PHYS 406

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Final Report

Refurbishing a 1965 National Westwood N6422TR Amplifier

Connor Gooding
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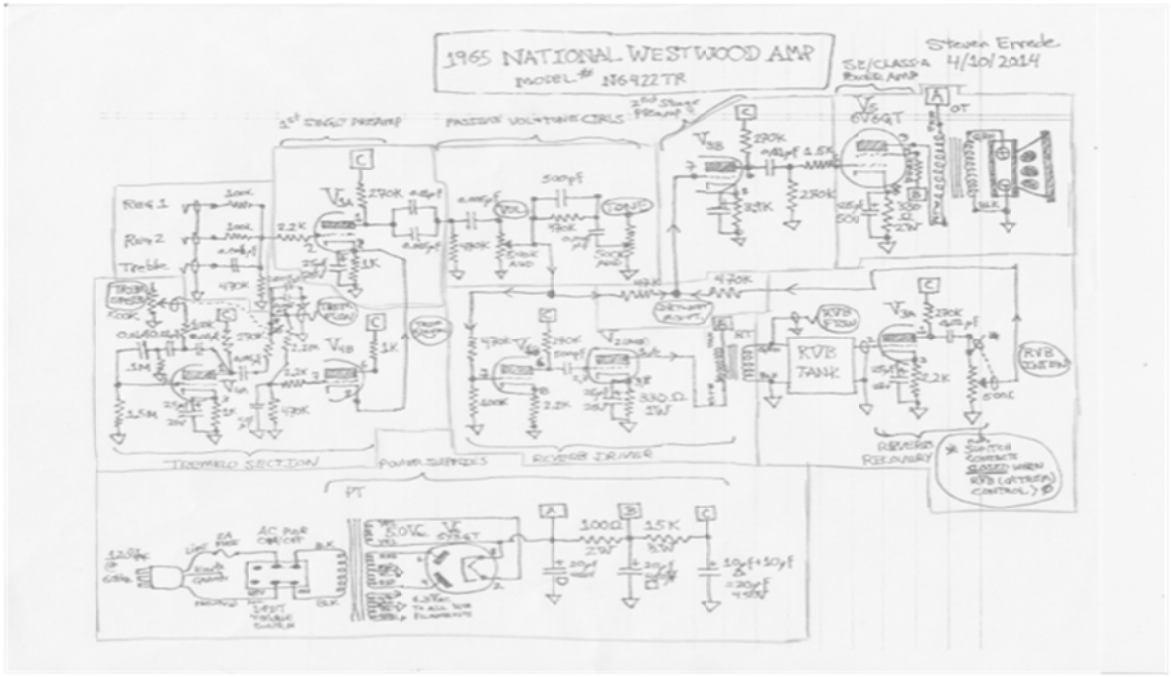
Prof. Steven Errede

Introduction/History

This 1965 National Westwood N6422TR is a combo tube guitar amplifier that was produced by Valco, a manufacturer of guitars, amplifiers, and other musical instruments based in Chicago, IL from the 1930s to 1968. Valco made musical instruments under several different brand names, most notably Supro, National, and Airline, and the name National probably originated from the founders' involvement with the National Dobro Company or the National String Instrument Corporation before starting Valco. Their combo amplifiers are coveted to this day by tonmeisters and collectors of vintage musical equipment due to their use in famous classic rock studio recordings; for example, Jimmy Page's amplifier of choice on Led Zeppelin's "Communication Breakdown" and "Whole Lotta Love" was a Supro Thunderbolt. Nowadays, the Valco name has been revived, but their amplifiers are made in an entirely different way than in the days of the original company.

Because Valco amplifiers and their components are no longer manufactured in the original fashion, our primary focus while refurbishing the Westwood N6422TR was keeping as many of the original components in working order as possible, only replacing parts that were either broken, missing, or no longer functioning in the proper way. Crucial original components, like the output transformers and the speakers (made by Jensen, a company that suffered a similar fate as Valco in that their modern-day products are not made in the way that they were in the 1960's), were handled with care and the circuit was modified in a way so as to preserve them.

Schematic



Circuit Description

The amplifier has three inputs for the guitar, two of which are labeled as "Regular" and one that is labeled as "Treble." The "Regular" inputs each simply pass through a 100kohm resistor, while the treble input has a 1 nF capacitor that acts as a rudimentary high-pass filter to the input.

