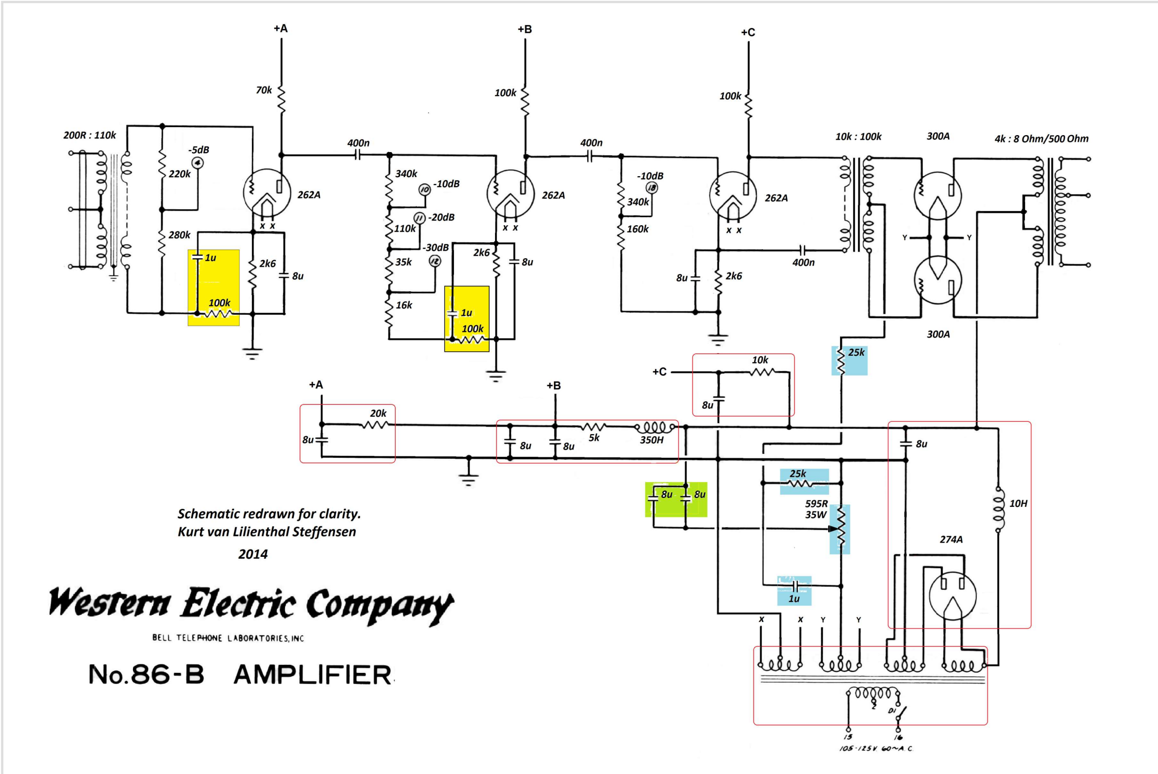
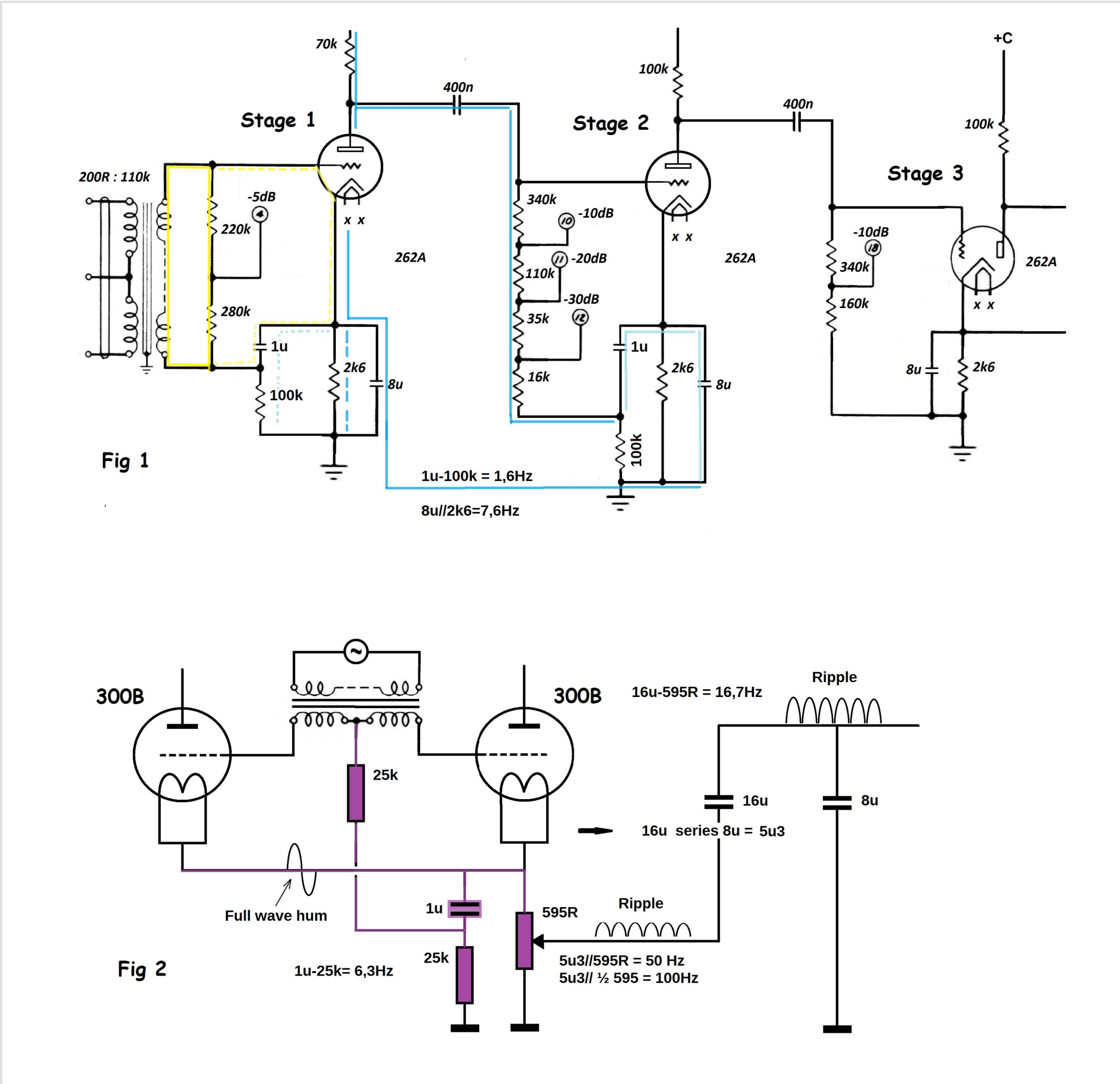


