This is the unexpurgated, pre-edited version of the article "Improved Anode-Circuit Parasitic-Suppression For Modern Amplifier-Tubes" that appeared on page 36 in the October 1988 issue of *QST*. A more recent treatment of the subject appeared in the September and October 1990 issues of QST. The article is titled "Parasitics Revisited. "

The purpose in publishing this manuscript is to allow the reader to see whether on not QST is influenced by advertisers. To do this, open up a copy of the Oct. 1988 QST, and compare. Anything in parenthesis is not part of the manuscript text. The information in parenthesis was added later.

Improved Anode-Circuit Parasitic-Suppression For Modern Amplifier-Tubes

The traditional copper-inductor/carbon-resistor anode [plate] parasitic-suppressor has been used in vacuum-tube amplifiers for at least 50 years. The earliest record of an anode parasitic-suppressor that I can locate was in a transmitter that was built in the early 1930s by the (Art) Collins Radio Company.

(In late 1990, I was made aware of some interesting information on anode-circuit VHF parasitic suppressors in the 1926 Edition of The Radio Amateur's Handbook. This information was inexplicably omitted from post-1929 editions. Info provided by Dave Newkirk, WJ1Z)

Much of the reason for Art Collins' early success can be attributed to the fact that he, almost alone, understood that where RF is concerned there is no such thing as a zero-potential "ground" and that any wire or strap was a capacitor-inductor VHF tuned-circuit as well as a conductor. He understood that an "RF-choke" acted like a short-circuit at certain frequencies and that sometimes a resistor would make a better RF-choke than an RF-choke! Because he understood these "RF secrets", he was the first manufacturer to build a transmitter that: worked on all frequencies up to 14.5MHz, was stable and could be tuned up every time with no surprises.

Anode parasitic-suppressor design has not changed during the last 50+ years while vacuum-tube design has changed markedly. In the 1930s, 40s and 50s, a "high-Mu triode" had a (voltage) amplification factor of 40. Today, a "high-Mu triode" usually indicates an amplification factor of 100 to 240. A fifty+ year-old parasitic-suppressor design that was usually successful at preventing oscillation in an amplifier-tube with an amplification of 40, may not be as successful on a modern amplifier-tube that has much more gain.

Modern amplifier-tubes have another factor, in addition to higher voltage gain, that makes the job of the traditional inductor/resistor VHF parasitic-suppressor more difficult. That factor is higher frequency capability. Ancient amplifier-tubes could barely be coaxed into amplifying at 28MHz. The 203A that was used successfully in the Collins 150B transmitter had a full-power rating of 15MHz.

Modern Amplifier-Tube Performance:

The popular 8802/3-500Z triode has an average amplification factor of 130 (Eimac) to 200 (Amperex). The Amperex version appears to be electrically equivalent to the 8163/3-400Z with the exception of the anode dissipation rating. The maximum-input rating of the Eimac 3-500Z, for "radio frequency power amplifier or oscillator service" is 110MHz. 3-500Zs work well above

110MHz if the power is de-rated as frequency increases. Other types of modern amplifier-tubes commonly used in HF-amplifiers have an even higher amplification factor and a frequency rating of up to 500MHz. The 8874 is a good example of a high gain, 500MHz triode. It has an average amplification factor of 240! This is definitely a high-Mu triode.

Oscillators:

If an amplifier-tube can amplify at a frequency, it can usually be made to oscillate at that frequency. This is good news for oscillator builders and bad news for unwary amplifier builders.

In addition to frequency capability, there are some other prerequisites that must be met before oscillation can be achieved: a feedback path between the output and the input of the amplifier and high-"Q" resonant circuits in the output lead and in the input lead to the amplifier-tube that are resonant near the same frequency. The resonant circuits are essential because they act like a flywheel and sustain the oscillation during the portion of the cycle that the amplifier-tube is not conducting and amplifying.

The (Incomplete) Schematic Diagram:
Understanding the nature of the parasitic-oscillation problem would be much easier if the schematic diagram of an amplifier circuit would show the interconnecting input and output leads to the amplifier-tube for what they actually are: inductors. These incognito inductors, combined with the inter-electrode capacitances of the amplifier-tube, form unavoidable VHF self-resonant circuits. See Figure 1, A-B-C The typical frequency range of these resonances is from 90MHz to 160MHz in 1500W HF amplifiers.

