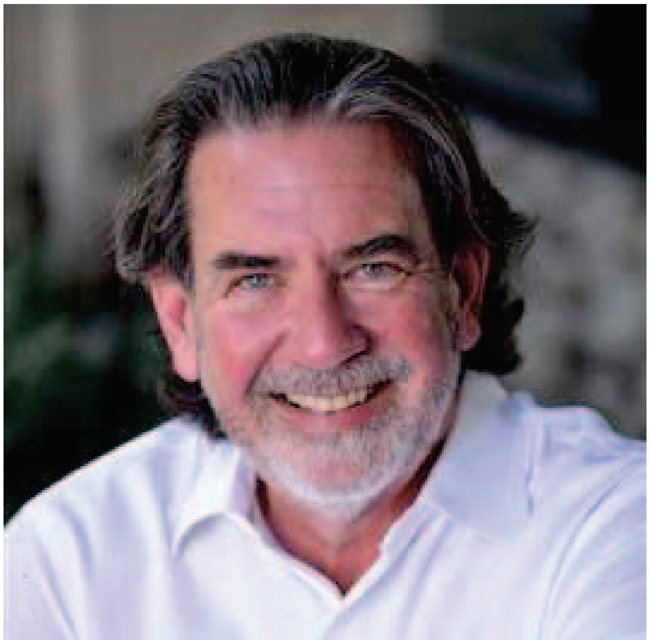
The Signal

OFFICIAL MAGAZINE OF THE COLLINS COLLECTORS ASSOCIATION * Q1 2015 Issue *

Warren Bruene "Talks to Us" ~ 30S-1 ~

$7.50 USA $8.00 Canada 700 優斉壘

Collins Collectors Association



From the President's Desk...

It is with great humility that I have accepted the responsibility of taking on the role of President for the next 2 years. I have watched the CCA grow and change over the last few years and it has been a rewarding and exciting ride!

When I look at what is going on in the CCA I realized there are a lot of guys making things happen. The 20 meter net keeps growing under the faithful leadership of Jim Hollabaugh, W6TMU. Jim is also new on the board and I look forward to working with him as he brings lots of wisdom and enthusiasm to the table. The membership has grown each year and the renewal process is helped along and recorded under the direction of Jerry Kessler, N4JL – maybe the most tedious job in the CCA. The 80 meter Tuesday and Thursday nets are operating each week led by Lloyd Rafalsky K4HWB. I listened to it last night but could not check in as my shop SSB transmitter is not working (need to get that fixed!) and it had three rounds of checkins over a couple of hours – all were having a wonderful time. The first Wednesday AM net is great fun across the nation coordinated by Larry Saletzki - WA9VRH (also our archive manager) -- look for some fun changes to the central time zone this month. I hear great things about the West Coast Net on Friday nights but cannot check in from Texas and it is run by Mickey Siegel - WA6FIZ.

Bill Carns, N7OTQ and Paul Kluwe, W8ZO (Board Member) are busy at work raising funds for the efforts of the CRHG and Bill, our past President and Don Jackson, W5QN, continue to do a bang up job on the *Signal*! Jim Stone - KW3Y, Hanford Wright - WA4LZC and Dick Blumenstein - K0CAT did a super job getting our event in Orlando off the ground and Jim Stitzinger - WA3CEX always brings us fun at Dayton and travels the country allowing Hams to get a glimpse of the Collins Van and Shelter. Floyd Soo – W8RO and his team always have the booth ready at Dayton and there are countless people who man the booth like Rich Davis - K8PJQ and Tony Sokol - W9JXN that answer the hundreds of questions by the constant stream of visitors. Dave Meitzen - AA9TT and I have had a great time putting together the Dallas Ham Com event each year and Dennis Kidder - W6DQ and Werner - WB6RAW have put together the second Pacificon West Coast event – which I am really looking forward to attending for the first time this year. Last but not least, Dennis Kidder, W6DQ records everything as CCA Secretary and Jim Green WB3DJU, keeps us in line as Treasurer.

There is simply not enough space to name each and every net control that gives up hours each week to run the five different nets, nor is there space to list all of the people who have made the CCA what it is since it was conceived 21 years ago by Bill J. Wheeler - K0DEW. While in Orlando last month Rod Blocksome – KODAS, Barry Buelow – W0IY and I sat for over an hour at the booth answering questions from visitors, sharing stories of Collins and ham radio and it hit me that the hard work of those above, and the countless others who have gone before us, enable the interaction of so many of us that share a passion for things Collins. We owe each our sincere thanks for the countless hours they put in to make this organization what it is!

You who are sitting on the sidelines enjoying all of this – I would like to reach out and invite you to join our efforts in volunteering and, through those efforts, exploring leadership. I really believe that those who are volunteering are having the most fun by being involved. Yes, I know that there is some work - but it is this group who gets the chance to interact with each other, know all the news before it is news, and have a part in the shaping of the future of the CCA. I know this from personal experience! So if you want to take your Collins experience to the next level drop me an email – I look forward to hearing from you!

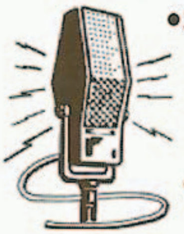
Scott Kerr – KE1RR
President

The Signal Magazine

OFFICIAL JOURNAL OF THE COLLINS COLLECTORS ASSOCIATION

Issue Number Seventy Seven - 1st Quarter 2015

Join Us on the Air!



- Sunday 14.263 mHz at 2000Z
- Tuesday 3805 kHz at 8pm CST
- Thursday 3805 kHz at 8pm CST
- Friday (West Coast) 3895 kHz at 10pm CST
- Sunday 10m AM 29.050 mHz at Noon CST
- 1st Wednesday AM 3880 kHz at 8pm CST

Sunday for Technical, Buy, Sell & Swap
Tues., Thurs., Fri., & Sunday for Ragchew

The *Signal Magazine*

Published quarterly by the

Collins Collectors Association

Editor & Publisher - Bill Carns, N7OTQ
Assistant Editor - Gail Sheehan, K2RED
Technical Editor - Don Jackson, W5QN

The Collins Collectors Association
P.O. Box 1269
Wimberley, TX 78676-1269

Come Visit Our CCA Website

www.collinsradio.org

See our New Features & Members Area.