Before explaining how that guitar signal is processed, the power supplies must be explained. On our refurbished model, the power cable supplies 120V AC to the power transformer from the wall with a DPST switch in between so the user can power the amp on and off. From there, the wall voltage is full-wave rectified into DC via the 5Y3-GT rectifier tube. It is then sent out to the processing circuit at three different points, labeled A, B and C on the schematic. Point A gives power to the output transformer and in series to the anode of the 6V6, Point B gives power to the screen grid of the 6V6-GTA power tube, and Point C powers all of the 12AX7 preamp tube anodes.

The input bay then feeds into the 1st Stage Preamp (I will explain the effects units after running through the clean signal chain), where the guitar signal feeds into the grid of a 12AX7 triode. The cathode of all of the 12AX7 triodes, except for one of the reverb driver triodes, is connected to ground with an electrolytic capacitor for and resistor for filtering and load, while the anodes are all powered by Point C from the power supplies. The guitar signal serves as a sensitive voltage control to Power Point C, and the sensitivity of the electronic component that is the vacuum tube means the guitar signal is effectively amplified by the Point C voltage out of the 1st stage preamp.

After a simple high-pass filtering by a 6nF-equivalent pair of capacitors in parallel, the signal then passes through the Passive Voltage and Tone Controls. The volume knob comes first, and it is simply a 500kOhm audio (logarithmic) potentiometer connected to ground. Following that, there is a tone control, which is a linear potentiometer that adds a boost to the mid-to-treble-range of the guitar signal via RC band-pass filtering.

The dry signal is then mixed into the reverb circuit, which will be explained in detail on in the description, and passed into the 2nd Stage Preamp. By now the guitar signal has been processed and amplified by the tremolo, reverb, and preamp circuits, and once again it is amplified by running through the grid of a 12AX7 triode powered by Point C.

The amplified “wet” (reverberated) signal then moves through one more 1st-order RC high-pass filter into the SE-Class A Power Amp. Instead of being fed into the grid of a 12AX7 for amplification, the signal now enters the control grid of a 6V6-GT tetrode power tube. The final amplified guitar signal is then fed into the output transformer, which sends the processed guitar signal out to the speakers. All of this high voltage is required to produce a high enough wattage from the matched-load, 8-ohm speaker [Figure 2] set so it can be audible to the human ear.

All of the previous information described a clean signal fed through the amplifier. However, this amplifier comes with a spring reverb tank and a built-in tremolo circuit.

The tremolo circuit simply modulates the bias of the 1st-Stage preamp tube, which is another 12AX7 powered yet again by Point C’s voltage from the wall. This amplifier only provides a potentiometer that changes the modulation speed; that is, the depth of the tremolo remains constant. Apparently there is a toggle footswitch that may have come with this brand of amplifer that plugs into the “Foot Switch” input next to the Tremolo knob. When the knob is turned to 0 or the foot switch has toggled the tremolo unit off, the switch contacts open up. They close when tremolo control are > 0.

The reverb circuit is perhaps the most complicated signal processing unit on this amplifier. It has two parts: the reverb driver and the reverb recovery. The reverb driver takes the clean signal and runs it through two rounds of amplification via 12AX7 triodes and then feeds it into a reverb-specific transformer (the reverb driver) that sends the signal through the spring reverb tank sitting in the bottom of the combo cabinet. There is also a footswitch input that catches the signal before the reverb tank. If it is toggled off, the switch contacts open up. The reverb tank [Figure 1] (which is a series of parallel springs that the signal runs through, created by Bell Labs to simulate the effects of long-distance on telephone calls) outputs the freshly reverberated signal to the recovery circuit, which is another 12AX7 triode that amplifies the reverberated signal and sends the fully wet signal through a Reverb Intensity potentiometer. If this potentiometer's switch is turned off, the switch contacts open up and no reverb is mixed into the dry signal. The fully wet signal is then mixed with the clean signal at the dry-wet mix point and that combination is what gets sent to the 2nd Stage Preamp.