The Parasitic-Oscillation Seed-Voltage:
The essential question is: Where does the initial VHF voltage come from that starts the self-resonant flywheels in motion that causes the parasitic-oscillation to take place? Certainly, it can not come from the exciter because all exciters have a built-in low-pass filter that is very effective at blocking any VHF signal. This leaves only the amplifier as the source of the seed-voltage.

The answer to that pivotal question involves Q. Q represents the "Quality" of a tuned circuit component. More Quality should be better. An old adage says: "more is not always better". Where amplifier design is concerned, more Q is certainly not always better. The appropriate Q for each part of the circuit is the best design. For example: HF tank-circuit components should have a high-Q. and, as I will explain, anode leads should have a low-Q.

For the purpose of this discussion, the most important rule about Q is: The RF-voltage that is developed across a resonant circuit is directly proportional to the Q of the resonant circuit.

This principle is best illustrated by the antique spark-transmitter. In a spark-transmitter, the transient-currents from a motor-driven rotary spark-gap (a motorized switch) were passed through a high-Q tuned-circuit. This caused the tuned-circuit to "ring" at its resonant frequency which produced a surprising amount of RF voltage and power. The tuned-circuit acts like a flywheel after each impulse. It coasts a bit after each impulse and then stops, like the ringing of a bell. This is referred to as "flywheel-effect". Lowering the Q will reduce the flywheel-effect.

Amplifiers are routinely subjected to numerous turn-on, switching, keying, and voice transient-currents. These transient-currents pass through the VHF self-resonant anode-circuit and the VHF self-resonant input-circuit. Each transient-current causes the input and output self-resonant circuits to ring and generate an invisible, damped-wave VHF voltage that is proportional to the VHF-Q of these circuits This is the source of the VHF seed-voltage that initiates the parasitic-oscillation.

Part of this seed-voltage will be fed back to the input of the amplifier by the feedthrough/feedback capacitance inside the amplifier-tube. The VHF voltage will then be amplified by the amplifier-tube and it will appear in the anode-circuit where some of it will be returned to the input of the amplifier-tube by way of the feedback-capacitance.

If the amplified VHF voltage arrives with the right phase and amplitude, an even larger signal may be fed back to the input of the amplifier. When this occurs, the parasitic-oscillation is off and running. This would not be a problem if the considerable energy that is generated by the VHF parasitic-oscillation could be safely dissipated in the load that is connected to the amplifier. Unfortunately, the VHF energy can not reach the output connector of the amplifier because it can not pass through the HF tank-circuit inductor. This inductor acts as an RF choke to the VHF energy. This traps the VHF energy in the anode-circuit. With no load, the grid-current and grid-dissipation of a high-Mu triode oscillator becomes excessive in a matter of milliseconds. This can start a chain reaction of events that almost simultaneously results in a loud bang and can cause severe damage to the amplifier.

Grounded-grid Oscillators:
Making a grounded-grid amplifier oscillate is easier than it might seem: In a grid-driven, grounded-cathode amplifier, the output and input voltages are 180 degrees out of phase. They oppose each other. Before regeneration can occur, the output and input voltages must be made in-phase, to aid each other, by adding a phase-shift circuit. In a grounded-grid amplifier the output and input voltages are already in-phase and aiding each other.

For many years it was assumed that grounded-grid amplifiers were inherently stable because the "grounded"-grid acts as a shield between the input and the output circuits, thereby blocking regeneration and oscillation. At HF this logic is true but at VHF, the logic is false because no matter how carefully an amplifier-tube is designed, at some frequency the "grounded"-grid will become self-resonant. This is due to the unavoidable, combined inductances of: the grid structure, the internal leads, external leads, and the tube socket, resonating with the capacitance of the grid structure. In a 3-500Z triode, the directly (as is possible) grounded-grid will self-resonate at about 95MHz. As frequency increases above grid self-resonance, the grid exhibits inductive reactance, and the grid is no longer "grounded".

When the grid is not truly grounded, as is the case above its self-resonant frequency, the assumption about the shield, that we are depending on to block regeneration, is in serious trouble. And, to make matters worse, as the frequency increases into the VHF region, the feedthrough capacitance from the input [cathode] to the output [anode] of the amplifier has fewer and fewer ohms of capacitive reactance.