You can renew your membership or join the CCA on our website using the "JOIN US" link.

- 2015 -

Looking Forward

This coming year will bring us many changes. Change can be a little scary sometimes, but in this case, it is exciting and just means that we are making good progress and doing what we should be doing. What are these changes?

First – and always good for an organization – new blood is coming in, and bringing along with that change the opportunity for new ideas.

Secondly, the *Signal Magazine* has started shifting gears and is returning to a more balanced format that will – we hope – serve the needs and desires of our audience well through 2015 and beyond. 2013 was the 80th anniversary of Collins Radio and saw the *Signal* get into major "history documentation" mode. Then, 2014 was our 20th anniversary and we – more or less – stayed in the "preservation" theme for the majority of our articles. Now, we are returning to a mix of restoration, maintenance, history and equipment articles.

Third, we will be using social media more to achieve our overall objectives of building a strong organization that both meets your requirements and fosters our overarching goals of preservation, documentation and education.

We will be continuing to support our alliance partner(s), the Antique Wireless Association as well as our friends at Rockwell Collins as they move toward similar objectives. We are particularly excited about continuing to work on making our STEM related efforts successful as we work with these partners. Our efforts related to the Collins Radio Heritage Group will continue to be emphasized.

There is one common element to all of these changes that should not be ignored. It is very important, if we are to succeed, that we have your input – your feedback – and that new potential leaders continue to volunteer for the help that we need. This volunteer effort also fosters the development of new future leaders of the CCA. If you would like to consider being involved in the future leadership of the CCA, please discuss this with the current staff and also get involved in the work that we have on our plate. We need you – that is for sure.

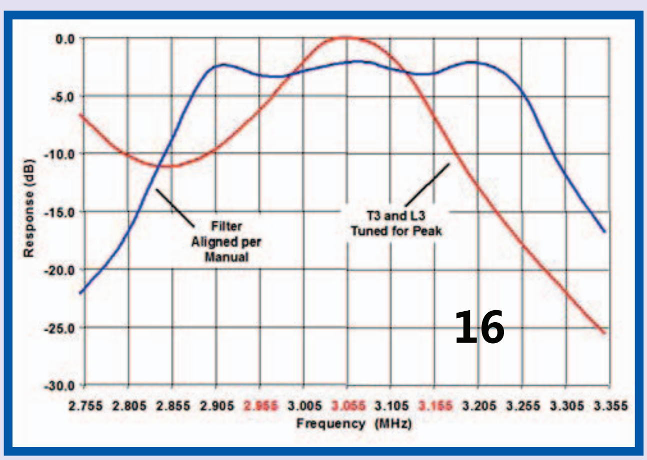
And, speaking of the future, think time travel isn't possible yet? Check out the "In the Shack" in this issue.

A Quick Look in This Issue

Issue No. 77

First Quarter 2015 Signal Magazine

CONTENTS



ON THIS COVER - We remember & honor Warren Bruene (1916 - 2013), and his wife Mildred Bruene (1920 - 2010)

FEATURES

REGULARS

OUR CONTRIBUTORS

WARREN BRUENE
"Letter from Warren" *pg. 7*

Warren went to work for Collins Radio just before World War II as a fresh-out from the University of Iowa. During the war, he worked on high power transmitters with the Navy. His experience and knowledge led to some very significant technical innovations including tetrode neutralization, the Bruene Coupler, the design of the 30K-1 through 30K-5 series, and our coveted 30S-1. He was, and still is, one of the most respected RF technologists in the industry - being well known for his high power transmitter designs.

BILL CARNS, N7OTQ/K0CXX
"Tuning the 30S-1" *pg. 12*

Bill is retired now in Wimberley, Texas after a career spanning 40 years, first in the semiconductor industry and then in business, marketing and business development. The technical portion of his career involved a significant amount of RF power work. He has been involved in amateur radio since age 15 (KN6TVB) and then saw his first piece of Collins in 1960 when the "Gold Dust Twin Bug" bit hard. He loves his Collins and what it represents in this countries history.

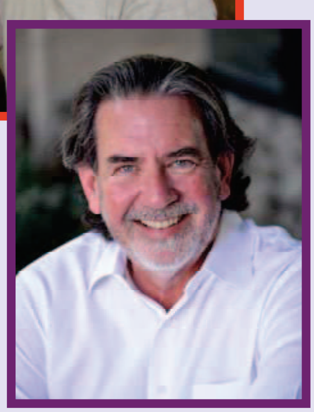
DICK WEBER, K5IU
"VIF Alignment" *pg. 16*

Dick was first licensed in 1960 becoming an Extra class in 1974. He works CW only using his S-Lines, and is a member of CWOPS. His interests during his ham radio career cover a wide range. He has been a diehard CW DX contester (holding a world title for five years). Now a casual DXer, antenna experimenter and modeler, he spends many enjoyable hours working on S-Lines. He has published numerous articles in QEX, CQ, Ham Radio, and Communications Quarterly. He has also had several articles published in *The Signal* covering S-Lines, and enjoys public presentations on his many interests.

Dick is now retired from Raytheon where he held the title Principal Engineering Fellow and Professional Engineer (BS & MS ME). He has 35 US patents, over two hundred foreign patents, and has published articles in the professional literature.

DON JACKSON, W5QN
"Service Line - Bucking the 516F-2" *pg. 20*

Don is now retired after a career in electronics engineering where he specialized in receiver design. His experience, however, is much broader than just receivers and he also worked in RF power design and related areas. He is currently our *Signal Magazine* technical editor and writes often for the *Signal*. In this issue, he helps us understand the subject of bucking down the input voltage of the venerable 516F-2 transmitter power supply. It should be added that he is an invaluable resource in the production of this magazine.



SCOTT KERR, KE1RR
"From our President & Events/2015", *pgs. 2, 19*

Scott has recently assumed the Presidency of the CCA after serving on the board as Vice President. He is an enthusiastic collector of things Collins. He lives in the Dallas, Texas area where he runs an IT company and pursues his many interests. He is also a dedicated motorcyclist and is currently trying to figure out how to mount a KWM-2 and MP-1 on his motorcycle. He is committed to furthering CCA membership value and to continuing the CCA's work with its partners in our quest to preserve and protect.

