The Ultrapath Line Amp

By Jack Elliano © 1998

Even after having been there and done that, I still wonder what I might have missed along the way. Would you believe that some politician back in the early part of this century made a move to shut down the Patent Office? He stated that everything had been invented and that it was just a waste of money to keep it open. History now tells us that he had just invented a new kind of stupidity. What also happened in the early part of the century was the development of the triode and the wonderful things that transpired because of that device. The circuitry has not changed much from when it was in its infancy, nor has the basic arrangement to accomplish amplification.

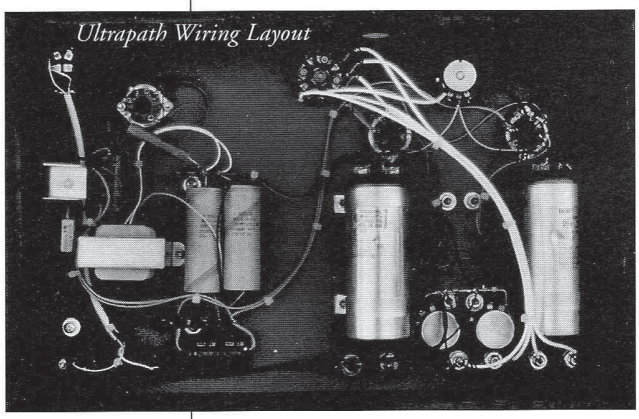
The "improvements" we have seen for years are mostly of the materials used to build the same devices. Manufacturers sell these improved components to replace the old ones that they sold you when that one was better that the last one. Still, the circuit is the same and the new components are used to sell their latest product. Point being, very little has been done in basic circuitry to improve the quality of amplification. Only the quality of components has improved. It appears that when one changes a tube or component value in a conventional circuit and it works, it gives the inventor the qualifications to write a story about this amazing find and the new sonic relevance. What follows is not a tube change story but a real, new, honest arrangement of components that has not been tried until now.

Many excellent designs have been around since the 1930s and are still the basic building blocks that we know and love. The "Ultrapath" circuit is a variation of the standard transformer coupled voltage amplifier. As shown in Figure 1 (p.12), the "Ultrapath," as the name implies, couples the primary return of the transformer back to the tube cathode through one capacitor. This, of course, can only be done with transformer coupling and not with RC coupled stages. In the case of RC coupling, it is the plate coupling capacitor reacting against the grid resistor of the next stage that conveys the signal. The plate resistor and grid resistor together form an effective plate load with a slight capacitive reactance. There is no return path, only an operating load resistance that the tube likes.

The transformer or inductive load reacts very differently. A tube's load line with an inductive load is not a straight line like a resistor, but rather an ellipse. The ellipse is in motion with the frequency impressed upon the whole inductance. The inductive plate load varies with its reactance to a given variation of current. This whole device must work in a cycle or loop with its varying power source, the tube and power supply.

To further explain the theory of operation, we must know what all components do in the circuit. A triode is a motional resistor whose operating points are set by fixed resistors and voltage values. A transformer is an impedance matching device that can transfer the variation of the motional resistor to the next device in the circuit while isolating the power supply. Actually, the alternating voltages do not go through a capacitor but around its associated circuitry. The power supply needs no explanation. These are very simplistic descriptions and they are not here to insult anyone reading this. Having one of each basic component performing its own electrical function is an interesting concept, especially in audio.

When designing an amplifier with basic components, its circuitry can become simple. No constant current sources or local regulated operating points, and no microchip band-aids. While experimenting with various line output transformer designs it was necessary to build a single tube amplifier stage. A 6J5 was selected due to its popularity and basic geometry. Having consulted with Cy Brenneman, "Triode Proctologist," as to the operating points needed for lowest distortion, a breadboard was built and fired up. As transformers were connected, measured, cussed at (a little-known engineering procedure) and rewound, an idea came to mind as to coupling the source closer to this transformer. In a conventional circuit, the return from the primary of the transformer would pass through the power supply capacitor, then through the cathode bypass capacitor to the tube. These capacitors are usually electrolytics and would be back to back or negative to negative. This seems strange now but it was the accepted, normal way to do it. Coupling back to the cathode with a capacitor from the end of the primary appeared to be practical, and was tried. Removing the cathode bypass capacitor seemed proper at this point.