In other words, As the frequency increases above the grid self-resonant frequency , the "grounded-grid" behaves progressively less as though it were grounded and the feedback, or regeneration, path between the input and the output of the amplifier-tube becomes more and more conductive to RF current.. This combination is not desirable unless the designer intends to build an oscillator.

Anti-Parasitic Techniques and Q:
Another important rule is: Q is equal to Reactance divided by Resistance, or Q= X/R . Q can be

decreased by increasing the resistance, or by decreasing the reactance, or both.

One obvious way to lower Q is to use resistive, or low-Q, conductors. Silver-plated copper strap has the highest VHF-Q known to science at room temperature and yet silver-plated copper strap is commonly used for anode-circuit wiring and for VHF "parasitic-suppressors" in HF amplifiers. A more accurate name for a silver-plated parasitic-suppressor would be a parasitic-supporter.

The Q of copper is about 94% of the Q of silver, so copper does not provide an appreciable improvement in Q reduction over silver. Trying to build a low-Q circuit with high-Q silver or copper conductors makes about as much sense as trying to make a pencil eraser out of Teflon®.

Reducing the inductive reactance by shortening lead lengths may improve stability IF the shortened lead places the cathode and anode-circuit self-resonant frequencies farther apart.

Another method of improving stability is to tune out some of the inductive reactance in the grid structure by bypassing the grid to the chassis with small capacitors. This increases the self-resonant frequency of the grid circuit to a point where the amplifier-tube will have less amplifying and oscillating ability.

The first grounded-grid amplifier that I know of that used this technique used (4) 811As and was built by the Collins Radio Company. Many currently produced commercial grounded-grid amplifiers still use this circuit. I discussed this in a previous article about parasitic-oscillation in grounded-grid amplifiers. {"Grounded-Grid Amplifier Parasitics", *Ham Radio Magazine*, April 1986, page 31.}

Grid-inductance cancelling capacitors are most effective when used with older design amplifier-tubes like the 811A that have a considerable amount of internal grid-inductance to cancel. This technique is only mildly effective at improving amplifier stability in modern amplifier-tubes, that have inherently low grid-inductance.

Another anti-parasitic technique that I discussed in the article was the use of an input parasitic suppressor-resistor, to lower the VHF-Q at the self-resonant frequency of the input (cathode) circuit. Input suppressor-resistors also reduce intermodulation distortion (IMD) with the tradeoff of a slight increase in the drive power requirement to the amplifier.

Input parasitic-suppressor resistors are moderately effective at stabilizing unruly amplifiers, but they are not always 100% successful. After the article about parasitic oscillation was published, about 5% of the follow-up letters and phone calls I received were from people who reported that their amplifiers were more stable with input suppressor-resistors than without, but still not perfectly free from the foreboding signs of instability like minor arcing and spitting at the tuning capacitor and/or bandswitch. The only area left for improvement was the anode-circuit.

In Search Of A Better Anode Parasitic-Suppressor:

The trouble with trying to troubleshoot a parasitic-oscillation problem is that the crazy things are not always predictable. It may be that just the right transient or rapid sequence of transients needs to come along to get the ball rolling. For example, you can change something like a conductor-length in a marginally stable amplifier and it will behave for months. When you are beginning to believe that the problem is "fixed", and you confidently put the rest of the screws in the cabinet, it will unexpectedly arc or burn-up the parasitic-suppressor resistor, or worse.

The perfect amplifier to experiment with would be one that had an unusually high gain amplifier-tube or tubes that consistently exhibited instability problems even with input suppressors installed. By a great stroke of good luck, just such an amplifier came into the possession of NF7S [Ed], who lives in Phoenix, Arizona. From Ed's point of view it was initially a stroke of bad luck.

The amplifier was a newly purchased model which uses a pair of 3-500Zs with either 2200V (CW) or 3200V (SSB) on the anodes. The new amplifier made an arcing sound, but he was not concerned since, on page 14, the instruction manual said that this arcing sound was "normal". After a few months the "normal arcing" had burned off some of the contacts on the output section of the bandswitch. The missing contacts made the amplifier inoperative. This was not an isolated case because I know of at least eleven other hams who have had to replace the output bandswitch on the same model amplifier.