Figure 1: The 8-ohm Jensen speakers that output the processed signal

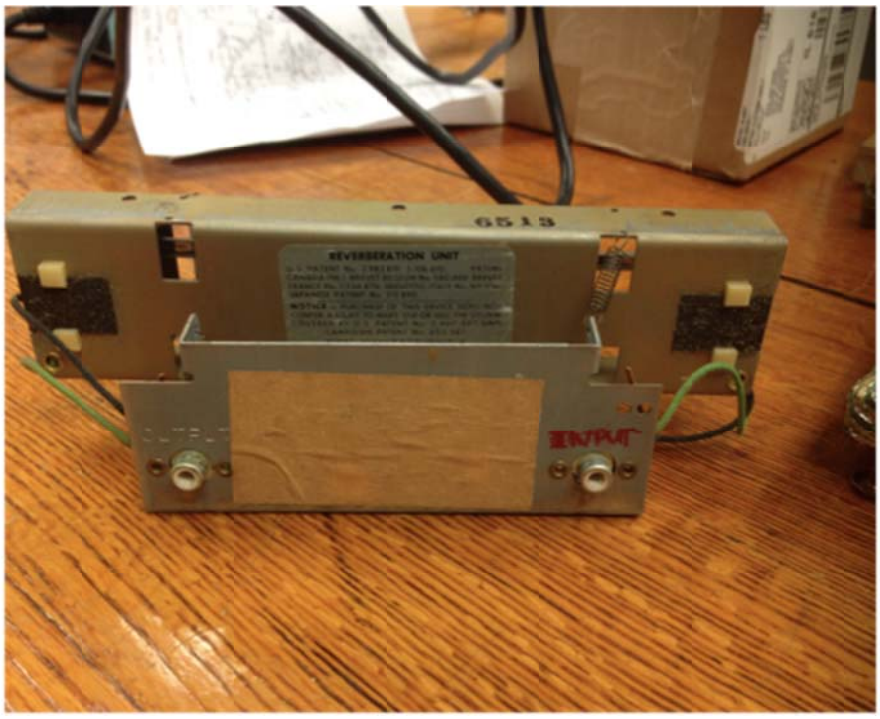


Figure 2: The spring reverb tank, unboxed.

Replacements/Modifications

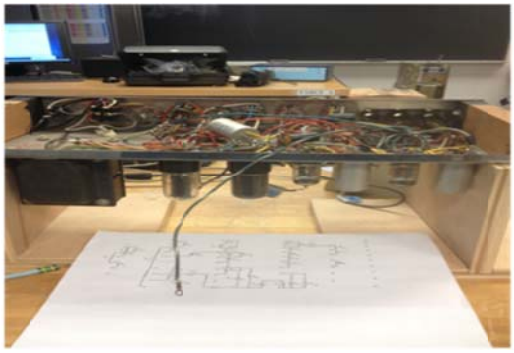
The major replacements during the refurbishing process were replacing the missing knob on the potentiometer and replacing the 50 year-old electrolytic capacitors with newer, Sprague Atom antique capacitors made in a similar way as the original ones. There were six total axial capacitors replaced along with a can capacitor (which contains higher voltage-rating capacitors for use in filtering the power points A-C post-rectifier). Another minor replacement was a 100 ohm power resistor that was snapped in half as a consequence of running the amplifier through the modern wall voltage before modifications were made. This resistor's wattage could not withstand the wall voltage boost.

As mentioned in the introduction, most of the modifications made to the amplifier were made for the sake of keeping the original, and therefore extremely rare, components fresh and safe from excess wattage and abuse. The most significant modifications in terms of keeping parts safe was updating the cathode resistor on the 6V6 power tube. Most 6V6-GT power tubes are designed to take a maximum wattage of 12 Watts in plate dissipation. Before modifications, the original circuit's design in combination with the new wall voltage was giving the 6V6 18.5 Watts in plate dissipation, over 150% of the maximum power rating for the tube. Therefore, another obvious replacement was the 6V6-GT itself, considering it was running on borrowed time after what could have been years of accidental abuse. The final replacement for the sake of keeping original parts safe was the removal of the tight spring latched over the reverb tank. This was added to keep the fragile tank in place, but it was putting too much on the tank's casing, causing the sides of the cardboard casing to crimp and dampen the oscillation of the unit itself. It is now held down by Velcro, relieving the tank's casing of any excess pressure or damping.

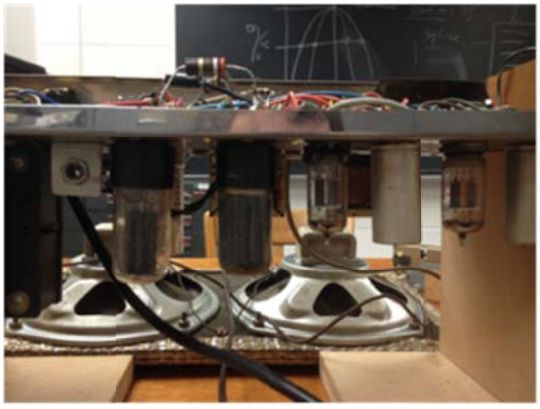
However, a few modifications were made for user safety and preference as well as keeping the components safe from harm. For example, the original circuit utilized a reverse polarity feature on the power switch. The feature is intended to reduce noise, but it is inherently dangerous as it uses a “pseudo-ground” that can cause the amp to become live. In fact, if I had switched the amp quickly from forward to reverse polarity in its original state, there is a high chance I would have received a powerful shock. Another safety modification made was the removal of a capacitor running from the power switch to a footswitch input. This connection between the input and a direct wall power component is so dangerous that it is now against federal law to have in a circuit like this, so naturally it was removed in the refurbishing of this amplifier. The last safety modification made was the addition of an earth-grounded, three-prong power cable to eliminate any other possibility of the amp becoming live and dangerous to the user.