FROM THE STAFF

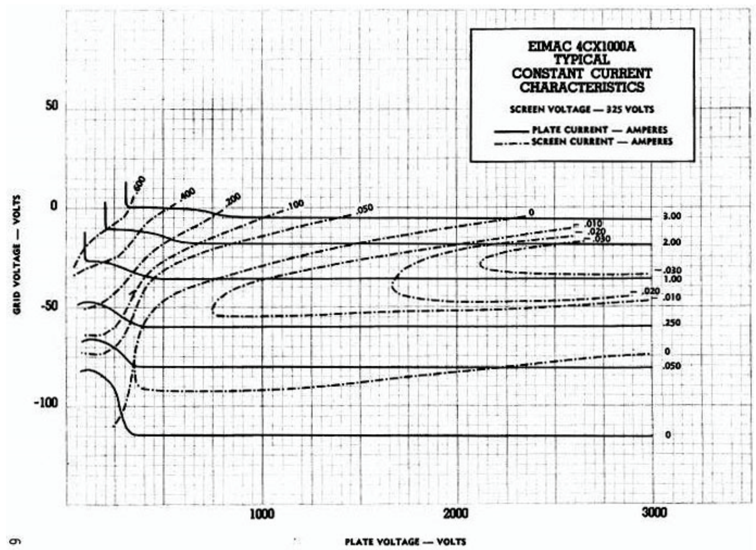
by Bill Carns, N7OTQ & Don Jackson, W5QN

From the Desk of N7OTQ

You could not ask for a better source of information about the 30S-1 amplifier than one Warren Bruene. It was Warren of course who did the fundamental first PA design with the then new 4CX1000 tetrode and gave us the big amp that we love so much. Just as a reminder, it was Warren Bruene who first patented the then novel way of neutralizing a large tetrode. This was only one of his many key patents that contributed to his, and Collins Radio's, success.

Several months ago, there was a flurry of activity on the CCA reflector about the 30S-1 and its operation, and more to the point, how to tune it properly – and why. There was a lot of good info put out on the reflector in response to that thread, but there were also some marginal comments and some that left things a little cloudy.

This led me, having had several cherished personal discussions with Warren over the years, to write an article on how to properly tune the amplifier and also cover some of its novel characteristics. We promised that this article would be placed immediately on the website – somewhat unusual – and then also published in the next (this) issue of the *Signal Magazine*. At this time, the article has been uploaded to the website and here it is in better detail for you to enjoy.



In this framework, the Gods smiled upon us and two members almost simultaneously provided me with copies of letters that Warren himself had written to them in response to questions about the operation of the amplifier. These are previously unpublished.

When this material became available, I could not resist zeroing in on the 30S-1 as a theme for this issue and printing those two letters here for you to read. Together they provide a unique picture of how and why that amplifier was designed the way it was and why Warren felt you should and should not do certain things with it. These letters also give us more perspective on Warren, his professionalism and his pride in his work.

I suggest reading Warren's letters first and then reading the 30S-1 article on how to use it along with some of the whys contained therein. It is not often we get the story right from the "horse's mouth".

de Bill, N7OTQ email: wcarns@austin.rr.com

From the Desk of W5QN

In the last issue of *The Signal*, there was an article on spectrum analyzers. During the creation of that article, I purchased a Rigol DSA815-TG. Although not a killer problem, I noticed that it had an issue with internal leakage that degraded its sensitivity when in Tracking Generator mode. Thanks to several folks who frequent the Reflector, I was able to gather enough data on a number of DSA815-TG units to come to some conclusions concerning this problem. If you would like to see some of the results and hear the whole story, drop me an email at w5qn@verizon.net and I'll fill you in. This is also of value to anyone considering purchase of this unit. I will say that, for the price, this spectrum analyzer is a great value.

As usual, I'd like to ask the members to contact me if you have something you think might be worthy of an article for The Signal. It can be technical in nature, historical, or anything else you believe might be of interest to the CCA membership. As well, if you would like to submit information for our "In the Shack" feature, please contact me. Don't be shy. Give me a shout!

73s - Don, W5QN email:w5qn@verizon.net

Warren Bruene "Talks to us" regarding the 30S-1 Linear Amplifier

Warren B. Bruene, W5OLY
7805 Chattington Dr.
Dallas, Texas 75248
214-239-2492

March 2, 1994

R. Charles Rippel, WA4HHG
1272 Parkside Place
Virginia Beach, Virginia 23454

Dear Chuck,

Yes, I would be happy to discuss the 30S-1 with you. I am retired so am home most of the time. Usually not home Wed and Fri evenings. Generally any time from 8:00 AM to 10:00PM is OK except for lunch from 12:00 to 12:30 and dinner from about 5:30 to 7:00 PM Central time.

I am a member of the Collins Collectors Association also and spoke to the group at the Dayton Hamvention 2 years ago. The Rockwell/Collins Ham club have a 30S-1 in the shack in the plant.

I built a working model of the it and even got a patent on the circuit, which I am sure has long since expired. Others did the detail design to put it into production. Fred Johnson was the mechanical engineer. He lives here in the Dallas area. The cooling system was designed for minimum fan noise while keeping tube temperature rise within limits. I still have some of my original engineering notes but they are not very comprehensive. Unfortunately, I don't remember many of the details but maybe I can resurrect some of the thinking.

At the time the 30S-1 was designed, the FCC limited the DC plate power input plus driver plate power input to 1000 watts as read on the peaks of the plate current meter "kicks" with voice modulation. Art Collins insisted that the power output be kept "legal". We did a little fudging by having the plate current meter built with a little extra damping so it wouldn't kick quite as high to keep it "legal".

The 4CX1000A was a hot new tube and it had to be operated Class AB1 because the tube data sheet says that the grid dissipation limit is zero. Later, Eimac came out with the 4CX1500B which could tolerate 1 watt of grid dissipation. The 30S-1 should not be operated without the ALC connected since ALC limits drive to avoid excessive grid current.