Ed contacted factory-service via an authorized dealer and described the problem. He was told that the output bandswitch was damaged by: someone who had rapidly switched the bandswitch while transmitting at full power. He had unpacked the new amplifier himself from a factory-sealed carton. He knew that he had never hot-switched the bandswitch. He immediately realized that he was talking to the wrong people.

I have heard the same outrageous story from other competent amateur radio operators who had talked to factory-service[?] about the same problem with this amplifier. I do not believe that any of these people were stupid enough to try band-switching the amplifier while transmitting.

He discussed his amplifier problem with me and questioned whether the voltage capability of the tuning capacitor and the output bandswitch were adequate for this application. Since the actual breakdown voltage of these components is above 5000VDC at sea level, and the maximum RF voltage is only about 2600V-peak, nothing should arc-over unless the amplifier was operated at an extreme altitude that would probably cause the operator to pass-out because of anoxia. Clearly, this was not the case in Phoenix, Arizona.

As the frequency of a specific AC voltage increases, its gas ionization ability also increases. This effect can be seen in the manufacturer's voltage versus frequency ratings for RF-rated relays: The rated RF peak operating voltage always decreases as frequency increases. This is one of the reasons why the waveguides of high-power radar transmitters are pressurized with dry nitrogen gas.

The presence of an unwanted AC voltage, with a frequency that was much higher than the normal 29.7MHz maximum, was indicated in Ed's amplifier. The source of this voltage could be a VHF parasitic-oscillation.

I recommended that Ed install some input suppressor resistors consisting of a pair of 10 ohm, 2W metal{oxide}film [MOF] resistors in series with the RF-input connection to the 3-500Z cathodes. After replacing the original bandswitch and adding the input suppressor-resistors, he was still noticing arcing in the general area of the bandswitch.

He threw in the towel. He asked me to see if I could fix the unruly amplifier; I said I would try. The amplifier and the original, damaged bandswitch, that he had replaced, made the trip to California.

The damaged bandswitch revealed that the most severely burned/vapourized switch parts were the anode tuning capacitor padder contacts for the 3.5MHz and 1.8MHz positions. The next most-roasted contacts were for the 28MHz tank-coil tap. The 21MHz tank-coil tap contacts were burned less than the 28MHz contacts and the 14MHz contacts were not burned. The pattern was clear: Only the contacts that were close to the anode were damaged. And the contacts that were closest to the anode were damaged the most.

The voltage that did this damage had a remarkable ability to jump an air-gap and also deteriorated very rapidly as it tried to travel through the inductance of the tank-coil. HF energy would have no problem traveling through the inductance in the tank-coil. The only kind of voltage that fits this profile is a high-voltage with a frequency in the VHF range.

Before operating the amplifier, I installed a 5.1 ohm, 2W MOF resistor in series with the HV positive lead. The resistor will act like a HV fuse and current limiter if a full-blown parasitic-oscillation occurs. This limits the discharge current pulse from the considerable number of joules of stored energy in the HV filter capacitor bank. If unlimited, this current pulse can disturb the grid to filament alignment in the amplifier-tube[s] which can cause fatal, grid to filament shorts.

A ceramic 10 ohm, 7W to 10W wirewound resistor would provide even better protection. A higher wattage resistor should be used only if justified by increased anode-current demand because the resistor is supposed to burn-out quickly during a circuit-fault and stop the flow of current. .

As a further precaution before firing-up the amplifier, I checked the 10W cathode bias zener diode. As is often the case after a parasitic oscillation and its accompanying large current pulse, the zener diode was found to be shorted. The zener diode was replaced by a series string of (7) ordinary, perfboard mounted, RF-bypassed, 1A, >50piv silicon rectifiers with the polarity arrows pointing opposite that of the original zener. This provides about 5 volts of cathode bias-voltage during transmit.

{The polarity is opposite because the new diodes will be operated in the forward conducting (.75v/diode) direction instead of in the reverse, zener-breakdown direction}

My first encounter with the unruly amplifier exceeded my wildest expectations. Even with input suppressor-resistors installed, this amplifier would oscillate reliably with only 2200V on the anodes on the 14MHz and 28MHz bands! With 3200V applied, the amplifier was unstable on some additional bands as well. I was impressed. It was an electronic "Pandora's Box". This amplifier was perfect for anti-parasitic R and D.

