathode ! There is further fb from the plates of the upper ECC83 to the grids of the lower ECC83. As there is no capacitor here it also acts as DC fb , maintaining the DC balance of the system. Finally the 4k7 resistor from the midpoint of the upper plates feds fb to the grid of one part of the balanced amplifier. That is an awful lot of feedback and though it lowers the 2′ and 3′ harmonics, hence THD, it creates a large portion of high harmonics. I like the simple schematic, but in my experience such fb themes rarely , if ever, sounds too good.

Still, I like that amp and imagines that it use to play a lot of early Beatles.



Suggested by JC Morrison:

Acro Sound 20/20, EL84 PP, 1960

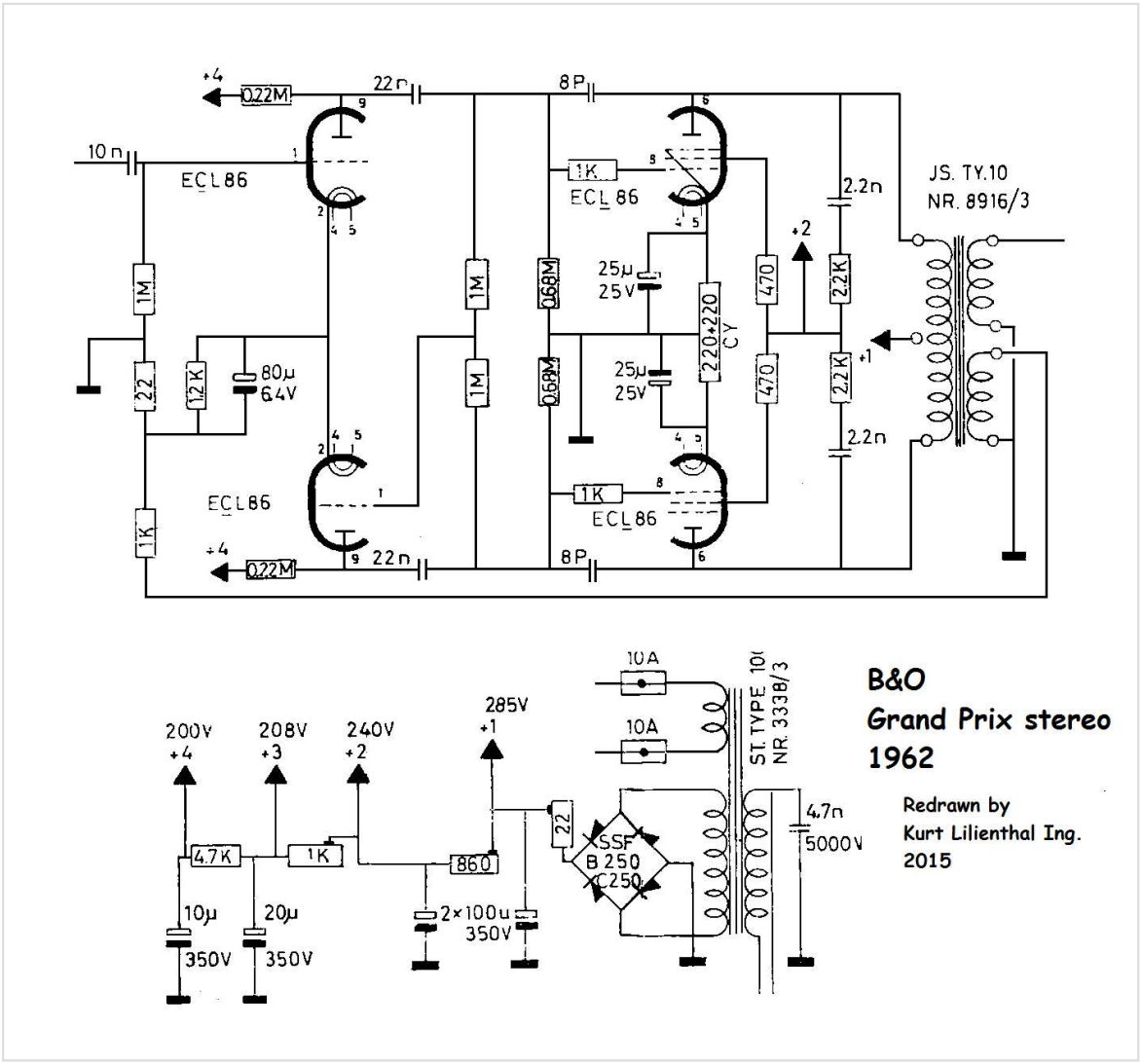
Yup – this is a neat little thing. Stage one:amplifier and phase splitter, stage two: output. Simple and efficient.

It is similar to a lot of designs from the time.

Rogers “Cambridge”, Madison 360, Dynaco, B&O just to mention a few.

Sometimes this arrangement was made by one of the triode/power pentodes in same envelope.

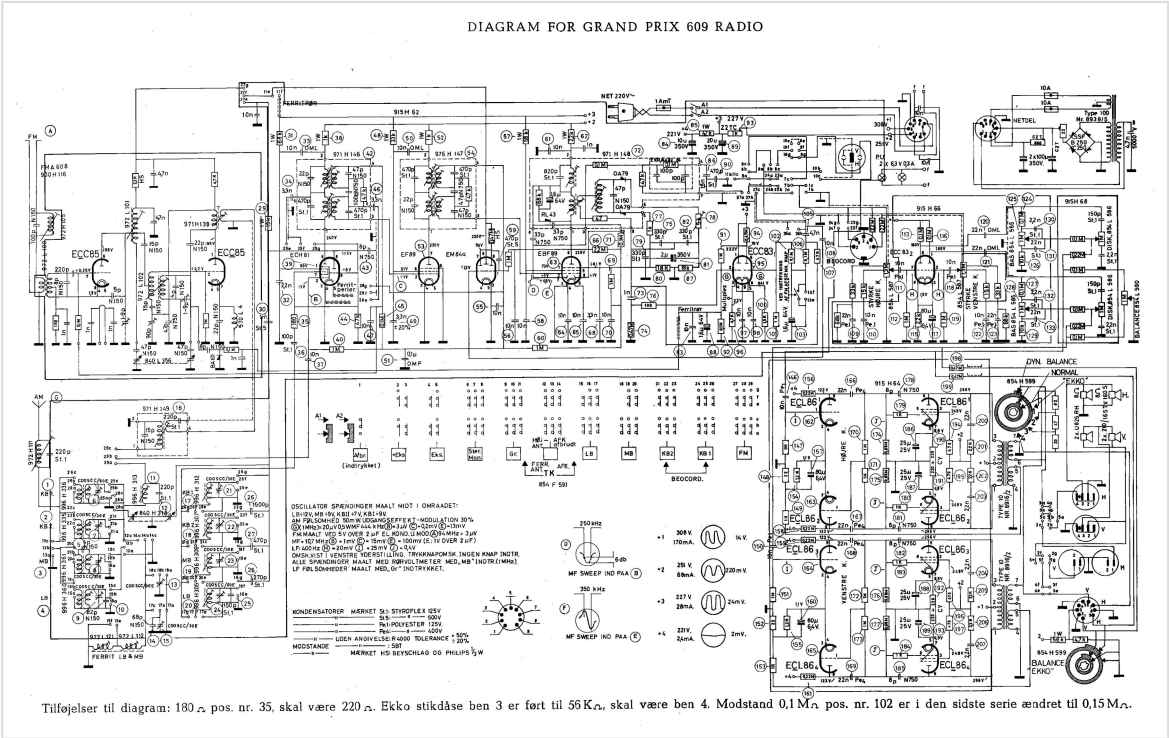
This Acro, however, are direct coupled.The cathode return to the input is not signal feedback, it is DC feedback in order to prevent runaway and improve DC balance. Nice, really nice……



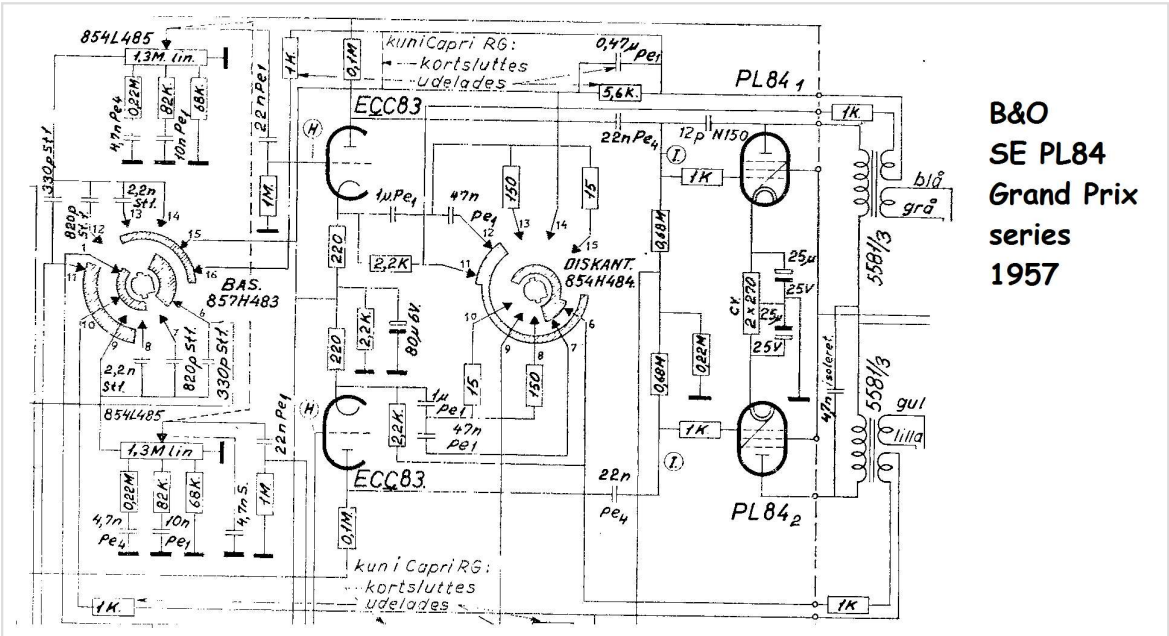
Suggested by yours truly:

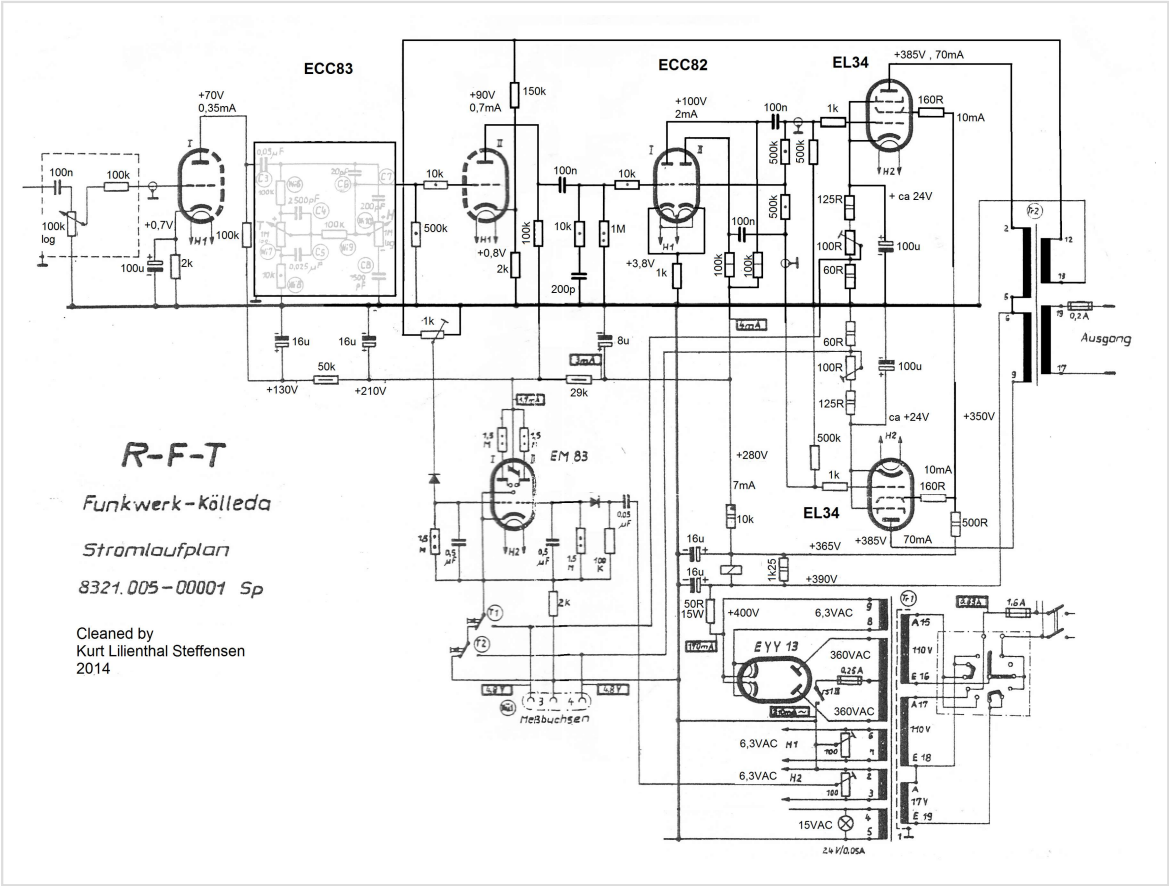
B&O, Grand Prix 609/610 stereo, 1962

It is nothing special from an engineering point of view. Tiny J. Schou OPT. But it sounds SO darling good and I use to amuse myself by playing this along with friends new fancy top gear Mark Levinson, Audio Research etc., and pretty often this “Bang and Nil” would beat the hyped gear to shame. B&O began their Grand Prix series around 1938-40 and dosen models were made. In 1959 they made a nice PL84 Single End stereo version. I use to have both of them and used them frequently as demo’s. B&O had a separate PSU , placed away from the tuner and amplifiers.