From the tube curves, I estimate that the grid bias for 200 ma idling current for SSB with 200 DC screen voltage is approximately -37 volts DC. Based upon the feedback circuit capacitor values and the tube interelement capacitances, I estimate that the RF feedback voltage is approximately 45 volts peak. The total RF voltage on the cathode then has to be 45 + 37 = 83 volts peak to get grid current for ALC.

The screen voltage consists of the 200 volts DC screen to cathode voltage plus the 83 volts peak of cathode drive for a total of approximately 283 volts at the instant of maximum plate current. This achieves the benefit of being able to use an optimum value of idling current for low distortion and have enough peak screen voltage for the desired peak plate current at zero grid voltage (bias plus RF). Enclosed are copies of plate current transfer curves for screen voltages of 225 and 325 volts DC. Note that the extention of the straight line portion (on the 225 volt curves) gives the optimum bias voltage and above it the idling current of 250 ma. The optimum current will vary approx as the 3/2 power of screen voltage so that with 200 volts screen voltage the 200 ma of idling current is close to optimum.

Now look at the curves for 325 VDC screen voltage. The optimum idling current for low distortion is approximately 400 ma. This would increase zero-signal plate dissipation to 1200 watts! Using only 200 ma idling current with 325 volts on the screen raises IM distortion. The bias would be increased to about -65 volts. The peak screen voltage then will be 325 + 65 + 45 = 435 volts if there is enough drive to produce grid current pulses for ALC! PEP output would be well above the legal limit of 1500 watts.

The advantage of a 325 volt screen supply is a substantial increase in PEP output (perhaps 2 dB) to more than 1500 watts PEP. One of the disadvantages discussed above is higher IM distortion - although it may be no worse than other linears on the air. Driving it with a rice box instead of an S-Line would probably increase distortion substantially also.

The other big disadvantage is that it increases plate dissipation and would overheat the tube unless a larger cooling fan was used. Some hams have done this but it causes more air noise.

The original design was highly optimized and raising the screen/cathode voltage affects many things. I suggest that if raising the PEP output to 1500 watts is important to the owner that this could be accomplished with a much smaller increase in screen voltage.

CW power output can be increased by just operating in the SSB mode. I haven't looked at what might be done to optimize CW operation for 1500 watts output.

Your scheme of using the trapezoid looks like an excellent way to set the loading indicator. On larger transmitters, we usually calculated the value of DC screen current and plate current at PEP and then adjusted loading and drive to get those values. Then we set the automatic tuning system to tune for the ratio of RF plate voltage to RF grid voltage existing in that PEP condition.

The 4CX1000A tube has a large negative screen current region and apparently just gets back to zero at the desired peak plate swing limit. More swing would produce a rapidly rising screen current and rapidly rising distortion. Screen current loads the input circuit like grid current does in triode GG linears.

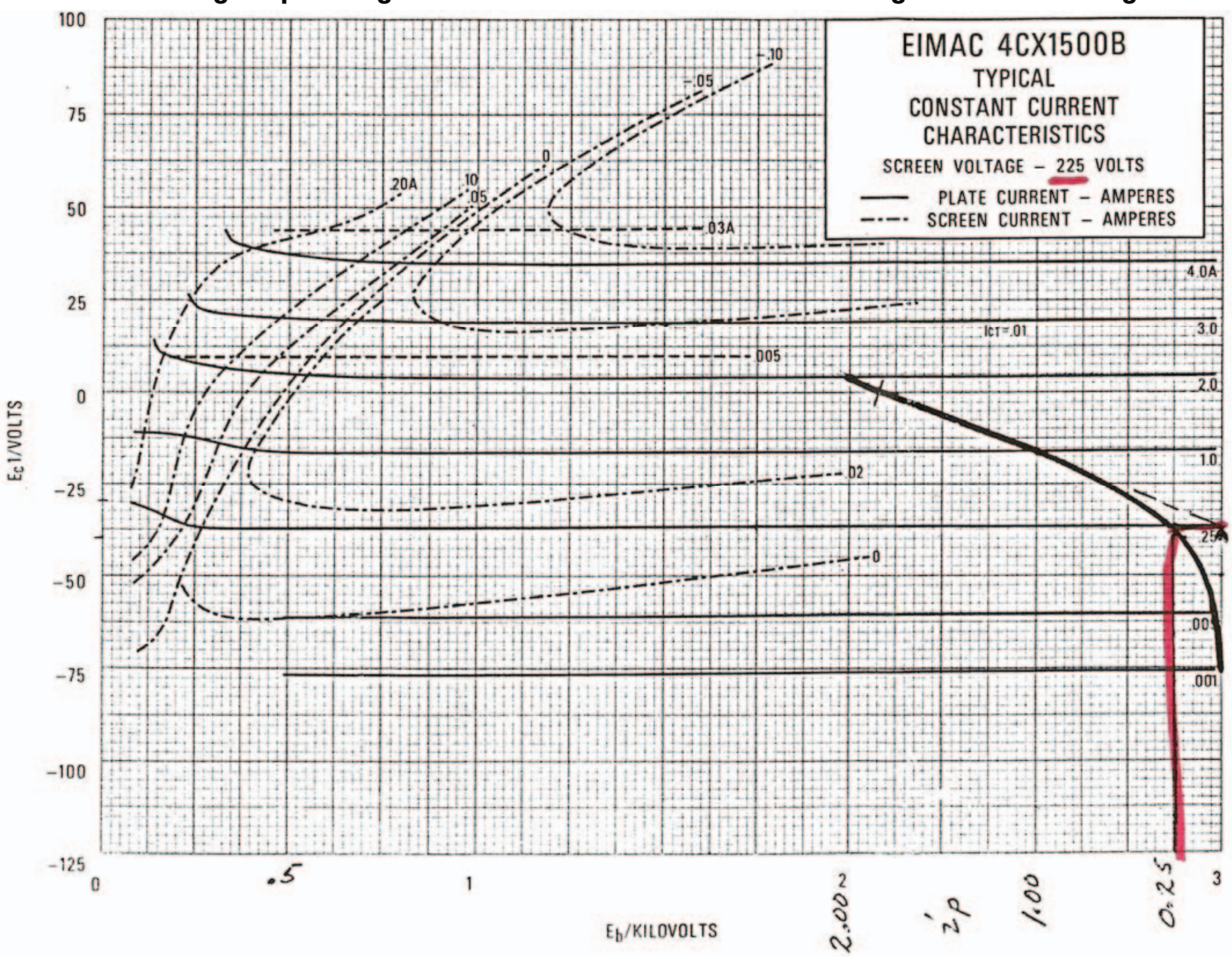
Well, Chuck, I have rambled on and on and perhaps have answered most of your questions. Please call if I can be af any further help. I will be looking forward to your article. It makes me proud that the 30S-1 is still considered to be one of the best.