This situation was amazing to me because I owned an identical model of the same amplifier that had been stabilized by using the same input suppressor-resistor circuit that was used in the unruly amplifier. The only difference between the two amplifiers was the particular pair of 3-500Z tubes.

Ed's 3-500Zs had remarkably high gain. With 100W drive at 3.8MHz, they would deliver 780v p-p [1520W PEP] into a Bird 50 termination. This does not necessarily mean that they would have also had abnormally high VHF gain as well, but it is probably a safe assumption after witnessing their ability to oscillate at VHF.

I set the unruly amplifier aside for a week and discussed the problem with some of my amplifier-builder friends. After some enlightening technical discussions and a suggestion to have the amplifier exorcised , I was ready to proceed.

In every HF amplifier design, there is an unavoidable VHF tuned circuit formed by the anode to ground capacitance and the total inductance of the wires or straps between the anode and the output tuning capacitor. The resonant frequency of this anode-circuit can be varied only slightly by adjusting the output tuning capacitor. I measured the anode-circuit's self-resonant frequency in the unruly amplifier, with a dip-meter coupled to the wire between the HV blocking capacitor, and the anode-choke. I found a very sharp, high-Q dip at 130MHz.

Next, I checked the self-resonance of the center-conductor of the coax that delivers the input signal to the cathodes. The input circuit self-resonated near the same frequency. This was not good.

Much of the inductance that formed the resonance in the anode-circuit appeared to be in the 50mm [2 inches] of "U"-shaped #12 copper wire that connected the HV blocking capacitor to the top of the anode RF-choke. This innocent looking #12 wire has about 39nH of inductance. At 130MHz this inductance has a reactance of +j32. I soldered a 5.1 ohm non-inductive MOF resistor, with "zero" lead-length, across the "U"-shaped #12 wire to damp the Q of the tuned circuit. I "fired up" the amplifier on the 14MHz band and applied drive power. As usual, I saw fire and I heard a familiar bang. The fuse-resistor exploded again as did the added 5.1 ohm MOF Q damping resistor ! Thanks to the fuse resistor, the 3-500Zs remained undamaged and unshorted after this, fifth, full-blown parasitic-oscillation..

The 5.1 ohm Q-damping resistor's demise was amazing because it was virtually shorted-out by less than 0.0003 DC ohms of #12 copper wire when it went kaput ! This resistor had an overload rating of 20W for 5 seconds and it had been destroyed in milliseconds. The only thing that could have so quickly blown away a tough, essentially DC and HF shorted resistor like that was VHF current in the multi-ampere range.

I concluded that the anode-circuit self-resonance of 130MHz was probably the culprit due to the 3-500Z's 110MHz+ rating and the fact that the input resonance was tuned to almost the same frequency. If I could increase the self-resonant frequency of the anode-circuit to a higher frequency, where the 3-500Z's excellent amplifying ability was waning, I suspected that it might reduce the chance for a parasitic-oscillation.

I also decided that, because of the extremely sharp dip at 130MHz, the high Q of the anode-circuit was probably another contributing factor. This problem seemed to be exacerbated by the fact that high VHF-Q silver-plated strap had been used for the combination anode-suppressors/anode-leads. It did not seem logical to use the highest Q material to build a circuit that obviously requires a low-Q to prevent the creation of a transient- induced VHF seed-voltage that could start a parasitic-oscillation.

Low-Q Conductors:
The obvious choice for a low-Q conductor is nichrome ribbon or wire. It has 60 times the resistance of copper or silver. Q-measurement tests on a VHF Q-meter, confirmed that nichrome produces a much lower Q than any other commonly available conductor material. Unfortunately, nichrome wire and, especially, flexible nichrome ribbon, is not easy to find or inexpensive. Soft stainless-steel makes a good second-choice because it has 10 times the R of copper and it is commonly available.