Above is a full diagram of the 1959 stereo version. B&O used to supply very extensive service manuals, showing oscilloscope patterns and values for every single point around the whole mess. Every single damn component were described down to suppliers stock number. Telefunken valves and Beyschlag resistors were there prefered ones. Take a look at the full schematic above and gaze. Below is a “cut out” schematic of the Single End PL84 version. It won’t blast Led Zeppelin at concert levels, but it sure sounds so sweet and musical.



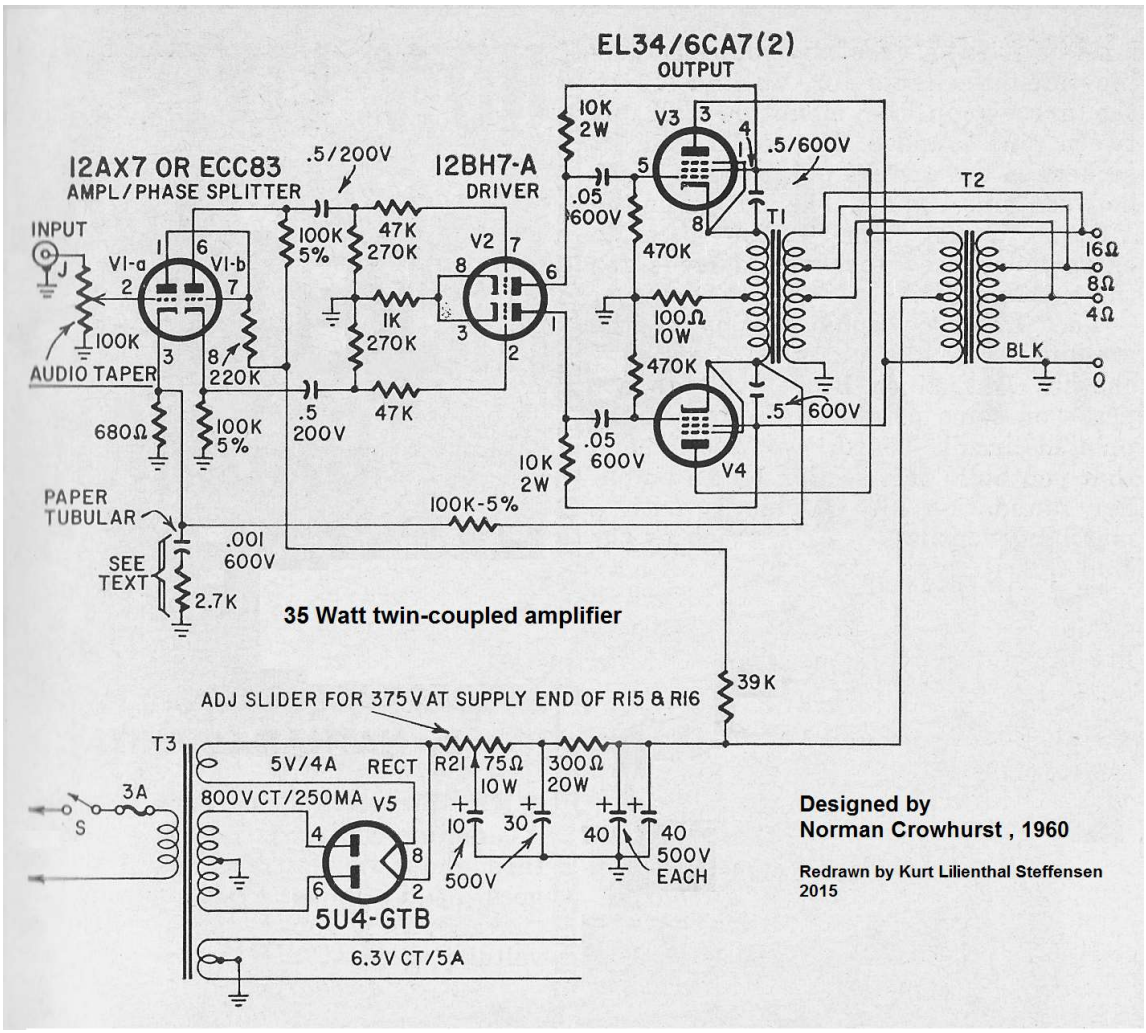


Suggested by yours truly:
RFT 8321.5 , EL34 PP, 1958-64 ?

Nice to see an amplifier that are neither Williamson nor Mullard design. This is a two stage ECC83 with a tone stack in between. Then an ECC82 paraphase phase splitter and driver. Then good genuine pentode class A output handled by trusty old EL34. Pretty nice and it sounds good. EYY13 is not your common rectifier, but it are quite similar to GZ34.

This 8321-5 is the only commercial amplifier I have ever had that made my old Tannoy Gold's series sing DEEP powerfull bass notes.But before you head out and buy one of these, you should be aware that it only has ONE output for high load speakers. I modified the secondary winding arrangement and a few other things – and – gaziinka – there it was. Sadly I did not have this mono block set in use for very long. To make a long a long story short, an accident damaged one of the amps and I put them to stock for later repair…It is still such late. But I will definately get back to this design, because by pure luck I got something very special from this amplifier. In time I will upload the information about this modification here.

RFT was the East German pendant to Telefunken/Siemens/Klangfilm and Philips and they made a lot of good stuff worth to explore.



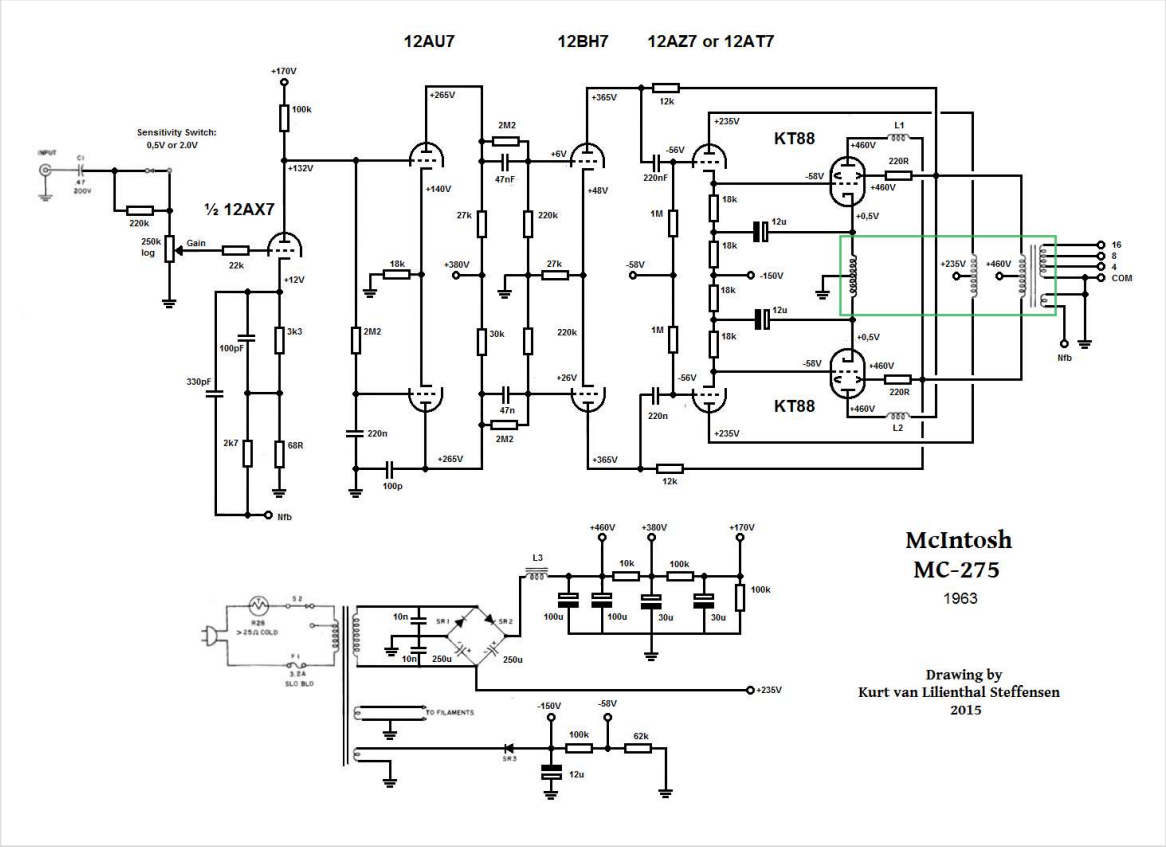
Crowhurst, twin-coupled, EL34PP, 1960

Norman Crowhurst, London was a personal hero of mine. He wrote a number of excellent articles about audio transformers in “Audio/JAES” , Wireless World” and many other such magazines during the 1950’s and 1960’s. He was an outstanding authority on that object as well as a fine engineer into audio electronics. This particular amplifier was the last design (to my my knowledge) in a series of articles from 1957 to 1960 about the so called “Twin-coupled” amplifier. As I understand it, it was a kind of “poor mans take on the McIntosh unity transformer”. What Crowhurst did was to twin couple two identical transformer in the manner shown, thus managing results similar to McIntosh. I am not quite sure how good the idea is – I suspect that differences between the transformers involved may affect the results. But keep in mind that an original McIntosh transformer was very expensive back then and McIntosh had the rights for the patent. Today McIntosh patens has been free for several years, but as it is so difficult to wind, I know of no commercial attempt to copy that old transformer. Tim de Paravicini made his version of the unity transformer for his EAR series of amplifiers and Papworth had a similar design for some of their amplifiers. If demand is high enough, I will make a version available to the DIY community and for OEM orders, but so far the need for such design has been negligible.

Anyway – this Crowhurst amplifier is a darn good Williamson design, whether you want a cathode or plate loaded EL34 Push Pull. For a conventional plate loaded amp, you will need an 4-6 k

Ohms, 40-50 Watts OPT and for a cathode loaded some 1-2 k Ohms about 30-40 Watts should do the trick. This circuit will actually drive a cathode coupled output stage.

Hats of to Norman Crowhurst.

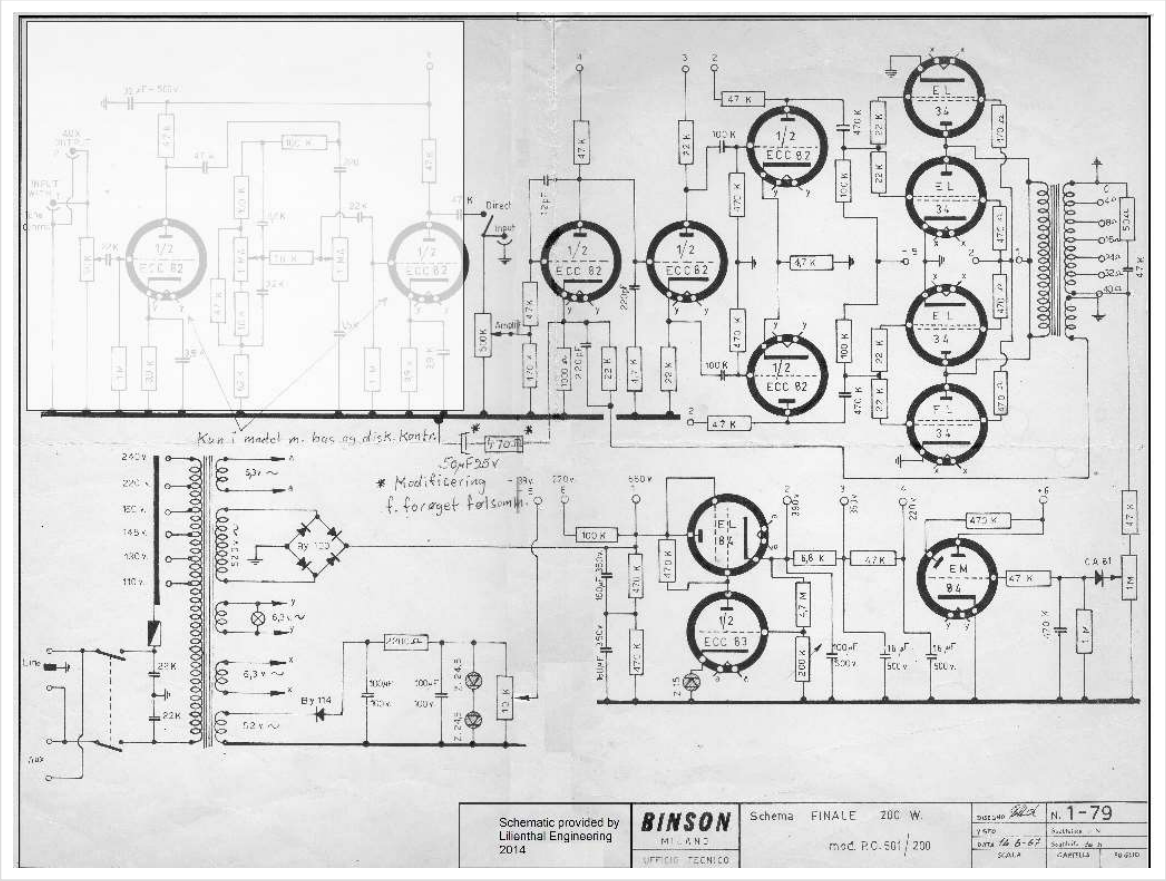


McIntosh MC275, KT88/6550 PP, 1962

This amp might be McIntosh's own milestone.