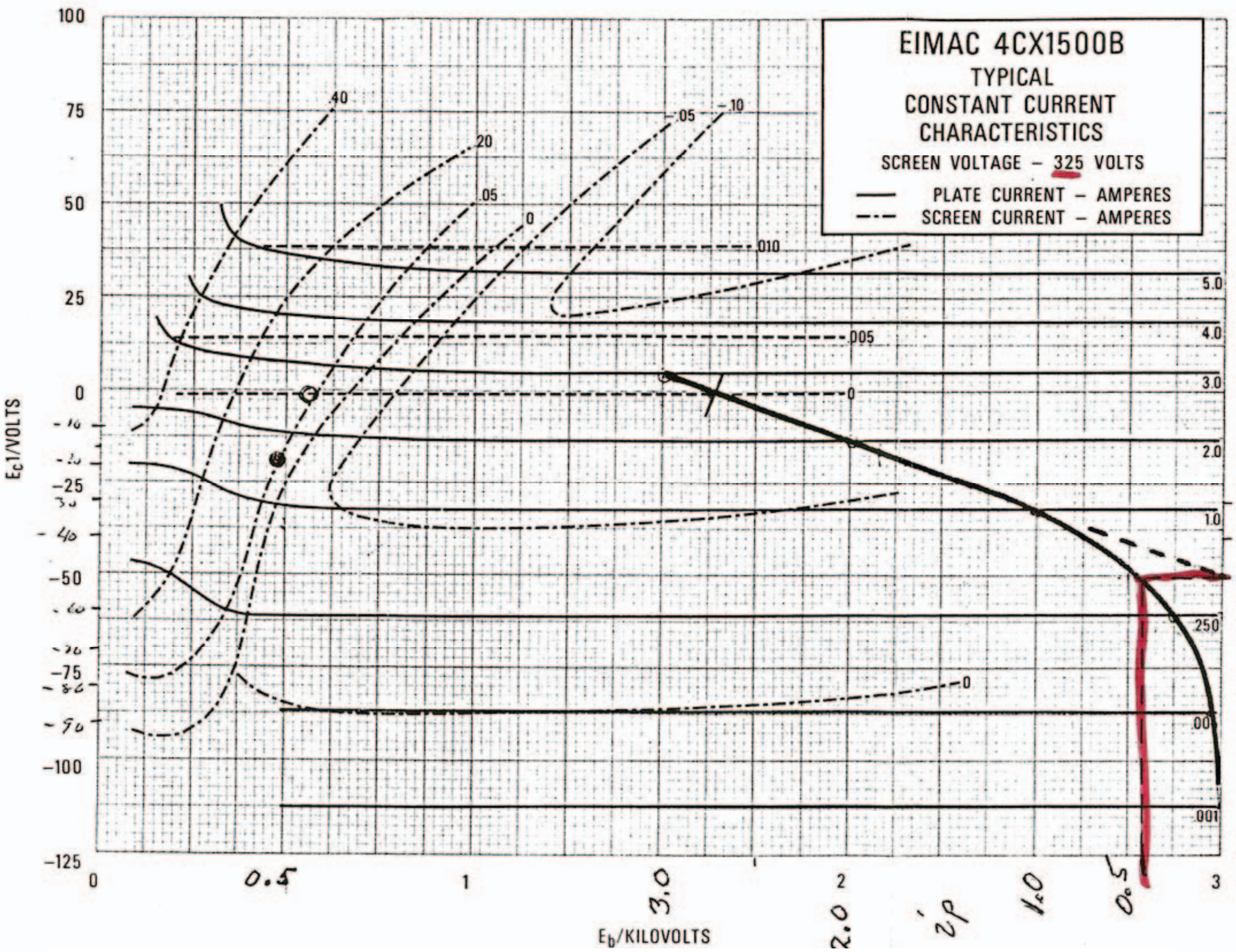
In case you missed it, Harry Snyder, W0RN, had an article "The Collins 30S-1 - Restoration and History" in July 1991 Electric Radio.

Sincerely and 73,

Warren

Warren enclosed the two following diagrams. The first indicating the design target operating area and then the second with the higher screen voltage





September 30, 1995

Richard Baldwin, KD6VK
2720 Twin Palms Circle
Las Vegas, NV 89117

Dear Richard,

It looks like you have a nice collection of Collins equipment. Hope that you are getting a lot of enjoyment out of it.

Yes, I invented the 30S-1 circuit using the new Eimac 4CX1000A tube back in about 1957. Art Collins had placed a requirement that all SSB equipment would have distortion products down at least 35 dB - and that was one IM product to one of the two tones. Now most ham manufacturers list IM products relative to PEP - which gives a 6 dB better sounding spec - so the 30S-1 when driven with the S-Line met 41 Db specified that way! I built and tested an engineering model to prove the circuit but others did the detail design for putting it into production.

I had to use several "tricks" to meet that requirement. One was to use a low screen voltage, another was to use some RF feedback and another was to use some multiple of 180 degrees electrical length from the driver plates to the 4CX1000A cathode. (That is the reason for the special length of coax from the driver to the 30S-1.)

In those days, the FCC power limit for SSB was 1000 watts input as read on the plate voltage and plate current meters - and if grounded grid - you were to include the driver plate power input also. The plate current meter has some damping so that the instantaneous peaks on voice were higher. Some have said that they get about 1100 to 1200 watts instantaneous PEP output in the original configuration. The FCC limit now is of course 1500 watts PEP output.