Anode-Circuit Modifications:
The #12 copper wire was replaced with a strip of nichrome ribbon about 3mm in width and 35mm long. A three-turn inductor, with an inside diameter of about 6mm to 7mm, made from #18 [1mm] soft stainless-steel wire was connected in parallel with the ribbon in order to stagger-tune the circuit. This increased the self-resonant frequency of the anode-circuit to about 150MHz and also lowered its apparent Q.

It is not possible to connect a VHF Q-meter to the anode-circuit of an amplifier, but I concluded that the in-circuit VHF-Q had been reduced appreciably. I arrived at this conclusion by judging how closely the dipmeter had to be coupled to the anode-circuit to obtain a 10% meter dip at resonance for each type of conductor material.

The factory-original, silver-plated, high VHF-Q L/R parasitic-supporters, were replaced with low VHF-Q L/R suppressors made from two 100, 2W metal{oxide}film [MOF] resistors in parallel, shunted by a 70nH inductor made from #18 stainless-steel wire. The inductor has 3-turns. A 9/32" drill-bit shank can be used as a winding-form. To keep the circuit's VHF-Q as low as possible, #18 stainless-steel wire was also used for the the leads at the ends of the anode-suppressor assembly. The ends of the wire leads are bent into circles for mounting with the original screws.

Construction Notes: 1: The inductor and each MOF resistor should be parallel to each other and separated by a cooling air gap of about 2mm. Note 2: To avoid a short-circuit and to facilitate cooling, the inductor must not be wound on top of the resistors because the conducting part of these resistors is on their outside surface.

For an even lower Q and better parasitic-suppression, the conductors could be made from nichrome wire in place of the stainless-steel wire.

If an amplifier shows signs of instability with the 3-turn suppressor inductors, try 3 1/2 or 4-turn inductors. Caution, the inductance can not be arbitrarily increased because too-much inductance will cause the inductor's voltage drop to be too great for the parallel 100, 2W resistors on the 28MHz band. The reason for this is that, on the 28MHz band, with an anode-voltage of 3KV, there is approximately 1.8a of RF current-circulating through each 3-500Z anode lead due to the 4.7pF anode to grid (ground) capacitance of each anode.

In amplifiers with longer anode-circuit lead lengths, two or more of these suppressor assemblies can be connected in series with each anode lead for an even lower Q.

Results:
The once unruly (TL-922) amplifier has shown no signs of instability since the anode-circuit was modified with low-Q conductors - even with all of the screws in the cabinet! The output power appears to be unchanged on a wattmeter although it is probably about 10 watts lower at 29MHz as a result of using the low-Q anode-circuit conductors.

The same anti-parasitic technique was used successfully on several unstable Heathkit SB-220 amplifiers; two, Henry Radio Co. 3CX1200A7 amplifiers and also on a notoriously unstable Viewstar amplifier that had previously destroyed a pair of 3-500Zs and numerous, other components as the result of a parasitic-oscillation.

A Closer Look At How And Why A Successful Parasitic-Suppressor Works:
A successful parasitic-suppressor must perform two, interrelated tasks. The first task is to reduce the flywheel-effect of a VHF self-resonant circuit by reducing the Q of that resonant circuit. The flywheel-effect is essential to oscillation. Reducing the flywheel-effect will reduce the chance of a parasitic-oscillation. The second task of a suppressor is to reduce the VHF voltage-gain of the amplifier stage.

The voltage-gain of an amplifier is approximately proportional to the output load-resistance (RL) placed on the amplifier-tube. High RL means high voltage-gain and low RL means low voltage-gain. If the VHF voltage-gain of an amplifier-tube can be made low enough, by decreasing the VHF RL , the VHF voltage-gain of the amplifier will be so low that it can not oscillate at VHF. If a high-Q conductor-inductor is used to connect the anode of the amplifier-tube to the, essentially VHF-grounded, tuning capacitor, a high-Q parallel-resonant-circuit will be formed. The capacitance in this parallel-resonant-circuit is the output capacitance of the tube and the inductance is the built-in inductance in the leads between the anode-connection [plate-cap] and the tuning-capacitor. A high-Q parallel resonant circuit acts like a very high resistance at its resonant frequency. Thus, the amplifier has a very-high RL and a very-high voltage-gain at the VHF resonant frequency which greatly increases the risk of a VHF parasitic-oscillation. See Figure 1,C.