The final modification was made for user preference, and that was modifying the connection between the speaker transformer and the speaker leads. Originally, the output transformer connected directly to the speakers via soldered leads, making the speakers difficult to remove from the amp head itself, which is not desirable when it comes to using advanced live sound techniques to put the amplifier comfortably in the mix with other musicians. To make the amplifier separable from the speakers, a 1/4’’ jack and cable head were added between the output transformer and the speaker leads. This allows for the insertion of specialized direct input boxes or the use of alternative speaker cabinets should the Jensen speakers ever prove undesirable.

Before and After



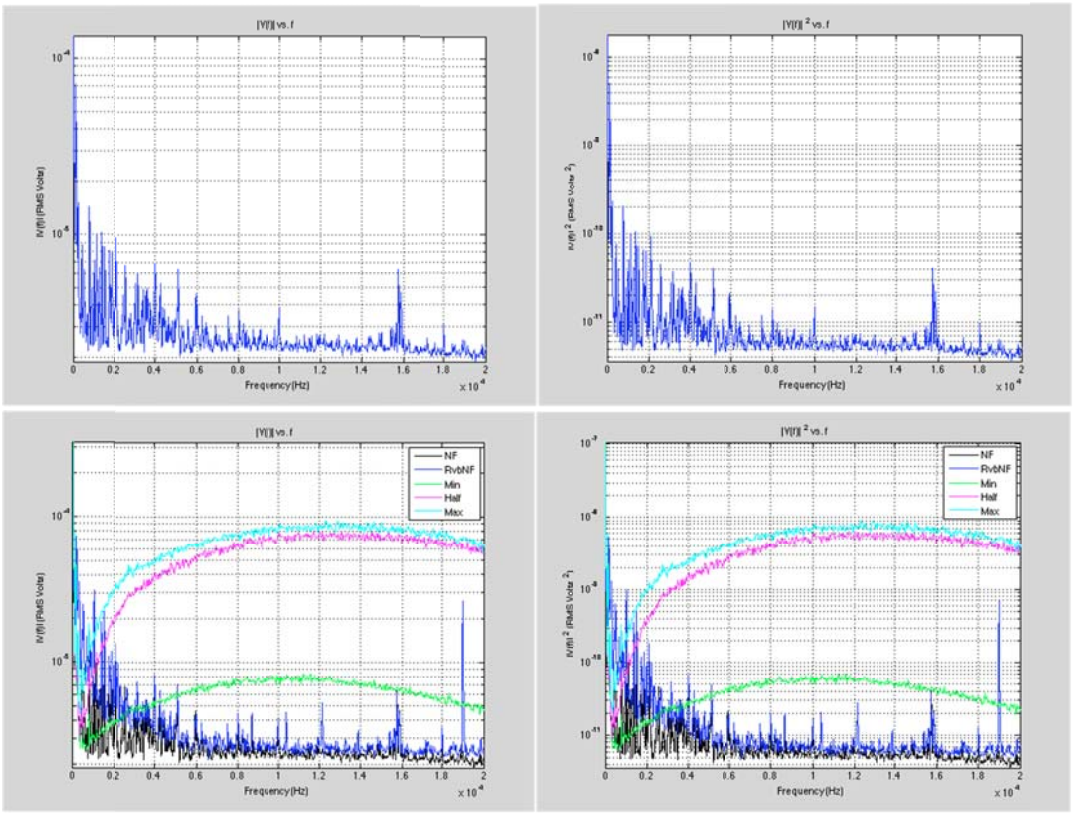
Amp before refurbishing



The addition of a 1/4’’ jack between output/speakers

The amplifier circuit post-modifications.

Frequency Response



Top Left: Noise Floor, Linear Voltage; Top Right: Noise Floor, Squared Voltage
Bottom Left: Tone and Reverb Effects on Voltage; Bottom Right: Bottom Left w/ Squared Voltage.