A classic status well deserved. I have only heard it briefly many years ago, but I seem to

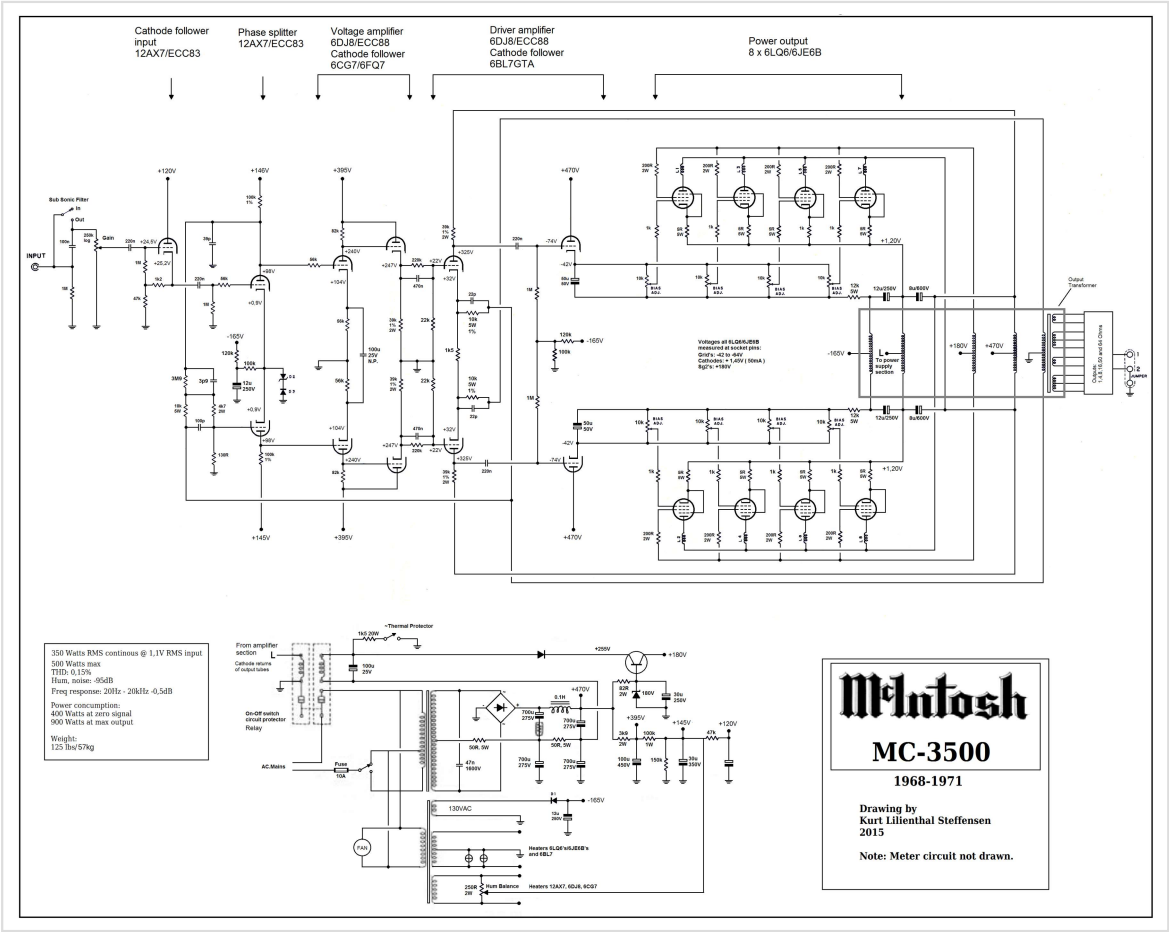
remember it sounded a little weird, slightly cold and “white”.?
I love the the design as well as the outlook. I remember a guy using it for bass guitar. He loved it too….
Grateful Dead could not get enough McIntosh power. Woodstock festival was powered by Mac’s….



Binson, PO601/200, 4xEL34 PP, 1967

Most of the professional PA power amplifiers made at the continental Europe from the 1950’s up to the early 1970’s were equipped with EL34’s. The Binson here is a typical example. Binson was an Italian company producing PA and orchester gear. They were quite popular here in Denmark. I picked this one because it is a typical and beautiful Williamson design, but in particular I quite like that all stages including the sg2’s are regulated – albeit not the best possible regulator. A smoothing choke would make wonders. I have fainted the pre/tone reg. amplifiers and kept the modification for higher sensitivity.It is also good to see a PA design without a single ECC82/12AX7 in the signal path. Do also note the EM84 “magic eye” power indicator. You can readily use this design for a high quality HiFi amplifier. One pair of EL34’s would need an OPT load of some 5000 Ohms, 50 Watts.

Quite nice.



McIntosh MC3500/MI-350, 8 x 6LQ6 PP, 1968

I have never heard or seen any of these wild amplifiers in real life and I doubt the sonic qualities will fit the delicate domestic redwine environments of most audiophiles. But it was an amplifier meant for the pro marked, PA and industrial purposes.

It is a grand tour in audio design, and the drama from 350 Watts of sheer tube power should silent most critics. 500 Watts for a few minutes – if you dare. I would guess that peaks are possible up to 2-3 times that.

Most high power tube amplifiers (if not all ?) are high Voltage and usually class B. This Mac use only 470 Volts and in runs the tubes in class AB ! 50mA per output tube adds up to a total of 400mA at idle taken from the output stage.

The more I look at this circuit the more fascinated I become. It is indeed a masterpiece. The output transformer are incorporated into the entire amplifier in a manner that was never seen before and has never been seen again.

The output tubes are plate, sg2 and cathode loaded. The cathode load also acts as local feedback, thus the need of excessive Voltage swing to drive them. The screen grids (sg2) shares the +180V winding. The driver stage are made up of two twin triodes working in a balanced mode: a gain section 6DJ8 and a cathode follower 6BL7GT with very low z-out capable of supplying lots of currents to the grids of the output tubes, when these are driven into the positive bias area. These two sections is incorporated with the OPT as well by means of two separate windings. Do also note that the plate supply to the 6DJ8 driver are connected to the plates of the output tubes, which means positive feedback. The reason of this is to keep the Voltage swing going as the two cathode

feedback windings of 6BL7GT and the output tubes demands a very high Voltage due to the cathode degeneration.(No gain)
Further feedback are applied to the phase splitter. All in all the feedback amounts to some 38dB. Positive feedback and feedback loops within a fb-loop never improves the sonic quality in my experience, despite the better THD figures. But it would otherwise be very difficult to drive the output stage if the full power are accommodated.

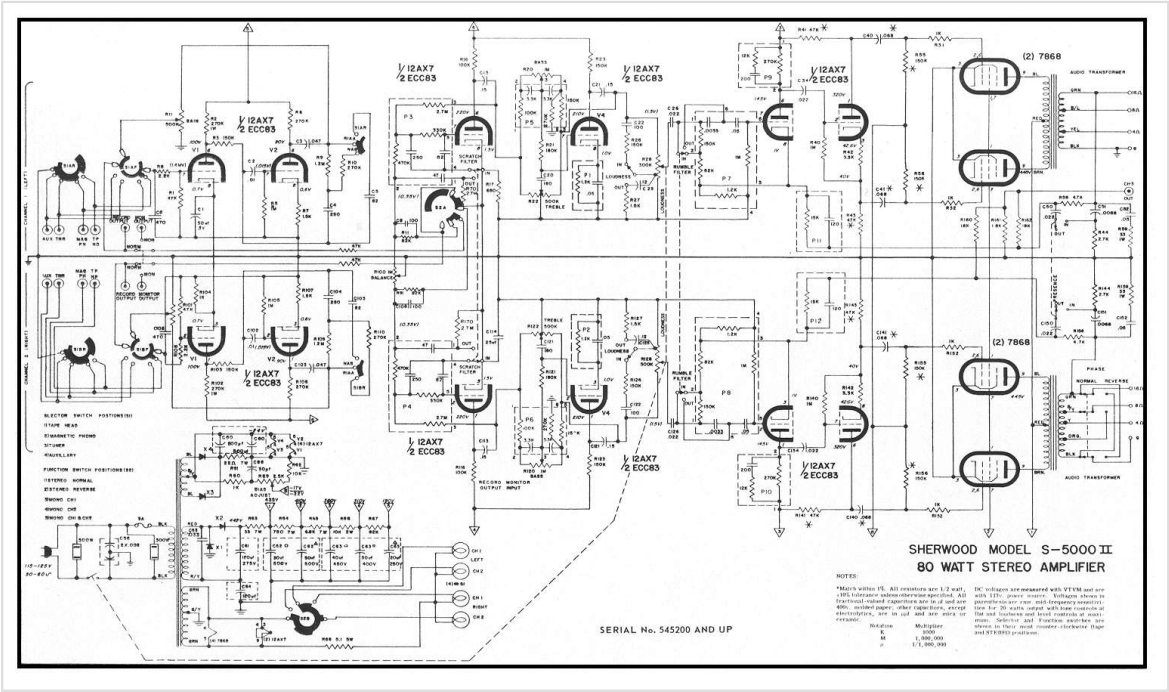
The power supply are very simple for such a monstrous amplifier and I am sure it would gain a little from larger electrolytics as well as yet another choke or two to smooth the power.

I am kind of puzzled about the cathode follower input. I simply can not see any reason why it should to be there.
The phase splitter stage represent a large 1M ohms load and it is very easy to drive.

I am impressed with the design and the specifications clearly shows that Mcintosh knew what they were doing.
The amplifier was designed by Mile Nestorovic and launched in 1968. The evidence of the master stroke are not least that we here 50 years later still discuss and admire the design. Mcintosh made many amplifiers for industrial and lab use and the MC3500 was a commercial version of the MI350 industrial amplifier.

As a young man I dreamed of owning a pair of these monsters. I spotted it in a Maplin catalog from England. Apparently they could not sell it at the price asked back then, and in the late 1970's I was offered the pair from Maplin stock at a very favourable price due to my continuous inquiry.
I cant remember the price anymore, but it was well below half of the asking price.
Should have bought them and directed to Ebay nowadays..

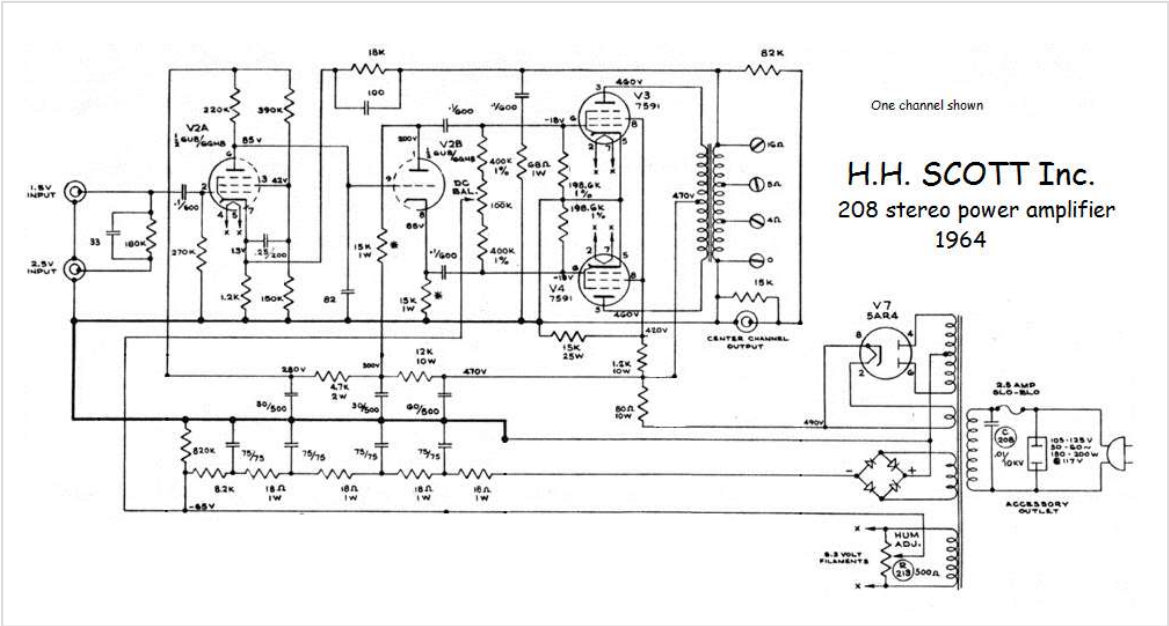
A milestone not least because it was one of the first monster amps in HiFi – despite it was targeted at the pro business.
(Well, it was small compared to some of the early Westerns….. 



Sherwood S-5000 II, 7868PP. ?

Simple abbreviated Williamson design. Although this is one of Sherwood's top model stereo amplifiers it is a rather typical Sherwood design. Well – it is indeed a typical 1960's design and could have been made just about every where in the world. The 7868 power pentode was a late development made exclusive for audio high fidelity applications. It was never used much, despite the high quality as transistors took over the hifi market in this period. The production of the 7868 ceased a few years after it was introduced.

I have no idea what Sherwood means by the stated "80 Watt amplifier" – perhaps 2 times the peak power ? I would estimate this amplifier to be a 25-30 Watt's class AB animal – as there is no way that an 12AX7 are capable of driving the 7868's into class B, even less so as a concertino phase splitter.