A low-Q, parallel-resonant circuit will have a relatively low-resistance at its resonant frequency. If two, low-Q, paralleled, conductor/inductors of slightly different inductance are connected in parallel and to the same capacitor (Cout) a dual resonant, broadband effect and an even lower-Q will result. This is similar to the broadbanding-effect that is achieved when the primary and secondary of an IF-transformer are tuned to different frequencies. This technique lowers the VHF-Q even further and decreases the VHF output RL which further decreases the VHF voltage-gain of the amplifier. The goal of parasitic-suppression is to reduce the net (VHF) voltage-gain, by lowering the VHF-Q, which lowers the VHF load resistance on the amplifier-tube, so that the amplifier-tube can not oscillate.

In a typical parasitic-suppressor, the two, low-Q paralleled conductor-inductors are: the suppressor's resistor, which makes the lower-inductance current path, and the nichrome inductor, which makes the higher-inductance current path. Both of the inductances in a parasitic-suppressor can also be constructed solely out of low-Q wire or ribbon as was the case for the low-Q replacement for the #12 copper buswire in the TL-922.

The "Bottom Line":
High-Q conductors, such as silver and copper, are the best choice for the anode-circuit/tank-circuit conductors in a VHF amplifier or VHF oscillator.

Copper is the best material for the conductors in a HF tank- circuit or tuned-input circuit. Silver-plating the copper will improve the appearance but not the performance at HF.

Nichrome exhibits a very low VHF-Q. Thus, it is a suitable material to use for anode-circuit, input-lead and suppressor conductors in an HF -amplifier. Round conductors exhibit a lower VHF-Q than flat conductors due to skin effect.

Appropriate Conductor Sizes:
1/4 inch [6.35mm] nichrome ribbon conductor is satisfactory for anode-circuits carrying up to about 8A of RF circulating-current. The circulating-current through the anode-lead of a typical 1500W amplifier is usually much less than this. The conductor width should be held to a minimum to lower the VHF-Q for better stability. It would not be good engineering practice to use 1/4 inch nichrome ribbon if a smaller conductor will carry the current. Bigger or wider conductors are not appropriate unless a smaller conductor is overheating from the RF circulating-current during 10 meter band operation.

The safe RF current carrying capacity of #18 gauge nichrome wire, in free-air, is probably about 3 amperes at 30MHz.

Construction Tips:
Nichrome and stainless-steel can be easily soldered with an ordinary soldering iron by using a

special flux that is made for soldering nickel-chromium alloys and 430ºF tin-silver solder. These materials are sold in hobby shops and in welding-supply stores.

Notes:

There is no single "sure-cure" for every case of amplifier instability.

1. Taming especially unruly amplifiers may require the intelligent use of a dip-meter, several anti-parasitic techniques, more than one L/R parasitic-suppressor per anode-lead and a, VHF Q-lowering, 1 metalfilm [MF] resistor in series with the L/R parasitic-suppressor.

2. In some cases, it may help to add a low-Q, series-resonant L/R/C suppressor between the cathode and ground. The resonant frequency of this series circuit should be at, or slightly higher than, the self-resonant frequency of the anode-circuit. The resistor should be a 1 to 5, 2W MOF or MF-type and the capacitor is 25pF. The inductance is controlled by adjusting the leadlengths on the resistor and the capacitor. The resonant frequency of this circuit is difficult to check because the cathode must be directly shorted to ground and the resistor must be bypassed with a straight wire in order to find the dip on a dipmeter.

In rare cases, a VHF self-resonance in the anode HV RF-choke or in the filament-choke can become a player in a parasitic-oscillation. This problem can be overcome in these ways: A filament-choke can be effectively isolated by placing a VHF attenuator-rated ferrite-bead (Mu850) over each filament lead on the filament side of the filament-choke. An anode HV RF-choke can be effectively isolated by placing an unbypassed 10, 15W, wirewound resistor in series with either end of the choke.

Parasitic oscillation can be one of the most vexing amplifier problems. If you would like to discuss any part of this article or the malady in general, please feel free to call me at [805] 386-3734.

Fixing a parasitic oscillation problem is definitely different. In the end, the only reward you get is: no surprises. Just be sure that you put all the screws in the cabinet before you relax.

End