Ultrapath Wiring Layout

Large enough to prevent degeneration, the oil capacitor has equal charge and discharge characteristics. There really is no effective discharge to zero volts but a variation nonetheless, in both directions. Back to back electrolytics in the path would produce various resistances at different frequencies and amplitudes. Making cathode and power supply capaci

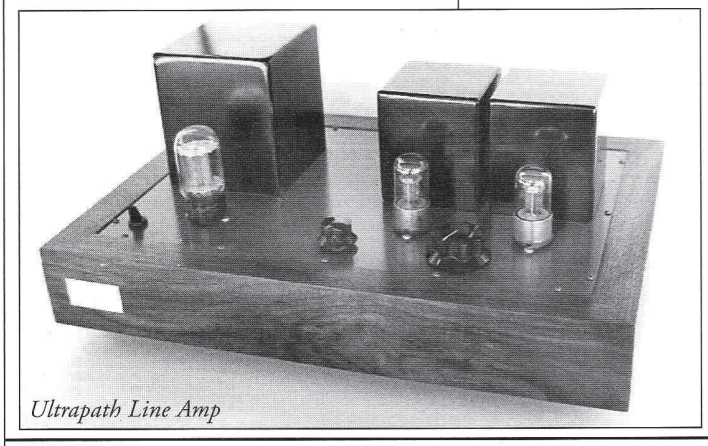


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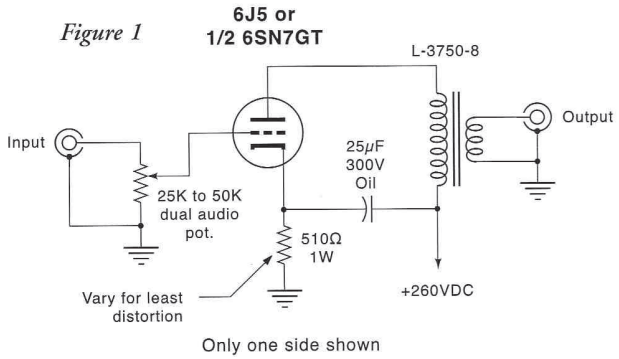
Figure 1



tors nonpolarized would help, but with two different values of caps in the path, the angular velocity or rapidity of variations will result in sum-differences in the circle of operation. The sound produced from these component combinations are usually explained away with tautology such as "grainy, veiled, pale, phlegmatic or zingy."

If the Ultrapath circuit was to modify the signal in any way, it would modify the signal less than any other type of circuit. The power supply is connected at the primary B+ end, of course, and is of very little consequence. The 510 ohm resistor was determined with the use of an HP 334A distortion analyzer under 600 ohms load, and with an HP 203A signal generator as the source signal. A 1K pot in the cathode is varied and the dip in distortion is noted, the resistance is measured and a fixed resistor is installed.

For the few that do not wish to use distortion analyzers, just connect it up to your existing system and adjust it for minimum audio signal damage. The cathode resistor will vary from about 150 ohms to 650 ohms or so, with different triodes. Medium-mu triodes, such as 6SN7, 76, 56, 6C4, 6C5, 12AU7 and the like will work. The plate impedance of each tube will determine the secondary impedance, that is, a loaded secondary will reflect back to the plate load. This will need to be optimized with each tube type, but as long as it is higher that it needs to be, all should work well with a line output transformer such as the L3750-8. Frequency response will vary only slightly if the load is around 600 ohms.