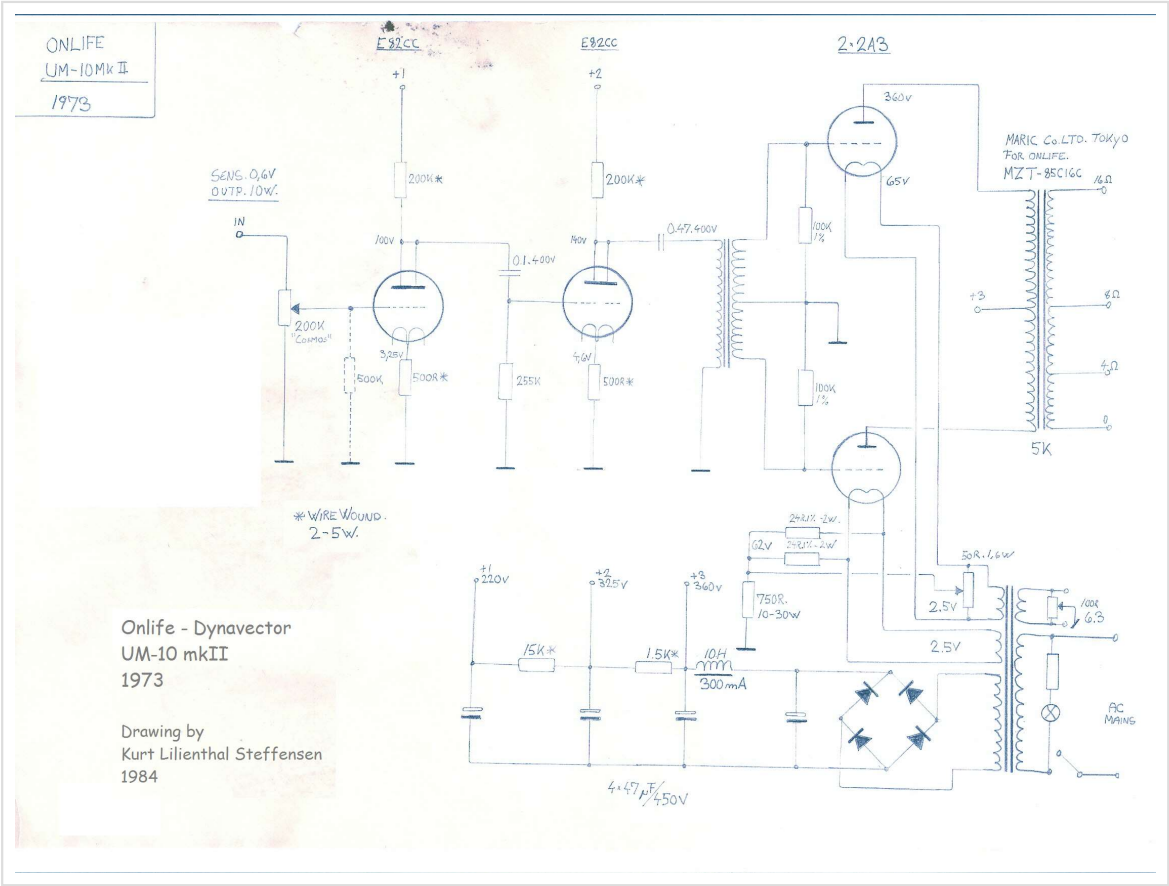


HH Scott, 208 st, 7591 PP, 1964

Joe Roberts suggest that I add some of Scott's PP amplifier design's in general.
Yes, the ones I know of are fine audio engineering. Nothing special but decent and rational designs. HH Scott was founded by Herman Hosman Scott in 1946. HH Scott company are best known for their splendid vacuum tube stereo receivers made from the late 1950's to the closing of the company in 1966. All the Scott's stereo receivers I have seen uses the Mullard 520 circuit with split load/concertino phase splitters as drivers. Often 12AX7's or 6U8's. This is not an optimal application from a audiophile pov, but it is an economic solution and Scott was heading for the main mid priced market. It should't be too difficult to modify the Scott's into a long tail phase split driver or perhaps a Williamson design. I am told that the transformers are pretty good, which should justify an throughout modification. The schematic are a typical example of Scott's stereo power amplifier – only one channel is shown.

The retro wave of tube technology.

The "back to tube era" began in Japan in the late 1960's and gradually spread to Europe during the late 1970's and finally to USA in the late 1980's. In the 1990's the interest in triodes, SE amplifier's and the socalled NOS (New Old Stock) tubes took new heights and the demand of tubes for audio gave rise for new productions of tubes.

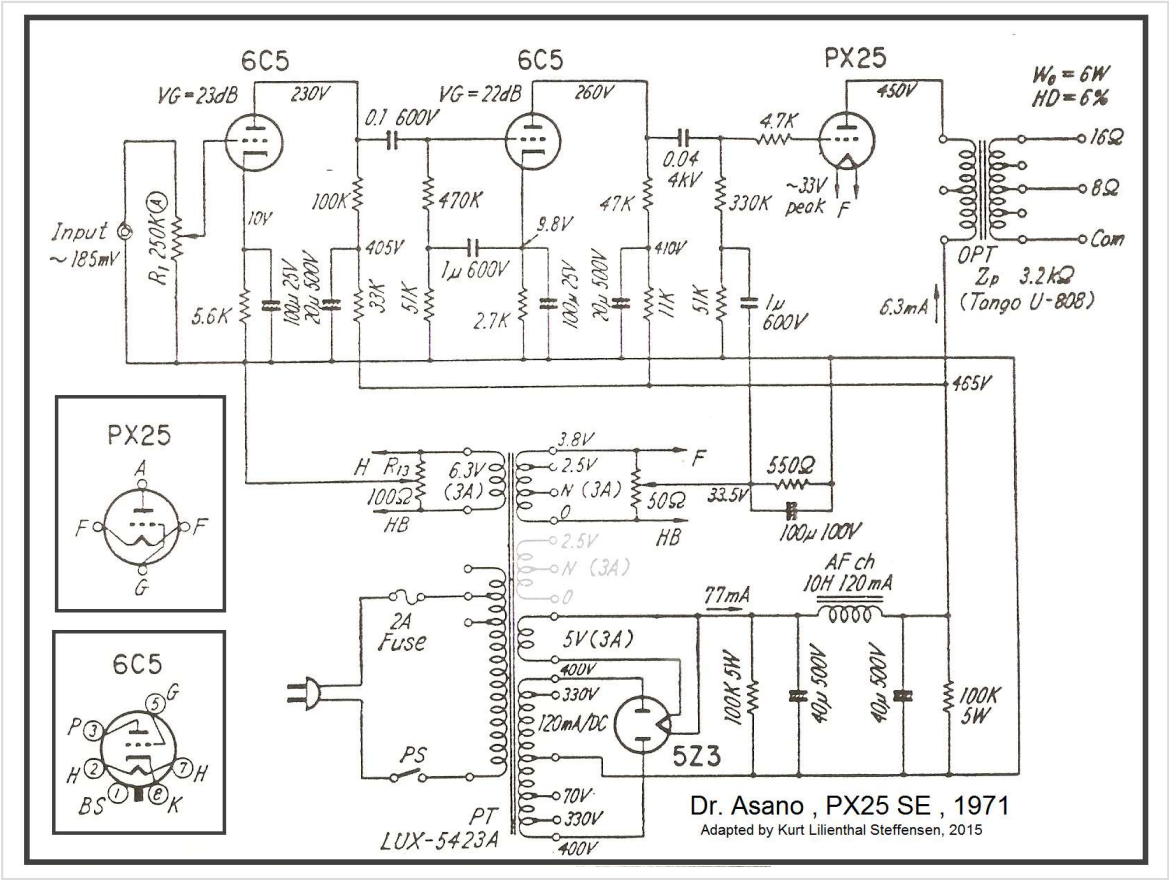


Onlife UM-10 mkII, 2A3 PP, 1973

I had the good fortune of having one of these amplifiers in my possession many years ago when I was still a young man.The painstakingly handdrawn and now damaged schematic is yours truly grabbing the opportunity to learn about a new circuit. (Does not seems as if my schematic technique has developed much since) This Onlife thing sounded fantastic, despite the unusually short part list of components. – or perhaps exactly because of that.

I quite like that some japanese audio companies had the nerve to produce amplifiers based on the technology of the past. They did not measure well, but they sure sounded much better than the transistor amplifiers of the 1960′ and 70’s. In my ears good valve amplifiers still outperforms even the best and most expensive transistor amplifiers.

I salute Onlife and Dynavector – made in Japan.

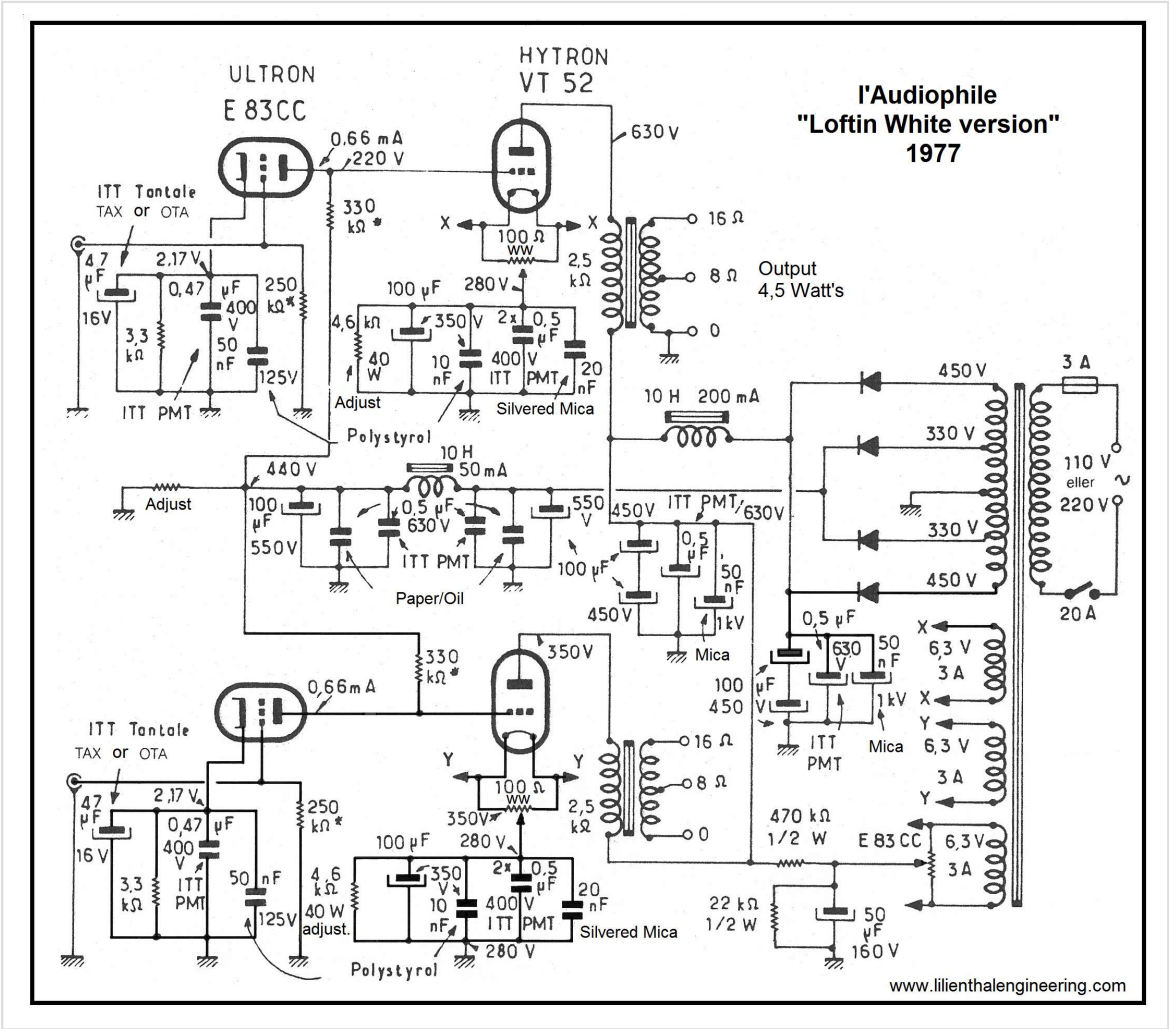


Dr. Asano, PX25 SE, 1971

It is impossible to say by whom or where the retrowave of tube amplifiers began. All the major commercial HiFi companies swifted to transistors during the 1960's and most of them never looked back. In Europe some pro-audio/PA amplifiers were still based on tubes and the entire pro-music branch was never capable of shifting to solid state guitar amps. But most certainly the retrowave of triodes in particular Single End triodes took of in Japan. Such notorious names like Dr.Asano picked up the old glass envelopes in the late 1960's. From Japan it spread to French – possible due to the French/Japanese audiophile Jean Hiraga , then Scandinavia, England, Germany, Italy and so on. And in the late 1980's early 1990's it slowly began to appear with the high power fixated USA audiophiles.

The PX25 amplifier above by Dr.Asano is nothing new at all. Actually it is a textbook example of the amplifier technology from the 1930's. But ironically this fact *is the news*.

