

## THE OUTPUT TRANSFORMER

I tried three alternative hookups. The first & best of these is a custom wound unit from Hammond. It has four separate primary windings which allows matching 6L6GC's to 1400 ohms or 6550C's to 800 ohms. The Hammond part number is H300767. The 800 ohm connection could also be used with KT88's or EL34's. The 1400 ohm connection would be OK for KT66's. Secondary of the transformer is the normal Hammond configuration of two windings allowing 4, 8 & 16 ohm loading.

A very good 2<sup>nd</sup> alternative is that using a pair of Hammond 125E universal output transformers. It occurred to me that if you could parallel connect resistors, capacitors or inductors to reduce the impedance than why not transformers? The transformer primaries are connected in parallel so that they will reflect  $\frac{1}{2}$  the data sheet impedance if similar secondary's are used. Keep in mind they are rated for 15 watts of audio each. That would be OK for the 6L6GC version of the amp. If you connect the secondary taps 1 & 5 of each transformer in series to an 8 ohm load you will reflect a load of 1500 ohms to the output tubes which will make them very happy. The damping factor is not as good as when the H300767 transformer was used.

The 3<sup>rd</sup> transformer hookup allows you to use some of the commonly available push-pull output transformers. The key here is that the two halves of the primary must be electrically isolated. You will find these in old amplifiers as well as replacement units now on the market. If the two halves of the primary are paralleled the impedance will be  $\frac{1}{4}$  of the normal hookup. For example, if you were lucky enough to have a transformer made for push-pull 6L6's with plate to plate impedance of 6600 ohms then the new connection would give you 1650 ohms. That is close enough to satisfy the 6L6GC's in this version of the Circlotron.

You will notice in the schematic for this alternative I have shown the transformer primaries connected to each others opposite connection, that is blue to brown & vice versa. As well, the transformer secondary's are also reversed, so that the output signals are still additive. In many lower cost audio transformers the secondary is wound around one end of the primary. This results in more stray capacity on one end of the primary than on the other end. For the Hammond 125 Series the secondary is wound around the brown end of the primary. This may cause problems unless you give it some consideration. In a pushpull amplifier, the high frequency balance of the output stage is disturbed. By paying attention to this simple relation, you can avoid that condition.

You will still need to provide a DC return for the negative power supply. That is possible by using a pair of resistors bridged across the transformer primary. See R38 & R39 in the diagram. The resistances used will need to be rather large in order to avoid audio signal power loss at this point, since they form a load across the transformer primary. That in itself is not a problem. However, DC return current in these same resistors adds too much to the output tube bias, tending to bias them off. For this reason I do not recommend this hookup.

Fortunately, most of the output transformers I referred to above come with Ultralinear (UL) taps. That will neatly step around the biasing problem I referred to. The taps are normally at 20% or 43% of each  $\frac{1}{2}$  of the primary. That means you can use a much smaller bridging resistance which will have much less effect on the output tube bias. Even still you will need to make a small adjustment in the bias network to bias the tubes properly.

As an example, I had set the idling current of each 6L6GC in the circuit to 42 ma in the circuit of the first output transformer alternative described above. When I connected this transformer alternative which has 43% UL taps the new biasing conditions had reset the idling current to 30 ma. Measuring the voltage drop across the bridging resistors I found that 5.72 volts had been added to the bias. The good news is that the audio signal voltage developed across the bridging resistors when the output was set to 12.5 watts was only 18.7 volts rather than 131 volts. That had allowed the bridging resistors to be reduced by 86%, a very worthwhile improvement in this part of the circuit.