(Suggested by Jan Schlatved)

Western Electric 86A/B, 300A PP (1934 ?)

I can dig that….Transformer input, two 262A triodes, then a 262A coupled to a transformer phase splitter…274A rectifier…..At first glance it appears pretty normal, but then you spot something weird. Look at the components I have marked in yellow. The secondary side of input transformer are **not** connected directly to ground. It refers to ground DC vice via a 100k Ohm resistor. The grounded side of the transformer are AC vice connected to the cathode of the 262 via a 1uF capacitor. This is very unusual indeed. It is not feedback as the amplification at the cathode is less than 1 and the signals are feed to ground via the 8u capacitor and the 2k6 Ohm resistor. Neither is there any signal at the 100k resistor, hence it does not seem to do anything important.I suspect this is done in order to save an expensive input transformer in case of plate to grid breakdown of the 262A. Remember that this was still early days and tubes were not all that reliable. Same thing applies the second stage, however, here the circuit is quite different. Third stage are straight from the textbook. But a similar arrangement are made at the output. I have marked these components in blue. The 595 Ohm resistor is a common cathode circuit from the two 300A's. Nothing weird about that. But do note that the cathode decoupling capacitor may be adjusted as the 595 Ohm resistor is a rheostat. (Variable resistor). It is also worth to note that this capacitor (Marked in green) are not referred to ground directly, but returns to ground via the PSU capacitors. Again quite unusual and I do not think it is of any advantage. **Peter Sikking,** Berlin (see: http://ultra-fi.blogspot.dk) raised some very good and relevant questions that made me dig a little deeper into these Western Electric quirks. I have drawn the first 3 stages and the output stage in a manner that may make it easier to comprehend what is indeed going on.



Alright, lets look at the first stage in **fig 1**. The signal path/current loop of the input transformer (Marked with yellow) are mainly passing through the two series resistors of 220k and 280k Ohms. A very small fraction of the current will pass through the grid, cathode and the 1u capacitor. These input signals can not pass to ground and the 100k Ohm resistor will have no input signal present. The amplified signal current of the 262 will have to pass through the cathode into ground. Now, the 2k6 cathode resistor are bypassed by 8u, which will lead (short) all signals above 7,6Hz to ground. Frequencies below 7,6Hz will pass through the 2k6 Ohms resistor that "shunts" the series connection of the 1u cap and 100k Ohms resistor. Hence there is NO feedback returned to the secondary winding loop of the input transformer. As I mentioned above, I am sure that the 100k Ohm resistor is there to protect the thin wires in the secondary winding of that transformer in case of failure of the 262A. It would be bad to business for WE if a simple and rather common thing such as this would bring the entire show down and mean an expensive transformer repair.