The Japanese audio magazine "Stereo Gallery" published a number of designs by Dr. Asano from late 1960's and upwards. Dr. Asano had a small workshop from which he sold tube amplifier KIT's to the japanese DIY's community as well as fully assembled units. According to JC Morrison, USA/Sweden it was in fact Dr.Asano that designed the Ongaku amplifier as well as many other later well know icons.



l'Audiophile , Loftin White version, VT52 SE, 1977

This amplifier was published in the french magazine l'Audiophile, 1977 and in the book of Jean Hiraga , mid 1980's. It is a typical example of the components gastronomie we practiced back then. – Still do to some content, I might add. Me and a good friend (Ulrik) got to the point of which we considered these special and hard to get components as sacred reliquary. Silvered Mica capacitors, ITT pm-mkII (It had to be the light brown one) , mill. specified tantalum electrolytics , silvered if possible, tantalum resistors, non inductive 2% resistors (Mill. specified – that goes without saying) , Beyschlag carbon film, green Resista metal oxides, Allen Bradley composition, custom made Jensen flash electrolytics and oil/paper and so on. It was a blast.

Suggested by Bill Perkins:

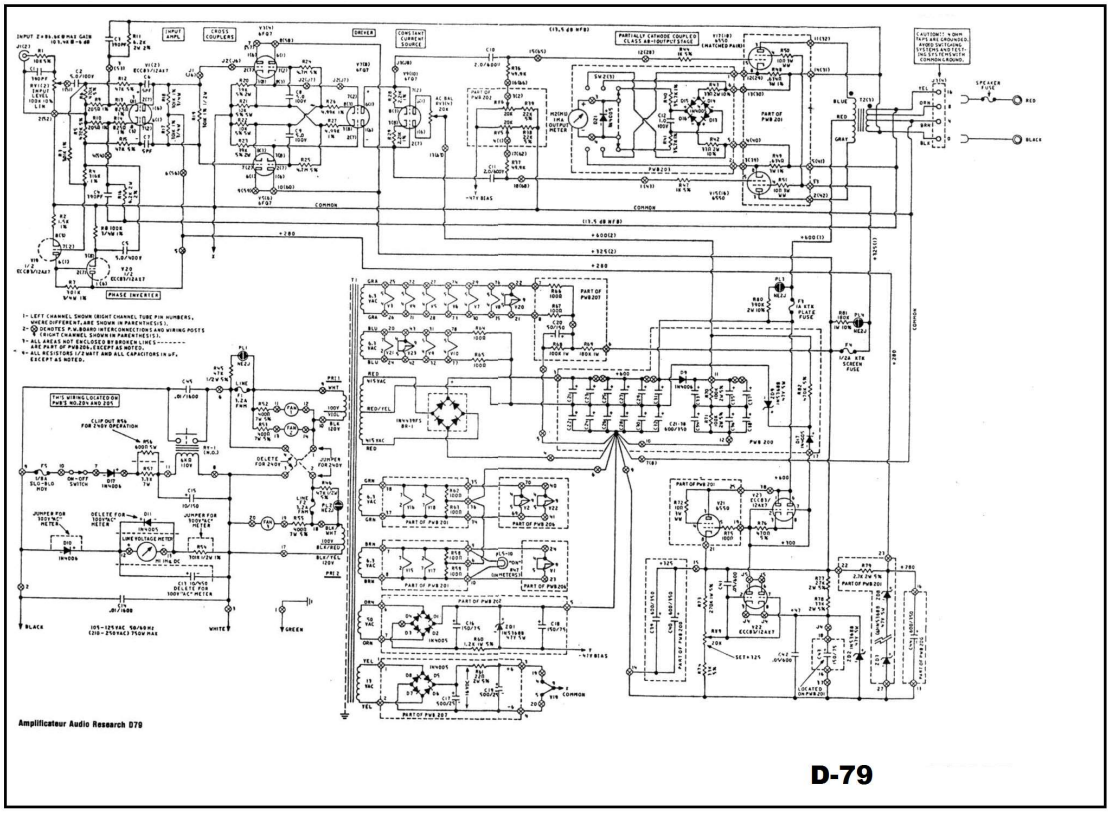
Audio Research D150, 6550 PP, 1975

This monster amp looks absolutely stunning…..I have always admired that lab look of this and the Electro Research's.

Boy – you really love them big amps, Bill.

Great looking classic.

I would also like to suggest the **Audio Research D79, 6560 PP**. – sure looks fantastic.


Amplificateur Audio Research D79
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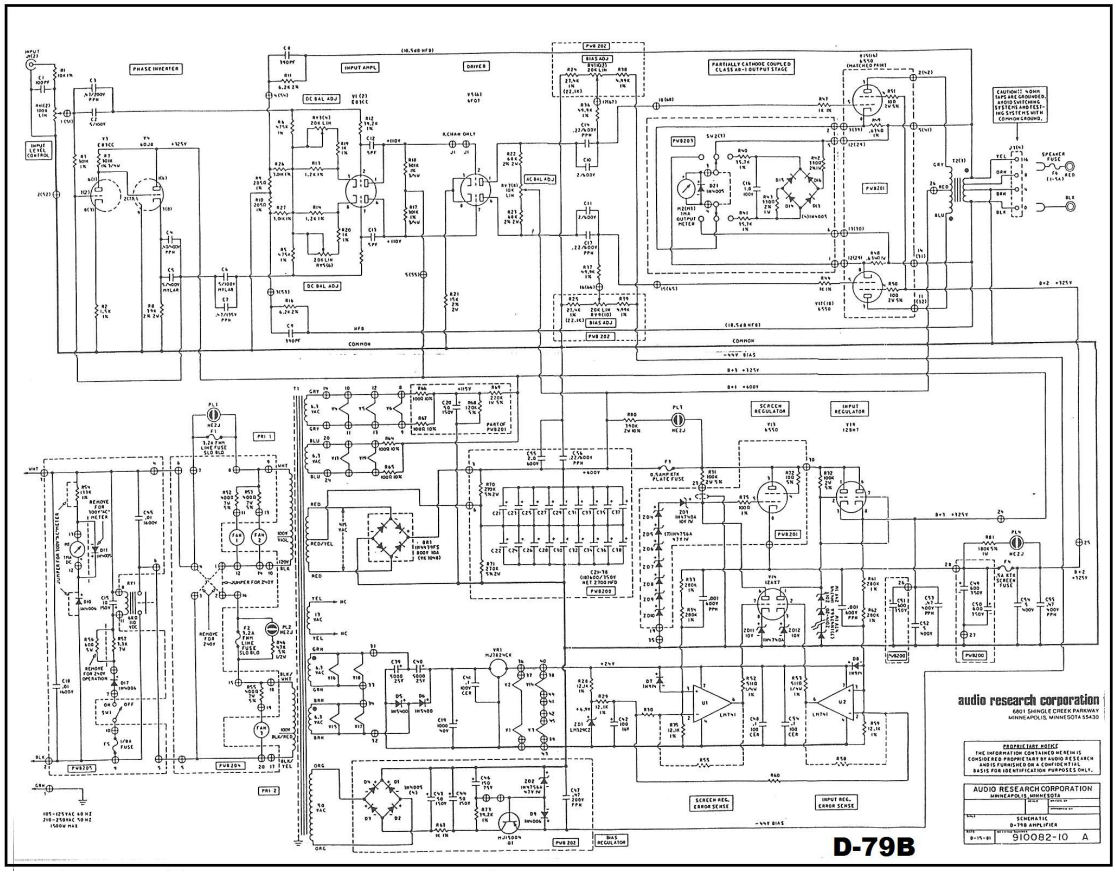
audio research corporation
6801 SHINGLE CREEK PARKWAY
MINNEAPOLIS, MINNESOTA 55430
AUDIO RESEARCH CORPORATION
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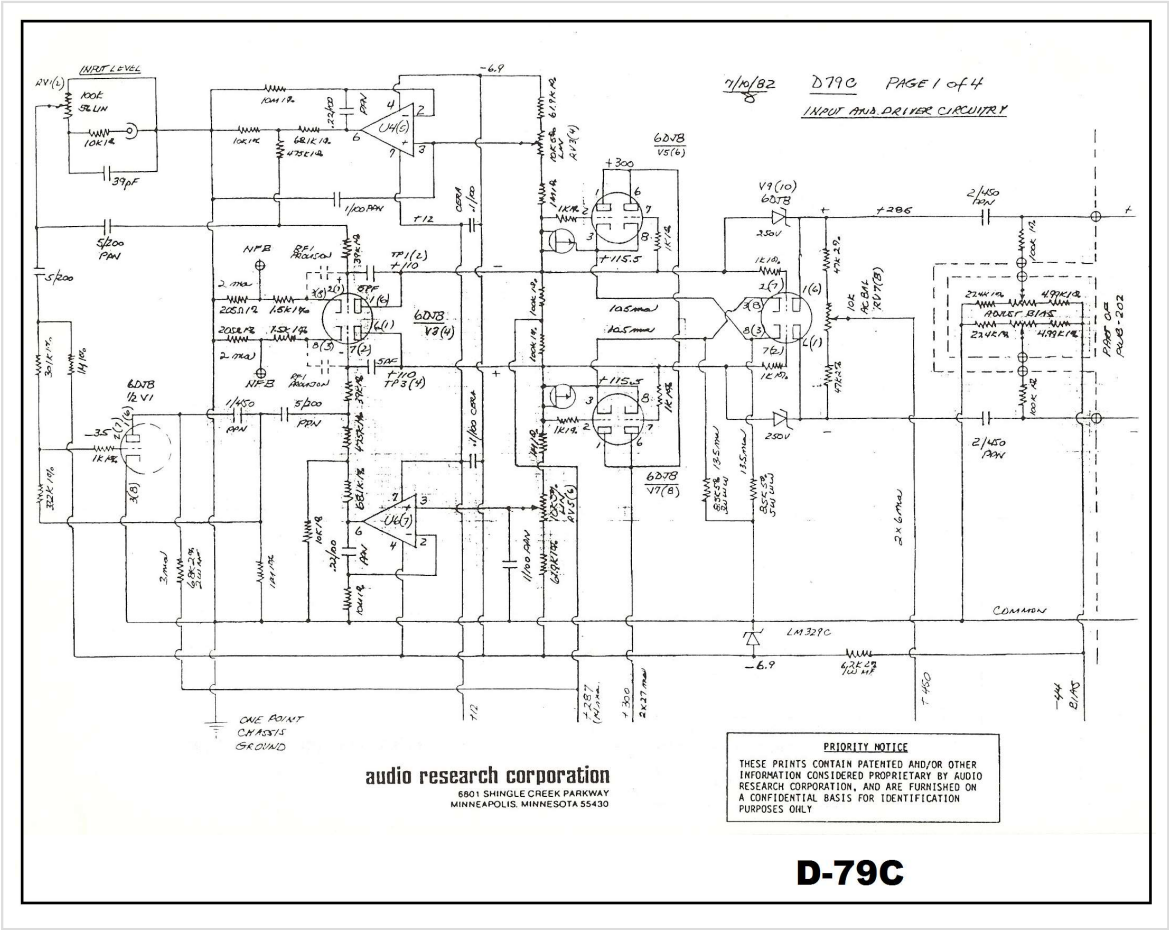


Like many other designers of vacuum tube amplifiers I have a mixed relation with the Audio Research tube design.

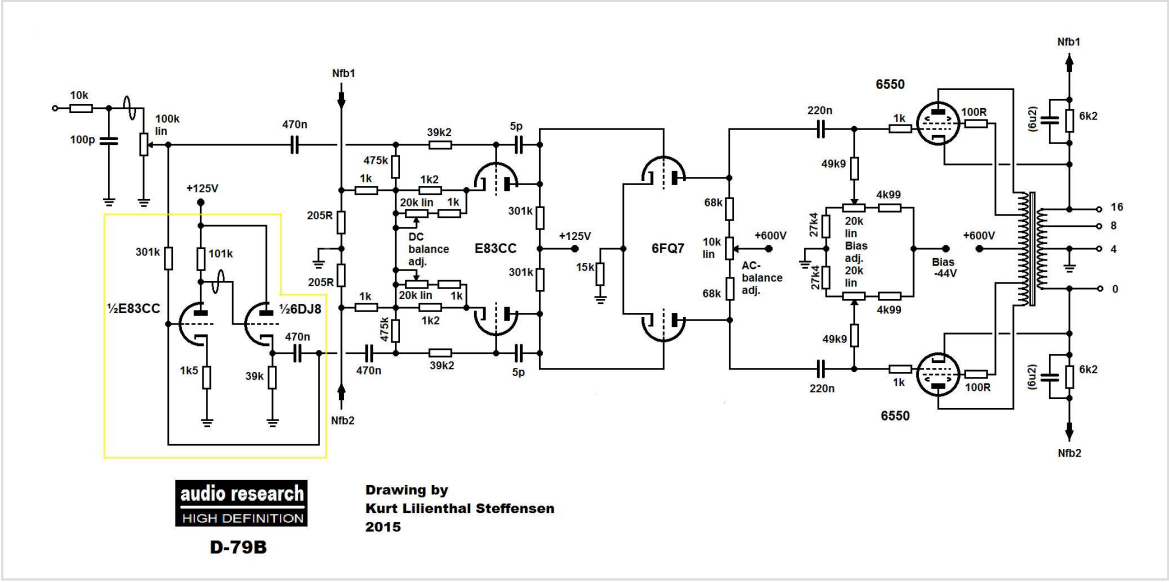
I have serviced, repaired and modified countless AR amplifiers. When modifying these tube amplifiers I mostly *removed* components and otherwise just simplified. Regrettably the tube and hybrid amplifiers designed by William Johnson are grossly over engineered in my opinion. They are indeed a mix of brilliant equilibristic solutions and an eccentric tendency to overcomplicate. Johnson would be wearing both braces and belts in the form of multiple compensations networks, double or triple use of passive components. These were often (mill. surplus ?) 1% resistors of such funny values like 301k, 205R, 4k99 , 49k9.