The power supply shown in Figure 2 is different in one way: The relatively large value resistor before the filter circuit. This helps isolate noise from power transformer interwinding capacity to the AC line and to reduce the peak charging current. The filter efficiency is increased and transformer heating is not a problem. The filter and its last capacitor is part of the path for the audio but is not the primary path. The 100uf electrolytic cap is an ample reservoir for power needed at the lowest frequency. The circuit measured out as follows:

Frequency Response -1db, 23 hz to 43 khz

Noise Floor -57dbV

Voltage Gain (600 ohm load) 2.6, or 1 v gives 2.6v output

THD .26% @ 20khz, .28% @ 2khz, 1.2% @ 24hz

The voltage across the triode should be 250v and the plate current should not exceed 20ma dcv for a 6J5. The cathode resistor adjustment will affect this and must be measured along with the distortion figure. Built as shown, this project should give very good results.

The Ultrapath was built in such a way as to be scrutinized, hauled, shipped and tested. The first listening test was with the Las Vegas Audiophile Society. The educated ears in this group range from seasoned musicians to soundstage engineers. Armed with their three favorite CDs and a "nothing is better than my stuff" attitude, they sat without saying a word. As each played the CD of their choice, all heard something more in the recording. I, having not noticed anything other than very clean sound, finally heard something that I knew did not exist when I played this piece before. I noticed that the voice was recorded with a slight reverb.

Reconnecting the other conventional linestage, the reverb was only heard because we listened for it. The Ultrapath circuit had revealed the reverb on the voice as it was recorded. Reverb is not a product of harmonic distortion, oscillation or inferior design in a circuit. In other words, it cannot be manufactured within the interior of a conventional amplifier stage.

Reverb is a very interesting effect. It is a superimposed, decaying continuation of a given waveform. Theorizing on why it revealed this type of waveform will also express why the conventional linestage did not. The conventional linestage used the two capacitors as described previously, in the return path. Due to the charge/discharge at two different rates at the same frequency, a nulling out or sum/difference would clean up the dominating waveform. This also can account for other discrepancies or modifications of sound sources in conventional circuit designs.

I have seen high price tags and claims of near perfection with less difference than this circuit demonstrates. The simplicity and performance of this circuit is amazing and we at Electra-Print Audio Company invite you to build this circuit for yourself, if so inclined, and see how great simplicity can be. The output and power transformers and choke are available from Electra-Print Audio Company, but other high quality units should perform equally as well.

Electra-Print Audio Company retains the rights to the "Ultrapath" name and the circuit published with this name. The reproduction of this circuit for profit by other than Electra-Print Audio Company is expressly prohibited.

Jack Elliano owns and operates Electra-Print Audio, Las Vegas, Nevada, a premier designer and manufacturer of audio transformers.

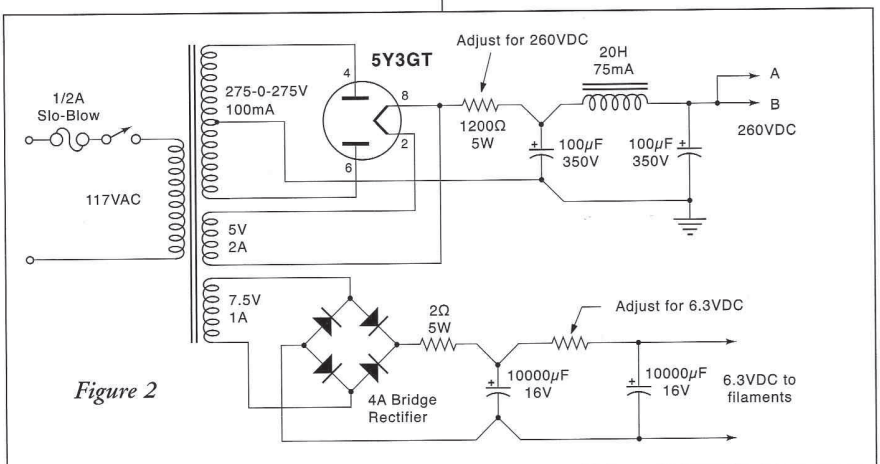


Figure 2