Tube type HF amplifier tuning

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Introduction

This guide is primarily written for those who are new to HF amps, or anyone who wishes to get the most out a Linear amplifier.

I have found that this procedure works well with all HF amps that I have used, regardless of the type tube used.

First, we must understand why a Linear amplifier must be tuned in this manner.

Plate impedance

The voltage used, relates to the "Plate impedance", each amp is designed to operate at a given plate impedance. The plate voltage can be reduced, or increased, but the plate current must be increased or decreased, to meet the plate impedance level. A person can think of a tube type RF amplifier much like a antenna tuner, matching the tubes plate impedance, to the output impedance which is usually 50 ohms on the output end. The relationship of plate voltage to plate current creates the plate impedance level, which can range anywhere from

500 to 5000 ohms or more, dependent on the voltages used and the plate current needed to reach full power output. Changes in plate voltage, can create plate impedance mismatches, which cause output waveform distortions, and loss of efficiency. Large swings in plate voltage, due to a poorly designed power supply, or a power supply that is operating beyond it's capacity, can also create this same type of distortion. In my judgment, a swing that exceeds 500 volts is enough to cause distortions in the output signal.

To tune an amp at a lower voltage, then increase the voltage to operate on, creates a mis-match in the plate impedance.

Problem; Many amps can't stand a steady carrier tune up in high voltage mode, due to limitations of the power supply design and components.

Solution; Use a reduced "duty cycle" method to tune the amp in high voltage mode.

Hence, the "pulsed" tune method, which has a duty cycle of about 50%.

One can use a store bought "pulser","cricket", or a CW keyer.

For using a CW keyer(which is more commonly available), set the keyer to about 40-50wpm, then tune the amp with it.

Step 1. Set the amp in the voltage mode, you intend to use on the air, low or high, it does not matter. For a person wanting to run lower power most of the time, use the lower voltage, it will be more efficient.

Step 2. Set the exciter, to about 20-30 watts output or whatever level that increases the plate current by 10-20% above the idle "zero-signal" current level.

Step 3. Preset the amp, to the manufacturers suggested settings, if available. Set the exciter to CW mode, ready to start transmitting.

Step 4. Begin tuning the amp, by "dipping" the plate current(while transmitting),

this resonates the plate circuit.

Step 5. While still transmitting into the amp, tune the load control, for "peak" RF out put. Un-key when this is done.

Step 6. Increase the exciter output to about 50-60 watts, another increase in plate current or 10-20%. And repeat steps 4 & 5.

Step 7. Increase the exciters output to full power. (Note; care must be used, not to exceed the amps plate & grid current ratings, if you reach MAX, plate current before reaching MAX exciter RF drive level, that is it, you can't drive the amp any farther.) (ie. If your amp has a MAX. plate current rating of 900ma. & 225ma.grid current, do not exceed these ratings, if you do, reduce exciter drive level.) Repeat Steps 4 & 5.

Step 8. At this point leave all setting where they are, now tune the "load" control to "over-couple" the amp loading, refer to (**"Grid current Rule # 1"**). Heavy loading is known as "over-coupling". This is the final tuning step.

Step 9. Switch the exciter to the mode that you wish to operate on. SSB is usually used on the high voltage setting, low voltage, is used for all other modes, but SSB can be used there also.

Step 10. You can reduce the RF drive power, if you wish to run at lower than full output. Do not change the voltage, unless you retune at that voltage level.

Now that you have tuned up, the amplifier is operating at maximum efficiency, and linearity.

ALC!

Any ham operator that does not use an ALC feedback circuit to control the exciter RF output to the amp, is an **idiot**. It is there for a reason. Most amplifier manufacturers have installed an ALC output on their units. It does not matter if your exciter can put out enough RF to overdrive the amp or not. Drive level is

only one item the ALC system controls. Should the amp be loaded into a high SWR, the ALC will reduce the drive level to a safer level. Every ham has had a "lapse" in memory, and left the RF drive level to high when using the amp, and this can cause unseen damage to the grids of the tube. This is especially true of delicate metal/ceramic tubes. The ALC system will act as a "safety net" should an error be made or a failure in the antenna system happen. It is inconceivable that someone would knowingly do without it.

Most ALC systems can be set in the following manner;

1. Load the amp in the normal manner to full output, with full RF drive applied.

2. Adjust the ALC threshold(usually a pot on the back of the amp), until the RF output is reduced slightly, then back up the adjustment slightly.

3. You're done. No further adjustment is needed. If the ALC system was designed correctly, the system will operate without re-adjustment on all bands.

Now you can rest easy, knowing that your amp is protected from overdrive, or other problems.

Grid current; Rule # 1, Less is better!

Once you have tuned the amp for max output, you can reduce the grid current, by increasing the loading. (Loading is increased by reducing the load capacitor capacitance, this couples the RF to the antenna where it should be.) This will reduce the grid current, drastically, with a small drop in RF output power. (OK, you ask how much of a drop in RF output? The general rule is 10%, (i.e. 1000watts out, reduced by 100watts or more.) The drop in RF output, is well worth the lower grid current, which will greatly increase the life of the tube (especially metal/ceramic tubes). The drop in grid current should be somewhere in the area of 30-50%, (ie. full drive grid current of 200ma, should be reduced to 150-100ma.)

If you turn the load control the "wrong way" the RF output will "peak", and the grid current will remain high, but if you turn the load control the correct direction, the RF output will drop slowly, but the grid current will drop quickly. This can vary from one make of amp to another, to verify the correct tune direction, look inside the unit to see which direction "un-meshes" the load capacitor, that is the direction of "heavier loading", the "correct" direction.

Care must be taken not to "over-load" the amp, as this will cause as much problems as "under-loading" can.

A good rule of thumb is; Tune for peak RF output, and lowest plate current, then load the amp slightly to lower the grid current slightly.

Peak RF output and minimum plate current should happen at the same tune point.

Now that you have tuned up using this procedure, your amp will now operate cooler, and with a lower IMD level, for a "cleaner" output signal.

The use of the CW keyer puts a lower stress on the tube, power supply, and all RF components. The speed of the pulses, gives a good meter indication, and makes it easy to tune.

Nearly all HF linear amplifiers can benefit from this method. Even if your amp has only one voltage setting, you can use the procedure.

A suggestion: Make a "cheat sheet", or chart, with the tuned up, settings at a given frequency. In this way, you can set the amp by number, and fore go, the tune up procedure, less tune time, means longer tube life.

With some HF amps, the tune dials are marked, 0-100. I found that "setting by number", is fast, and works very well, with no noticeable drop in output power. A cheat sheet for high voltage, and low voltage, are needed, as the settings WILL, be different.

Caring for your RF power amp tubes.