Johnsson obviously had an issue with phase splitters. Maybe he got allergic to the concertino phase splitter due to the poor way Dynaco used it in the Dynakits he modified back in the 1950's and 60's.

William Z. Johnson founded Audio Research in 1970. Previous to this date he had a workshop dealing with repair and such. In the late 1960's he made his first amplifier designs, using Dynakits as the basic parts. The first A.R. amplifier "Dual 100" launched in 1970 was equipped with Dynaco transformers. I know little of this amplifier, but the next product from Johnsson, introduced in 1972 was the "Dual 51". Johnsson stock to that design for the rest of his life. Just like Futterman and McIntosh he kept working back and forth on that circuit. All A.R. amplifiers are variations over that

theme. The Dual 51 was modified 12 times during the first 15 months of its life – that is almost a new variation per month.

Allow me to back up some of my opinions with some objective facts. The D79 series is a typical Audio Research design. Whilst the basic circuit remains the same in the D79 series, the difference between each ”generation” is relative large. In the first D79 model Johnson uses 12 triodes to do the preamplification, phase splitting and signal conditioning. In the B model he had simplified that to half that many triodes. The C model, picks up the thread from the first model, only here Johnson uses op-amp’s to do the job. I have chosen the most simple of these models as an example of my observations. I could have made many more practical points by using some of the even more more complex earlier designs as examples, but that would just occupy expensive ”bit space”. Lets have a closer look at the B model.



Above is the **Audio Research D-79B** schematic. I have not left out a single component, this is indeed the naked amplifier. The meter circuit are not drawn and Johnsson often decoupled his capacitors with small caps in values of a few picoFarads, these are not drawn either. The amplifier consist of something as unusual as three and a *half* stage ! The “half” stage are marked with yellow. We will get back to that later, as it is always best to analyze an amplifier circuit from the output and backwards.

The secondary of the output transformer is grounded at the 4 Ohms tap and this serves two purposes:
1) Balanced loading of the 6550 cathodes.
2) Balanced feedback to the E83CC differential amplifier.

This part of the amplifier is indeed wonderfull and intelligent design against mainstream. Most similar circuits uses single end global feedback taken from one of the “positive” taps at the output windings.

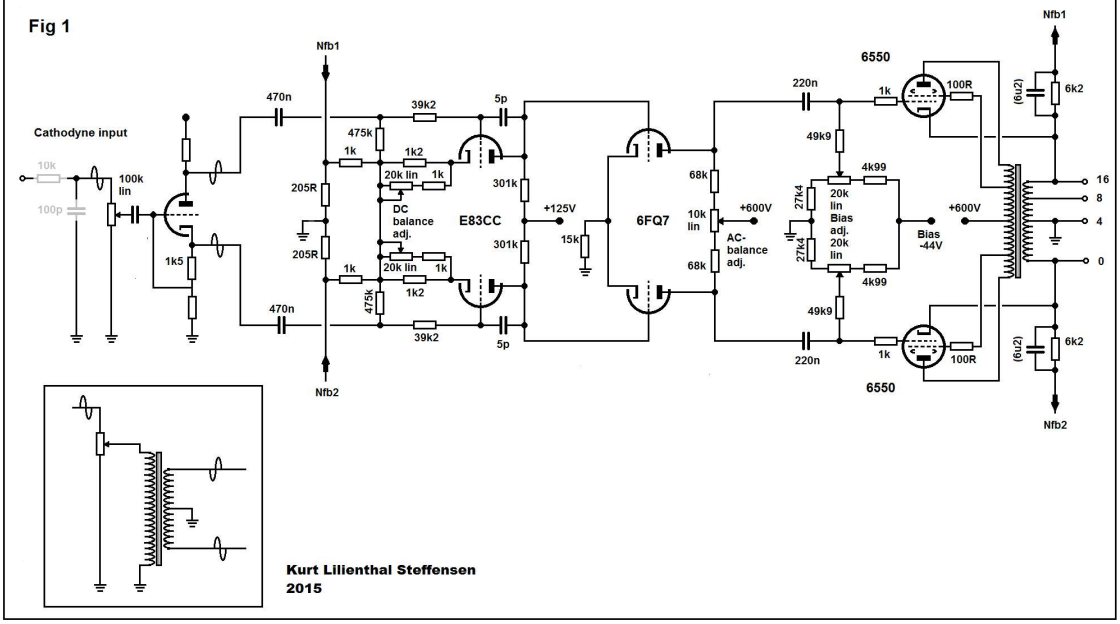
I produced a series of KT88/6550 mono blocks in the 1990's and I learned that the US made 6550's sounds best and lasts longest at about 450 Volts. I am sure that Johnson knew that too, but he decided to go for a 100 Watt design, hence the 600 Volts. You might question the 600 Volts applied to the 6CG7 drive (max ratings 300 V) , but Johnson really needed a lot of Voltage swing in order to drive that plate/cathode loaded output stage. A 12BH7 and/or step-up trannie would probably be a better solution. Talking about high Voltage – I do not like the idea of a potentiometer with 600 Volts at the center tap, I would rather place it at the cathodes or entirely avoid it. Anyway – these are subjective opinions of mine – and this is a William Johnson design – shut up, my self.

The thing about the AR design that really puzzles me are the phase splitter. For reasons I shall unfortunately never comprehend, Johnson chose to most weird solution for the phase splitting that I have ever seen. He took a part of the input signal directly to the diff. ECC83 stage, but the other part he directed to the utmost incomprehensible obscure detour in the history of audio. In order to achieve a signal of the opposite phase he passed the signal through an ECC83 triode of high amplification. Obviously as this would degrade the high freq response, he added a 6DJ8 cathode follower of high input impedance and low output impedance to deliver the signal for the next stage. In order to reduce the gain for the whole mesh to 1 as it should be, Johnson decided to establish direct feedback from the cathode follower output to the grid of the ECC83. Yet another capacitor to isolate the DC potentials. Can you believe that ?

I have spent many hours thinking and trying to find just the tiniest small reason for this circuit, but it does not exist. Heck, if it sounded better than a "regular" phase splitter – or even just as good , I would accept it. But it does not – neither is it cheaper, easier or anything – it is just plain wrong. Johnson adds a little noise, some distortion and a slight phase shift to half the signal for no reason – nothing is gained by this solution.

There many better ways of doing it – in fact the best solutions are right at hand. Let me show you……

Fig 1



Kurt Lilienthal Steffensen
2015

Fig 2

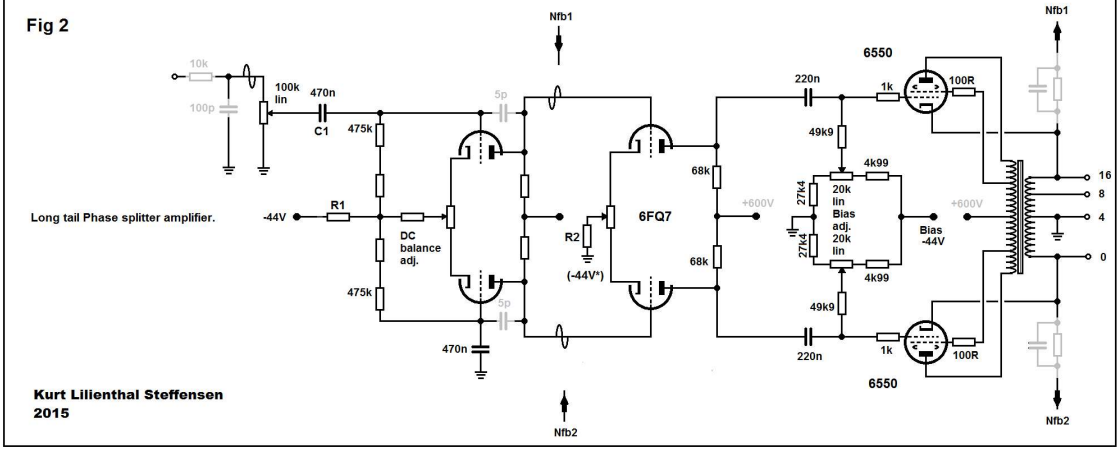


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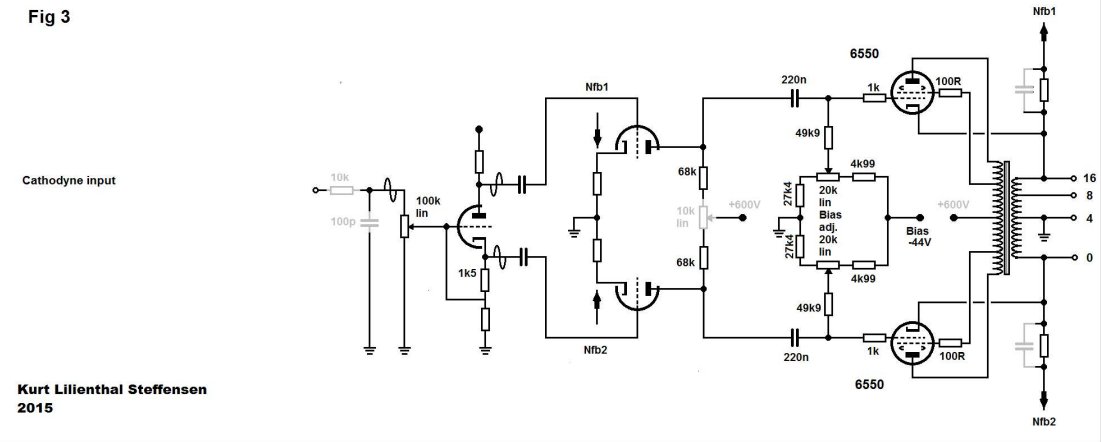
Fig 3



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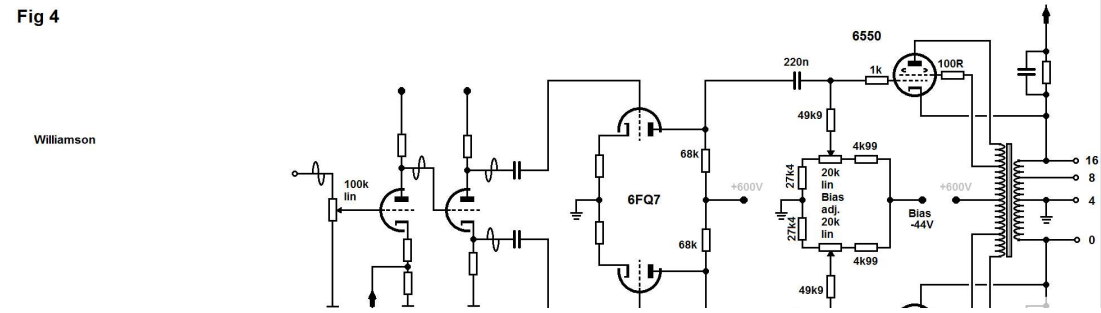
2015

Fig 4



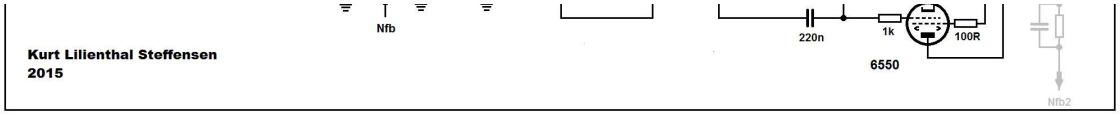


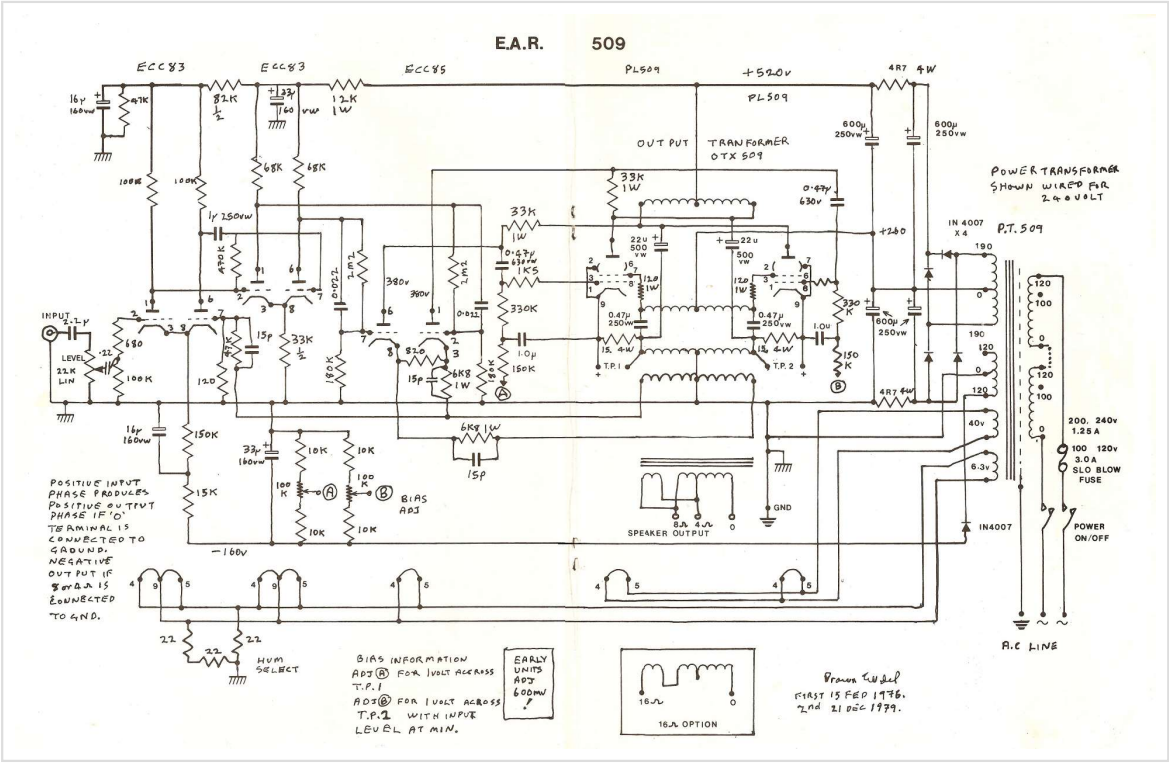
Fig.1 Here I have deleted one triode and some other components (Not least the extra capacitor). Apart from that it is the EXACT same amplifier as before. But we now have two symmetrical signals of opposite phase. In other words a “real” phase splitter. This one is the Concertino, Cathodyne or split load phase splitter. Yes, it goes by many names. The cathodyne or a transformer are some of the best phase splitters we know of – if made properly – that is. Just about any triode can do the cathodyne job. The precision of the phase splitting are determined by the match of the plate and cathode resistance. 1% resistors are fine. 22-47k will fit most triodes. Just remember to add the auto bias resistor to the plate resistance or deduct it from the lower resistor and you are there – simple as that. It is a common myth that the cathodyne are asymmetric or that the Z-out is different between the two half. It is not so – the plate output is in parallel with the plate resistor and the series string of the tube and cathode resistor. The cathode output is in parallel with the cathode resistor and the series string of the tube and the plate resistor, hence they are equal – except at very high frequencies.