The second stage is a little different. Here the output current loop of the previous stage input is also part of the input loop of the 2 stage 262A.This means that the INPUT signals WILL pass through the 1u capacitor to the parallel of the 2k6 and 8u into ground. Only a fraction will pass through the 100k resistor. The cathode AC signals from the 262 will also pass through the 8u and 2k6 resistor to ground. Hence there is no feedback here either. I have no explanation to why the 1u capacitor is here, other that common practice of WE.

That brings us to the output stage shown in **fig 2**. Yes, here the WE guys are doing it again. They really loved that little trick in the first decade of amplifier engineering. It is often claimed that this WE trick was a feedback thing pulled in order to cancel imperfections. I fail to see how this can be the case. All the purple marked wires and components are common mode, which means that it does not make any sense to apply feedback here, being that positive or negative as it has no effect. In practice there is bound to be some imperfections and imbalances are certain. The transformers were not particularly good in those days and deviations even in the best matched tubes are as certain as amen at the church. But even if feedback was possible, the signal at the cathodes are in phase with the signals at the grid. Again I would say that the two 25k Ohms resistors protects the interstage secondary winding and this may be the cause of these.

There is another twist about the WE power stage. The common cathode resistor of 595 Ohms has a wiper, here a 16u are attached and returned to ground via the 8u PSU capacitor. So – what is the purpose of this arrangement ? Lets first see how it works as a decoupling of the common cathode resistor. First of all it is a common mode point. In theory there should be nothing to decouple, but imbalance are unavoidable hence it will decouple these. Decoupling of such will remove these imbalances from the cathode resistor but it will not fully cancel – sometimes quite the opposite, but maybe they was not aware of that back then.

As the resistor is variable it will change the degree of amplitude, as well as frequency. Turned full up to the cathode, the cathode will be exposed to a decoupling of 16u in series with 8u = 5u3 and the decoupling freq in parallel with the full 595 resistor will be 50 Hz. This means that above 50 Hz the audio signals are coupled to ground via the series network of the 16u and 8u. Below 50 Hz the gain will fall due to the local FB. At the midpoint of the resistor this freq will be 100Hz, but divided between the "two" resistors halfs of the 595 Ohms resistor. This is all from the point of view if local feedback was indeed possible, but being a common mode configuration negative FB is only possible to the individual opposite phase grids of the 300B´s (or any earlier stage). Imbalances can only be truly dealt with by a large cathode resistor, best of all a "constant current sink" /active cathode resistor. This is quite the opposite of decoupling. When the wiper of the 595 Ohms resistor are turned all down to ground, the 16u capacitor is effectively out of the cathode circuit and acts as an additional 16u capacitor to the 8u (16+8= 24u)

The other common theory is that the 16u capacitor couples power supply noise, meaning ripple to the cathodes of the 300B's in order to cancel noise. Lets see if this is possible. First of all – the common cathode resistor is a common mode point of the balanced push pull stage. A signal applied here will by nature be common for both tubes, hence rejected. Secondly the ripple noise produced by the power supply are present at both plates of the 300B's, thus also rejected to a very high degree. Finally the ripples coupled to the cathode resistor via the 16u cap are in phase with the common B+, meaning positive feedback. Hardly a good method for cancellation. The last part of the noise cancellation theory is that the ripple noise exposed at the cathode resistor are supposed to cancel hum. But as hum is a full wave swinging positive and negative and the ripples are rectified full wave to the same phase, it will only reduce hum at every second part of the fullwave, the other part will be amplified by the positive feedback of both being in same phase. Hardly a good idea.

Finally it is also unusual that the capacitor at the driver tube are placed in the ground side rather that the "hot" side. This arrangement place the primary side of the transformer at the B+ DC and builds a capacitive potential between the primary and secondary windings.. Quite unnecessary, but a thing that is easy to forgive as this was still early days of electronics. The components marked with red are power supply components. Despite these minor peculiarities, I really like this circuit. It has personality and character. If you consider to make a copy of this classic WE , I suggest that you avoid the first input transformer/tube stage. All that gain is of no use for modern signal sources.

The Voltage to the OPT should be between 4-450V and some 400 Volts for the second Voltage amplifier stage and driver stage. The quality of the inter-stage transformer and OPT are crucial in order to make it all worth the effort.

A true WE classic.
