Tetrode and Pentode
RF Power Amplifier Information

By Larry E. Gugle K4RFE, RF Design, Manufacture, Test & Service Engineer (Retired)

Tune-Up Procedure

When adjusting a RF Power Amplifier using either a Power Tetrode or Power Pentode, for proper excitation and loading, it will be noticed that the procedure is different, depending upon whether the Screen Grid Voltage is taken from a, Fixed Screen Grid Power Supply with good regulation, or from a Dropping Resistor from the Plate Power Supply with poor regulation.

If the Screen Grid Voltage is taken from a Fixed Screen Grid Power Supply with good regulation;

1. The Current is almost entirely controlled by the RF excitation. One should first vary excitation until the desired Current flows.

2. The loading is then varied until the maximum power output is obtained.

3. Following these adjustments the excitation is then trimmed along with the loading until the desired Control Grid Current, and Screen Grid Current is obtained.

If the Screen Grid Voltage is taken from a Dropping Resistor from the Plate Power Supply with poor regulation;

1. The stage will tune very much like a Power Triode RF Power Amplifier.

2. The Current will be adjusted principally by varying the Loading, and the excitation will be trimmed to give the desired Control Grid Current.

3. In this case the Screen Grid Current will be almost entirely set by the choice of the dropping resistor. It will be found that excitation and loading will vary the Screen Grid Voltage considerably and these should be trimmed to give about normal Screen Grid Voltage.

Contrary to popular opinion, a RF Power Amplifier using either a Power Tetrode or Pentode should never be loaded for maximum power output, like a RF Power Amplifier using a Power Triode.

1. Loading should be set to obtain a pre-determined value of Screen Grid Current under a Single-Tone or Continous Wave (CW) driving condition. Ideally, loading should be set for minimum distortion - a rather difficult feat to practice.

2. It is recommended that an attempt to duplicate as nearly as possible a given set of Data-Sheet conditions as presented by the Tube Manufacturer.

3. These typical operating conditions are usually given for Peak Envelope Power (PEP) operation using either a Single-Tone or Continous Wave (CW) and represent the maximum input power on CW or the Peak Envelope Power (PEP) Input (not meter peaks) on single sideband.

4. After adjusting the Exciter Drive, Tuning, and Loading to duplicate a given set of conditions, Single-Tone or Continous Wave is removed and the Single Side Band (SSB) audio gain is adjusted so that Control Grid Current is never drawn and the condition adjusted for above is never exceeded on peaks. The peak-to-average ratio of DC Plate Current (as read on a fluctuating meter) varies, with the individual voice, from about 2:1 to over 3:1. Thus it is normal on voice peaks for the plate-current meter to read no more than half the value of current obtained in the maximum static single tone condition.

A straight forward Tune-Up Procedure consists of the following steps:

1. Ensure that the Tetrode RF Power Amplifier is neutralized and free of parasitics.

2. With the recommended Heater, Plate, and Screen Grade Voltages applied;

    a. Adjust the DC Control Grid Bias Voltage to obtain the recommended zero-signal value of Plate Current.

    b. This value affects Linearity and Plate Dissipation.

3. Connect a suitable Dummy Load and set the loading control for rather heavy loading.

4. With a single-tone or Continous Wave (CW) source, gradually increase the drive from zero to a value that produces a significant though small change in screen current.

5. Resonate the Plate Tank circuit by tuning for a peak (in the positive direction) in Screen Grid Current.

6. Resonate the Control Grid Tank Circuit (if any) by watching for a peak in Plate Current.

7. Now increase the drive until either the desired value of Screen Grid or Plate Current is reached (whichever is reached first).

8. Without drawing Control Grid Current, adjust the Loading, Plate Tank Tuning, and exciter drive level to duplicate as nearly as possible a given set of data-sheet peak-Envelope conditions. Remember that;

    a. Plate Current Increases with drive.

    b. Screen Grid Current Peaks at Resonance

    c. Screen Grid Current decreases with heavier loading.

9. After matching a set of data-sheet conditions, the amplifier is ready to connect to an antenna.

    a. With a suitable antenna connected, it should be easy to repeat the operation obtained in Step 8 above by merely adjusting plate-tank tuning and loading with the same drive level as before.

    b. Set up for voice single-sideband drive and adjust the audio gain for the highest level possible without drawing grid current on voice peaks or flat-topping (check this with an Oscilloscope).

Tetrode and Pentode Input Resistance

The design of a typical Control Grid-Tuned input circuit is quite similar to the design of the Resonant output circuit. For class C operation, or any class where Control Grid current is flowing, the input circuit must have sufficient "Q" to maintain a sinusoidal grid wave shape. ***The tube's "Input Resistance" loads the input circuit. It is considered good engineering practice to have a***

circuit "Q" of between 12 and 15. In any class of operation with no Control Grid Current, the Control Grid circuit requirements are not as stringent, provided broad bandwidth is not a factor. Applications where broad frequency coverage is desired may better utilize a ferrite loaded impedance matching transformer terminated into a non-inductive resistor (typically 400 Ohms to 1K Ohms); this is then coupled to a parallel resonant circuit at the control grid. The net power gain resulting from such a circuit is somewhat less than that of a conventional high-impedance grid-tuned circuit but this circuit generally does not require as much neutralization, due to the swamping effect of the low grid impedance.

For the 4CX1500B example using a parallel tuned matching circuit, ***the tube's "Input Resistance"*** is approximate the power
delivered to the Control Grid of the tube divided by the square of the DC Control Grid current.