Fig 2 indicates a Schmidt or long tail phase splitter. This one is also almost present in advance with only a few minor allocations of the resistor network. I would suggest that R1 and R2 are replaced by a simple FET constant current source. The negative Voltage are already present. This applies to the circuit in fig1 as well. Grounding of the grid circuit – if possible, depending upon which method chosen – may delete C1. A floating paraphase phase splitter is possible as well, with just as little effort (Not shown), but these are not really good in HiFi amplifiers. Feedback may be applied to any of the two stages – even to the grid circuits if one prefers such a radical solution.

Fig 3 . This is just to show that without any feedback or very little to the cathodes of the diff. stage – a shorter signal path is possible. We may run into difficulties in driving the output to the full in lack of gain/Voltage swing. Further gain would be accomplished by adding a common input stage as shown in **Fig 4** – and then without realising it , we have made a Williamson amplifier..he he…. I can understand why Johnson did NOT wanted to bring such quaint design to the show , when he reintroduced tube amplifiers in America.

I would loved to have met Johnson and discussed his intriguing and weird design. There is so much unused potential in the Audio Research amplifiers – it would have been a unique privilege to be allowed to design an AR amplifier, based on the basically splendid ideas of Johnson. Sadly this will never happen as Johnson passed away recently – 2011. Well, it would never had happen anyway – but it is good to have dreams

Rest in peace, Mr. Johnson – I hope you are at the *high end* up there.

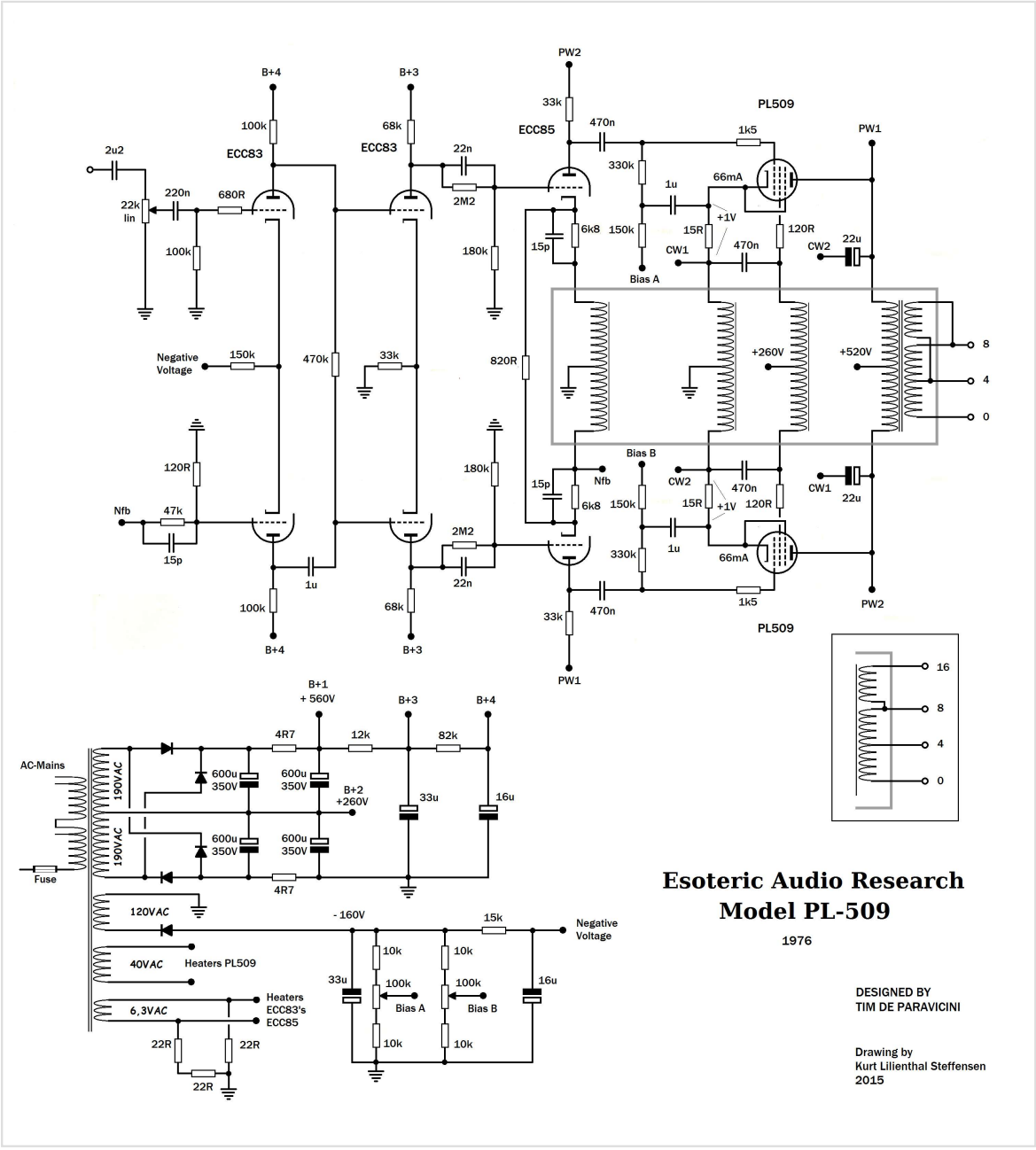


Esoteric Audio Research PL509, PL509PP, 1976

This was the first *real* valve amplifier I had. – Well, I had an ex-jukebox EL84 PP as a kid and several guitar amplifiers, but this amp was an ear opener to me in the late 1970's. I got it from Tommy Horning (Horning Hybrid), who got it from Peter Qvortrup (Audio Note, UK) back then when he was still living in Denmark. At that time, I use to have Luxman and similar "semi high end" solid state gear (I was a great fan of Luxman) and it was a revelation to hear this unusual amplifier. It sounded dramatically better than any of the Luxman, Denon, Technics, Marantz etc. I have had previous to that day. I cant remember if it was when I had my huge JBL system or if I had swapped to the Magneplanar MG-IIB's at the time, but I loved these PL509 mono blocks.

The PL509 power pentode was made for television line deflections. It is a very tough valve capable of pretty high current if needed.(I seem to remember 1,4A peaks and even more when "pushed")

As much as I love hand drawn schematics, as difficult they are sometimes to read. I missed a few important details while analysing the circuit in this schematic, hence decided to clean it up and draw a new one. Hopefully this is a bit easier to read.



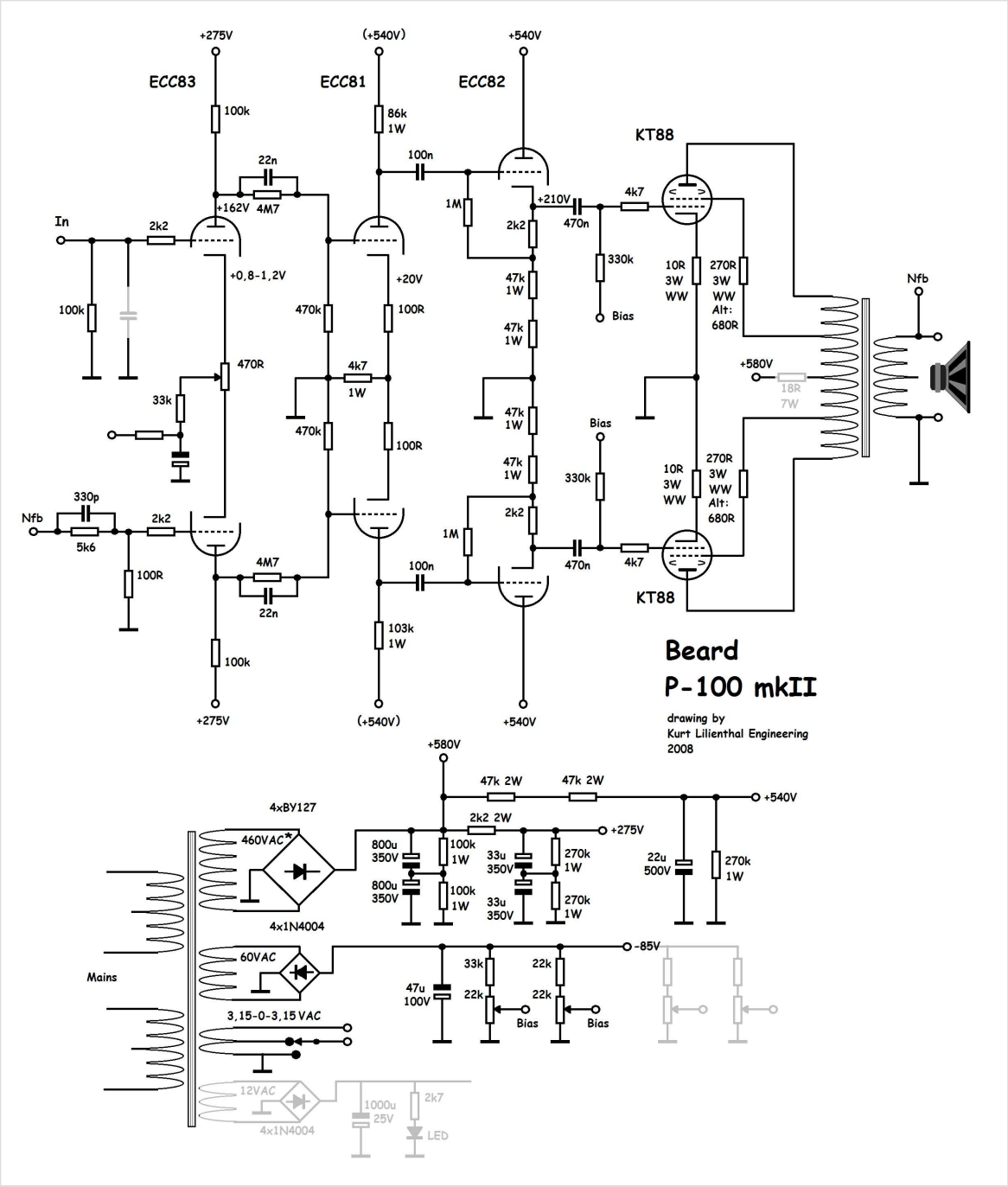
The circuit of the amplifier is quite similar to McIntosh's unity coupling and to a contend Walker's balanced QUAD's, but wears the indisputable signs of Tim de Paravicini from that period.

I am still writing and editing the analyse of this amplifier- more to come.

The PL509 amps are good amplifiers – but they do need a little care and modification in order to bring the best out of them.

It was designed by **Tim de Paravicini** and I suspect that the the old original hand drawn schematic are by Tim's pen. I would like to use this opportunity to celebrate Tim de Paravicini. When I first saw the Michaelson Austin circuit I immediately recognized the similarity to the EAR circuits. At the time I knew nothing about Tim, but I realised that there had to be a definite thread between these

two amplifiers. I learned many years later that Tim de Paravicini has engineered several amplifiers for Michalson and Austin, Luxman and many more. I seem to like the TVA's a little better from the point of view of simplicity. But all that Tim de Paravicini touches seems to come out as high quality audio items.