I agree that the grid in the 4XC1500B is much less subject to damage from overdrive - although the ALC should prevent that. The 4CX1500B has a much denser cooling fin structure on the anode. You have to use a much higher pressure cooling fan or blower to get 1500 watts dissipation. My estimate from looking at the properties of the two tubes and the blower is that - with the installed cooling fan - the 4CX1000A can dissipate 1000 watts but the 4CX1500B probably only about 850 watts. Therefore, if you choose to use the 4CX1500B, you should use a higher pressure blower.

Eimac lists 325 volts for the typical grid-driven operating condition on the data sheet. (The absolute max is 400 Volts DC.) When you drive the cathode, the peak RF voltage on the cathode ADDS to the DC screen-to-cathode voltage. The RF feedback to the control grid increases the cathode RF voltage by an equal amount. The peak RF voltage on the cathode is probably on the order of 70 to 90 volts. **THAT IS WHY YOU DO NOT NEED AND SHOULD NOT USE 325 V DC (OR HIGHER) ON THE SCREEN FOR 1500 WATTS PEP OUTPUT!**

The DC regulation of the cathode DC supply is rather poor - mostly because of the 40 ohms resistance in the DC filter choke. A 10 ohm choke would be much better but would have to be designed to resonate at 120 Hz with the 0.5 UF capacitor across it with just bleeder and tube idling current flowing through it. It probably would be about 4 times as big. I suggest that it be left as is but that the 10 ohm resistor R232 be removed or shorted. To get up to 1500 watts PEP output, you would probably have to add a boost voltage of about 50 V AC in series with terminal 10 on transformer T201.

Before all of the above I suggest that a good stiff 240 V AC power source be provided. The rig is rated for 230 V AC input but the transformers are rated for 50/60 Hz, therefore they can handle 240 V AC, 60 Hz OK.

Boosting the power is probably not worth it because it stresses the components more. Increasing power output 20% causes 44% more heating of some components. I could go on but I have already probably said more than you cared to hear.

Hope I have been of some help.

Sincerely and 73,

Warren

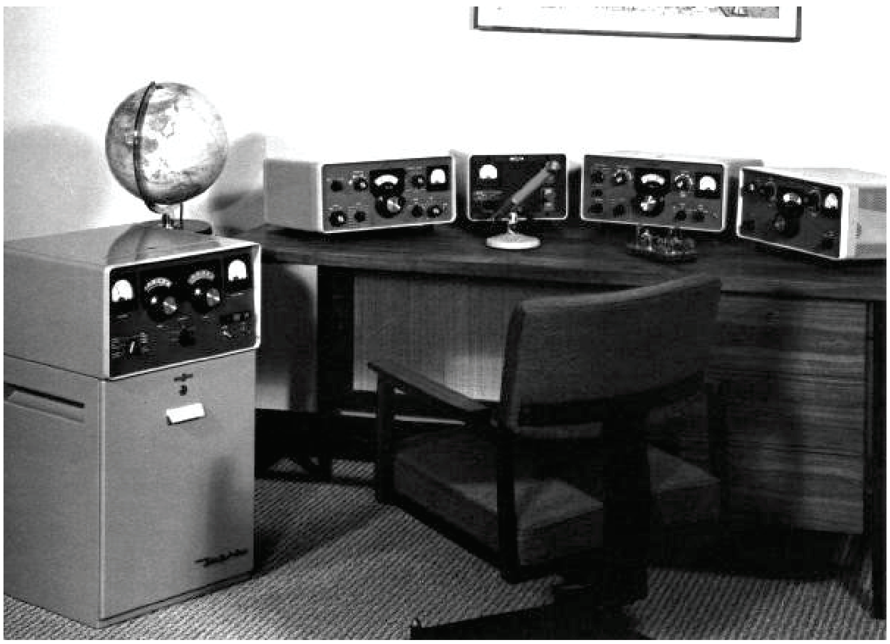
Tuning the 30S-1 Amplifier – How & Why

A Preface

For the uninitiated, tuning a higher power amplifier can be a bit intimidating. On one hand, they do deserve a bit more "respect", but on the other hand, a 30S-1 is no different than a 30L-1 or your driver PA for that matter. The noises just get louder, and the repair bill higher, when those "events" happen.

The following is meant to be a primer for those so intimidated, or new to the game. Tuning is actually pretty straight forward and, if you follow the basic steps, the results gratifying and easy to achieve.

Some of you may know most of this. However, reading through this you may find a new perspective or a tidbit or two that you did not know – or that will help your perspective on what is happening inside and outside the amp during its operation. Enjoy.



Understand & Correctly Tuning your Collins 30S-1 Amplifier

The Collins Radio 30S-1 linear amplifier is well known and well understood to be one of the best linear amplifiers ever produced. It was introduced late in 1960 and stood the test of time, remaining in production well into the 70s. It has become the subject of much discussion due, not only to its popularity, but also to the tantalizingly higher dissipation rating of the follow on 4CX1500B tube that was not available when the amplifier was first developed.

It was developed by a man considered to be the guru of high power RF amplifier and transmitter design – one Warren Bruene. Warren's contributions to the field included significant patents regarding Tetrode Neutralization, RF Feedback techniques, RF Directional Couplers, ALC and Gain Control and included patents on AM Digital Modulation, a significant contribution to the future of AM. He worked for Collins Radio for 44 years and lived to be 95 years young.

The 30S-1 employed the newly developed 4CX1000 ceramic "lighthouse" tetrode and a novel and effective power supply and biasing circuit in which the Control Grid was at RF ground, and the Screen Grid was at hard ground. This allowed the amplifier to be Cathode driven in class AB_1 service while keeping the screen effectively grounded.

Understanding Your 30S-1

First, let's examine the power supply and biasing employed in the amplifier. The effective plate voltage on the tube is the sum of the applied plate voltage (in this case 2800 Vdc – above ground) and the minus 200 volts (200 volts below ground) on the cathode for a total effective plate voltage of 3000 volts Plate to Cathode.

The implications of this bias scheme at BOTH quiescent and RF dynamic conditions are very relevant if you are going to understand and not abuse your amplifier. While the Eimac 4CX1000A tube data shows a recommended typical Screen Voltage (bias) of 325 Vdc, the 30S-1 employs a more conservative static 200 Vdc bias. Warren was always quick to point out that, under the conditions specified at the time (1 KW stage input power and, as tuned, 300 mA of plate current) the typical additional screen RF voltage developed at the point of instantaneous peak plate current is approximately 83 volts, resulting in a screen instantaneous voltage of about 283 volts. Remember that the absolute maximum screen voltage rating for the tube is 400 volts.

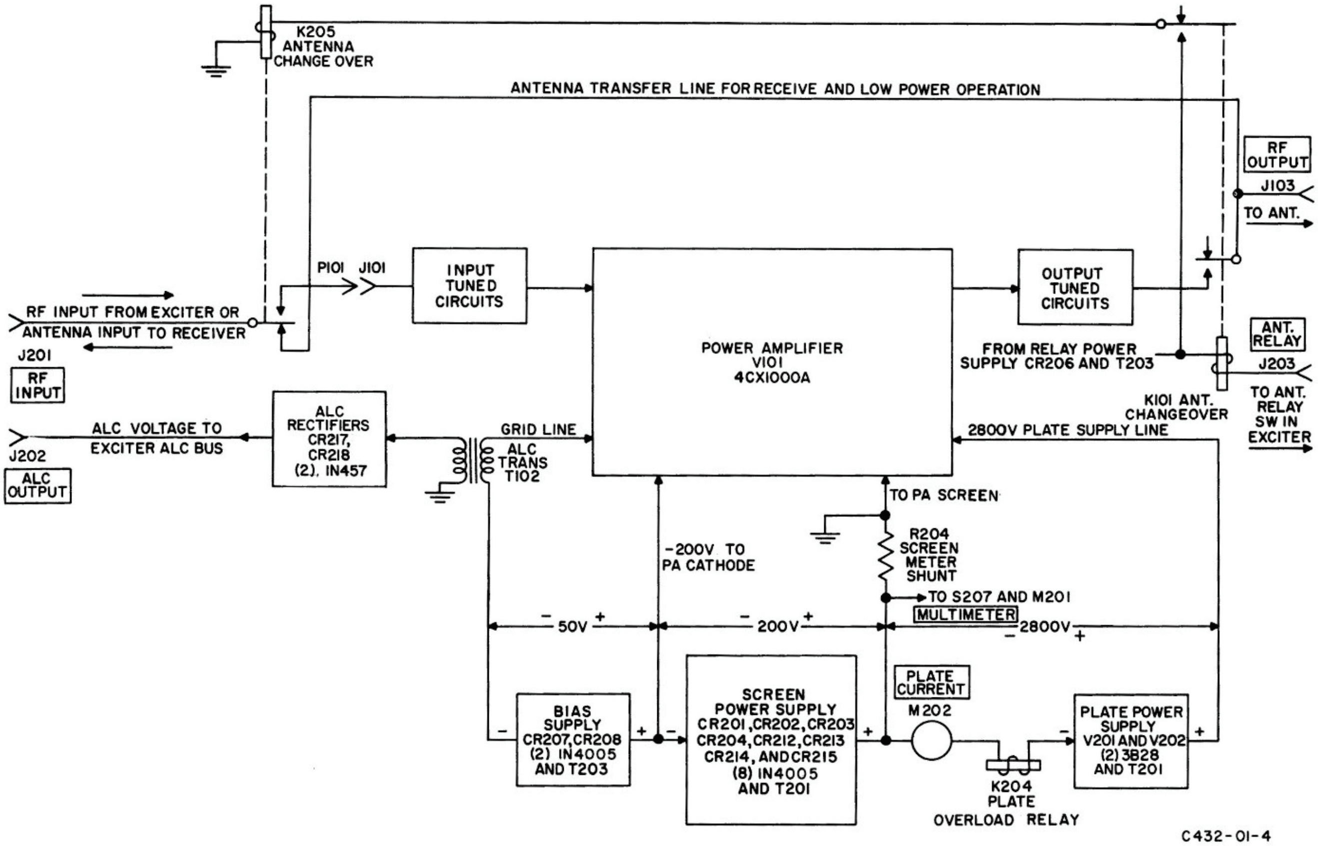
There is a commonly held thought that raising the screen DC bias to 325 Vdc will give higher performance. Here follows a caution, and also a smidgeon of understanding of the trade-offs that Warren made in the interest of overall amplifier performance.

The selection of screen voltage within the limitations of the tube's characteristics is not particularly critical, but there are recognized effects. The screen voltage is the most significant accelerating voltage that an electron sees when it leaves the cathode and starts its journey to the plate. If you choose, for instance, to increase the screen voltage of the 30S-1 design, this then provides a more intense "screen bias field" and makes it easier for the Control Grid to drive the plate current to a given positive value during dynamic operation. The result is higher dynamic RF gain for the amplifier. In other words, you need less drive from your KWM-2 or your 32S-3 to achieve a given power output of the amplifier.

Here is where there was some "system" thinking going on. Remember, in 1960, the power output of the 30S-1 amplifier in amateur service was limited by the legal Input Power limit of 1 KW total stage input which was the total of the DC plate input power and the RF drive applied to the stage.

This resulted in a 30S-1/ S-Line transmitter drive system where the driver had to be adjusted to an idle current of 50 mA and the loaded plate current reduced to 200 mA in order to optimize the IMD products produced by the combined driver/amplifier system. Drive levels were then typically 60 - 80 watts at the then legal limit of 1KW input power.

If Warren had elected to use a higher Screen Bias Voltage, the basic RF gain of the amplifier would have increased, the required S-Line drive power (already low) would have gone down and it would have resulted in a "system" where it would have been much easier for an operator to over-drive the amplifier and to risk getting up against the Screen Voltage absolute maximum rating. Let's say you raise the Screen Grid bias to 325 Vdc. Perhaps you are doing that to get more gain but for sure you are doing that to get more power out. So, the



instantaneous Screen Grid voltage is now north of 390 (RF + DC) volts peak (you pick your poison) and the tube is getting right up there against the screen limit. There is no margin there for error.