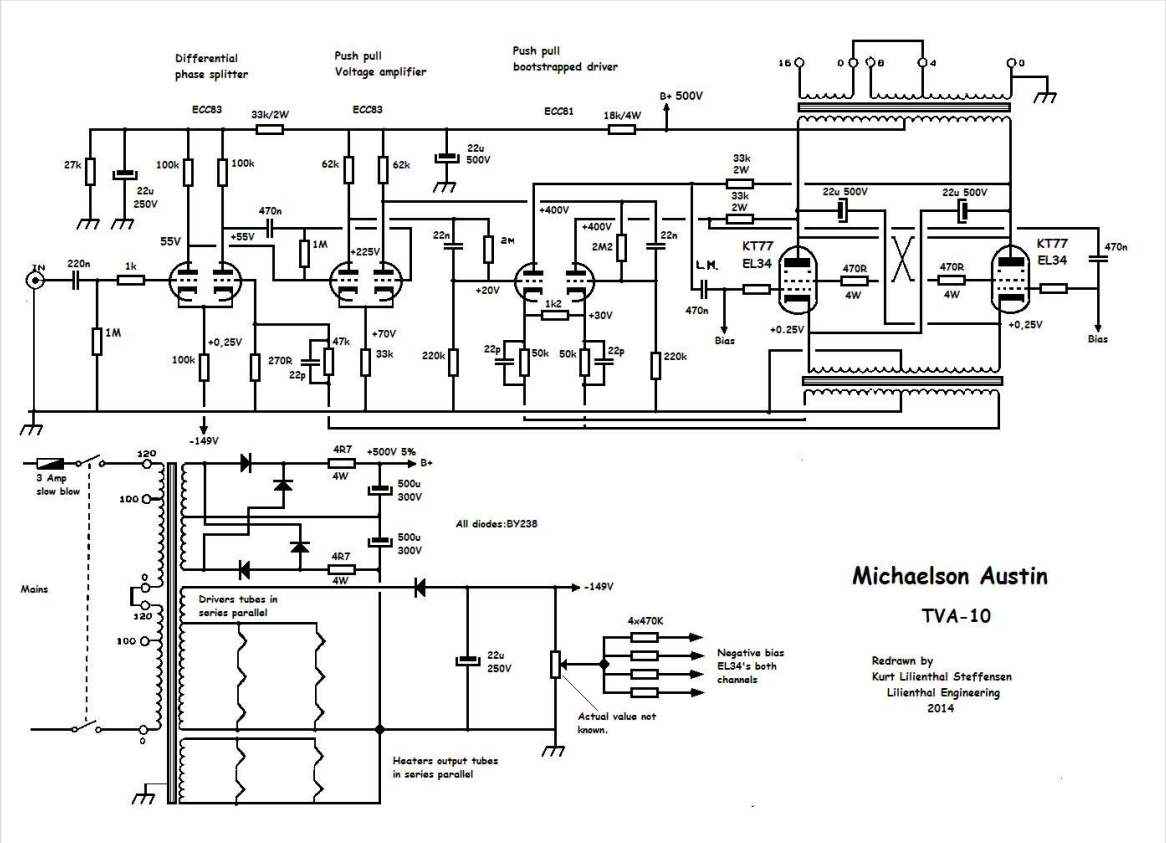
BEARD P100 mkII, KT88 PP, 1970's ?

The circuits I have come by from Beard shows a remarkable familiarity with the signature of Tim de Paravicini. I do not know if the P100 was indeed engineered by Tim or if it was just inspired by Tim's work.

I had one of these in the workshop for repair several years ago (1994 or so). I modified it and it sounded like a dream. I can't remember anymore how it sounded before the modification, possible

because it was dead (I don't think I did much modification to it), but I kept it in my lab as long as the customer allowed me to do, simply because it sounded SO good. I wonder if it was equipped with Partridge OPT's ?

I seem to remember that the customer came back some weeks after collect and gave me a bottle of good red wine. I guess he agreed with me and that is always nice.
Update: I have found the notes of my BEARD modifications. I will upload these later on.



Michaelson Austin, TVA-100, EL34PP

This design are very close to Tim de Paravicini's EAR circuit above and it is easy to spot Tim's "trademark". I once had one of these and I was quite happy with it, although the bias network needed a modification rather badly.

PAPWORTH, M200, 4xEL34PP

The Papworth's are very close clones of Tim's circuits. I will upload the schematic and some mod's I once did, not least a dedicated regulated PSU for this amp, as soon as I find my papers and notes. Stay tuned…….

Bill Perkins:

Audio Research D250; many 6550 PP, 1983

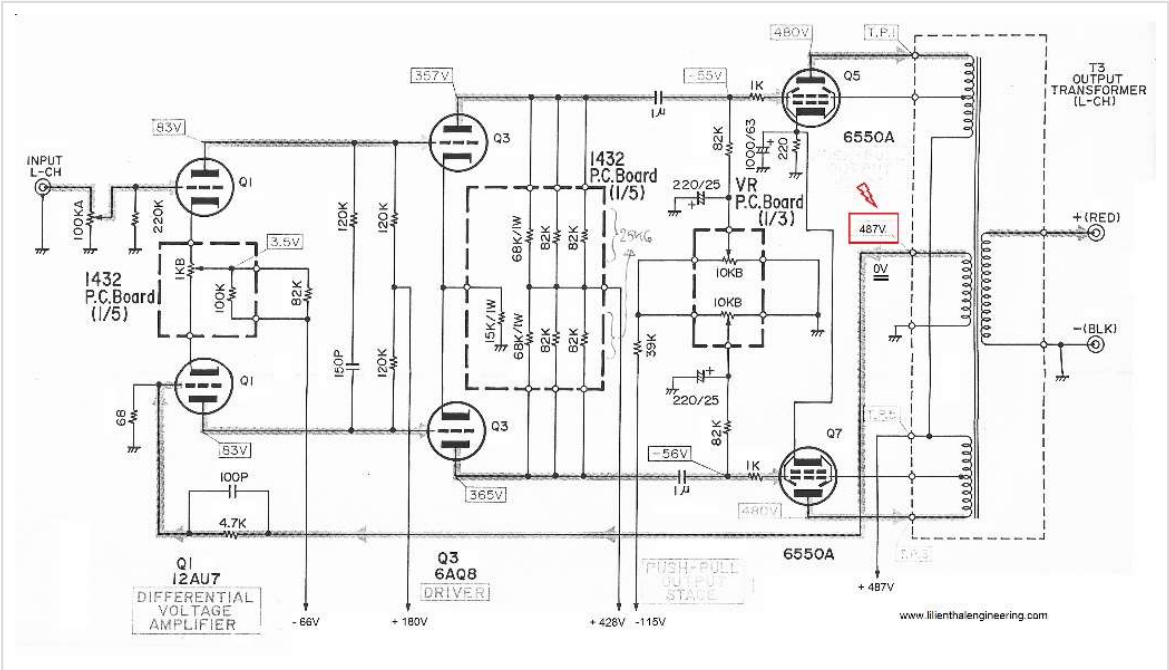
Massive monstrous tube stock machine…..Is it like 20 piecessss of 6550's….?

May be bridged to half a kilo Watt….. (= you need a better speaker…or ears..)

Not my barrel of tea….

I cant remember if I have had any of these in my workshop…Audio Research'ers were regular patients in my tube hospital. Boy – I ended up almost fearing them….Heavy monsters, lots of PCB mounting and solid state and op-amp for regulators, relays etc. Not at all easy to repair. Modern AR's are not particularly good engineering in my book. (post 1980 or so).. I have modifies SO many AR's in my time…All I did was to REMOVE parts and rearrange into proper engineering….They always sounding and measured better after a serious overhaul.

But this D250 is a serious HEAVY one and needs to be on this list.



Luxman MQ-50, 6550 PP, 1983

I think it is quite appropriate to end this vignette series with a Japanese amplifier. The MQ-50 is one of Luxman's better tube power amplifiers. The input is a differential ECC82/12AU7 amplifier performing phase splitting as well as gain. A negative supply insured high impedance at the cathodes which improves the balance. A Constant Current Source would have been even better. The global feedback is taken from a separate winding at the OPT and this restores the balance. Note, the funny little error at the schematic indicating +487V at this winding. Of course there is no Voltage potential here.

once had one and although I modified it quite a lot it was actually good – even straight from the shelves. The Luxman iron is good, albeit tiny…. When studying this design I smell Tim de Paravicini. I do not know if it is indeed a design from his hands, but it sure looks a lot like his favorite circuit and I know that Tim worked for Luxman around this period. The building quality was not bad at all, but certainly not very rational either. The parallel of three resistors to form a 25k6 resistor is "over-engineering" and reminds me a of Audio Research. A single 27k resistor would do perfectly here – valves are not 1% items, neither are they that case dependent. I do remember lots of small silly PCB's inside these Luxman's many of them seemed more time consuming to solder on to, than simply wiring the stuff. But there you go. The size of the Lux' iron was always on the low side, but I really liked the look of them.Luxman made a lot of tube amplifiers, most of them rather mediocre. I have serviced many of them the worst one being a 50CA10 – so called triode. Boy – what a piece of ..eh..not good….But it looked good.

I have also owned a CL32 and CL34 pre-amplifier. These were no good either, but – they looked good. Luxman on the other hand made a lot of real good transistor amplifiers and as said – they all looked good. (I still have one of them)

Luxman started as a transformer manufacturer and it is ironic that they entered the HiFi market with an OTL amplifier – at least according to rumour. Anyway – I like Luxman and this MQ-50 is a rather decent tube amplifier. And it LOOKS good . Period.

I simply HAVE to mention **C.G. McProud**. He made several interesting amplifier designs and wrote a good deal of interesting articles and books.
But first of all – C.G. McProud founded the Audio Engineering Society. (Magazine Audio, later AES)
I can not think of any one person of whom had such a huge impact on audio.
Hats of to McProud. (What are the C G ? Carvin Gregory ?)

I will leave the solid state amplifiers to another, Joe.

Quotations from the Sound Practice Joe's that helped me making this list:

J.C. Morrison : "Acro 20/20 and the Brook 12A… two amazing PP amps better than any old SE in my book. The Acro UL2 is also worth a mention, mainly because it is the basic amp audio research, Conrad Johnsson, in fact all modern UL pp EL-34 and 6550 amps are based on, and rarely equaled. Even the Citation II, which is Harmon Kardon's copy of the Acro amp, is really good… some "high end" companies just bought old Citation II's for the power and output iron. rebuilt them as their own. Copied from Keroes..and for solid state, you can't leave out the ML-2 (john curl's 20 watt SS amp). Even today that is a badass amp. and the TNT-100 from Acoustat… one of the best early SS amps."

Guido Tent: "For the "no valves inside" section: Hypex n-Core"

Bill Perkins: "Favorite amps at my house are the Altec 260As, modified; the Altec 1520s, also modified; the original Audio Research D150(?), which was their first seriously large amp; and the subsequent D250. I liked the ARCs for their tremendous low-end performance and their spectacular 3D Imaging. Alos, and unlike most, I quite liked the ARC D100 — their first foray into s/s — BUT not until completely rewired with the old, round Cobra wiring was shit for literal decades, and pretty much trashed the sound of much of what they made.

Francis Stephanik:"count me in with my hard to beat Sid Smith's amps
(1947) RADIO CRAFTSMEN RC-2,PP 6V6. Sweet,musical,simple! And musical, RADIO CRAFTSMEN model 500,KT66, (1950)best OPT's by far……test selected by US NAVY. Time before Marantz.

While we're at it listening, right now pair of David Bogen's PX-15,PP6L6, (1951) premier flagship amps.
They are my top picks.

Have
fun,

Francis St.

Joe Roberts:
Once I started writing a book on this topic, finished vignettes of 10-15 amps, then lost it all in a Mac crash, along with a half-edited issue of SP.

I'd add: 1926 Daven RC amplifier, That ugly brown RCA 245 PP amp from 30s consoles….forget the model # EH Scott PP amps–the first home hi-end audio , Hallicrafters HT-5/BC-614 speech amplifier WE Beachmaster, Early McIntosh unity coupled 15 W, 30W, etc
Altec 1420A, Peerless A-100A ,Fisher 50A. Western Electric covers most of the primordial specimens of tube topologies.

Many of the most important designs were not products but published DIY circuits, including tube manual circuits and transformer catalog amps (UTC, Thordardson).

Al Marcy aka "Happy Ears" :
I started this insane hobby, ~twenty years ago, when I bought two Fisher amps from a TV repair shop, in Phx. X-202-B and X-202-C. Both were way better than my Sony receivers… but, the bias circuits both had problems I did not know how to fix. I got tired of buying new 7591 tubes. I decided to learn to fix tube amps. I figured I would build a few to get the idea… my first 6BM8 SE blew away the Fisher's. We all learn what we learn, even if it is not what we intended to learn.

Products are business transactions. Homebrew Audio is another transaction, entirely. Western Electric built great tubes and amps and speakers and made tons of bux providing early movie theaters with technology, on lease, and trained the operators and everything. They did business the old fashioned way… very well.

WW2 introduced "systems".

We are living with the consequences. (We may each puke when whenever we need to puke, dig?)

There are still some great artifacts laying around.Some folks renovate old cars. That is fun, but, it was even cooler to customize cars, back when…

"Different strokes for different folks…and so on and so on and skoobie doobie doobie…"

Happy Ears!

This ends the article series of 100 amplifiers to lift your hat – although I am continuously editing and adding new stuff. I might follow up with a series of recent designs, but contemporary designers

has a silly habit of considering their schematics as “top secret” secret secrets. I do not know why, as anyone who wish may draw the circuit directly from the amplifier in a matter of hours. Modern companies claims copyright of their designs to such a degree that they seem to want the schematics to remain invisible ? They do not seem to understand that schematics on the internet are some of the best possible advertisement they could ever wish for. Peter Qvortrup of Audio Note, understood this very early on and he took care that lots of Audio Note schematics were available to the public. He is still in business, while many of the secret companies has indeed turned very secret. (Read: closed) The same service friendly and sympathetic approach are conducted by Audio Research, Fender and Marshall. Schematics are available from the homepages of these companies at no cost for the users. Personally I prefer to recommend products of which the relevant schematics are easily obtainable.