In other words, it would have been a lot easier for the average amateur radio operator to produce a less than stellar signal and/or damage the tube. Notice here that we are talking about total system considerations. This is always a good perspective to think about when you are choosing to monkey with one parameter of a known quality "system" in order to get a "better" result.

Well, you say, we are going to substitute in a 4CX1500B.

Hmmmm This tube indeed is a bit more rugged. The Control Grid rating is now 1 Watt max dissipation, so you can now get away with running a little Control Grid current without disaster, but notice something else. The Screen Grid ratings are the same (400 Volts Max and 12 Watts dissipation). Now look at the data sheet and the typical class AB1 operating recommendations for both tubes.

Some years had gone by since Eimac designed the 4CX1000A, and they had gotten more experience with this tube family. The Screen Grid Typical Operating condition for Class AB_1 operation now shows not 325 V on the screen, but 225 V, and the "Useful" output power has actually been reduced from the 1600 plus Watts shown for the 4CX1000A to 1100 watts for the 4CX1500B.

OK, let's park that thought for a while and look at another aspect of Warren's system design. He was also VERY quick to point out that the 30S-1 was designed (as a system) to provide very low fan noise. He talked about the fact that since the legal limit was 1 KW PA stage DC input power, Collins had reduced the airflow from the Eimac spec'd (sea level) airflow of 25 CFM for max rating (1 KW to start with) to a lower flow in order to use both a smaller fan, and to produce less air impact noise in the ductwork. (For reference, at 25 CFM, the pressure drop across the 4CX1000A is just 0.2 inches of water column)

Note: Therefore, your 30S-1 4CX1000A is NOT rated at 1 KW dissipation. Unfortunately, until we get some good actual airflow data, we do not know what the rating is. Operating the amplifier at greater than the manual recommended plate currents (higher Pout) therefore puts you in *no man's land.*

OK, but we can substitute a 4CX1500B. You get better Control Grid dissipation and higher plate dissipation. But, wait! Looking at the data sheet for the 1500B, we see that the specified airflow for its rating of 1500 watts is not 25 CFM (Sea Level), but rather 34 CFM with a pressure drop of 0.6 inches of water column. Looking carefully at the tube, we also see that the fin density of the 4CX1500B is denser than the 4CX1000 - and thus the airflow as used in the 30S-1 will be even lower than it was with the original tube.

More *no man's land* - and it gets worse. When you sub a 4CX1500B for the designed 4CX1000A, as we said, the airflow though the tube is lower. How much, we do not know. Sitting on top of the tube, and serving as a last ditch protector of your tube and amplifier, is a bimetallic strip thermal interlock sensor. If the air temperature of the cooling air reached the point where the bimetallic strip opens the interlock, the amp drops off line (HV kicks out) and gives you a moment to think about things.

If you look carefully at the circuitry surrounding this interlock, you will see that the trip point is adjustable. This adjustment is accomplished by running a AC bias current through the strip to heat it up (or bias it up thermally) so that it is closer to tripping. Interesting is the fact that, if you consider the static (no drive applied - so no thermal rise of the tube air above the idle temperature) bias temperature of this thermal interlock, this temperature is a function of airflow over the sensor. Reduce the airflow (by substituting a 4CX1500B into the equation) and the bias temperature of the thermal interlock, K102, will rise, making it more sensitive and causing it to trip at a lower air temperature. Ha...more systems considerations.

Continued on Page 23

The practical result of all of this involves both tube configurations. If you are tempted to just run a little (maybe a lot) higher Pout with the 4CX1000A and the amp otherwise stock, but push it above the 1 KW input power operating limit, that sensor will get you at some point.

If you run a 4CX1500B and maybe the higher screen voltage with a boost mod, then the airflow will be reduced and the sensor will get you, unless you adjust it of course.

What we see in many actual cases is that the sensor is moved, or removed, from the airflow and tube protection is lost. Now, fan failure = Tube destruction. Or, some folks figure out the adjustment, and "tweak" it using Kentucky windage. This is not a good plan. This lands you deep in *no man's land again*. In the manual, the adjustment of K102 is listed as a factory adjustment and "Do Not Tamper".

I have seen the factory adjustment spec, and it is not for the faint of heart. You need to drive the amp above limits VERY CAREFULLY. Then quickly – after it stabilizes – adjust R106 that controls the AC bias current through T103 and K102. Someone who is not experienced in this adjustment may well damage the tube in the process.

What is the take away from all of this? Each of you must reach your own conclusions. We all know that the 30S-1 (as unmodified and with a 4CX1000A installed) is capable of running better than 1000 Watts Pout. Many do it regularly with no apparent damage done. Stay within tube limits, suffer the occasional thermal sensor trip and all is well in amplifier land.

I happen to use a 4CX1500B in my amplifier and like the fact that it is a bit more robust on average. I do not drive it hard. The fact is that the small difference between 1000 Watts output and 1500 Watts output is a mere 1.76 dB increase in power into your antenna, which equates to less than a half S-Unit at the other end of the path.. Now, do I do the full legal power enchilada when running my 204H (which is rated conservatively at 2.5 KW) – of course I do. I like full power as much as the next guy when it is useful. In many case it is not necessary at all.

Draw your own conclusions, but base them on a system approach. That system, when you are on the air, not only consists of the amp box with all of its nuances, but your antenna, your neighbors and the propagation path. Who am I to judge.

What do those two big knobs do – anyway?

There is one last tidbit of confusion that I see about tuning. Without going into a lot of technical detail, the Tuning knob sets the resonant frequency of the tuned circuit in the output of the PA. Setting this circuit to resonance allows maximum transfer of power from the amplifier to the load - for a given loading condition. The tube in your 30S-1 has two different Current vs. Voltage (I-V) characteristics. The first underlying I-V characteristic is the DC load line. This is the DC current that will flow when you just adjust the Grid Bias and set idle current under "no drive" conditions. This load line has a very low resistance and the DC current is controlled only by the DC Grid Bias. There is very little actual resistance in the High Voltage path. The more relevant load line, or I-V characteristic, is the dynamic load line and, for the 4CX1000A, this amounts to about 3700 ohms real at resonance and under typical as-designed conditions.

The output matching network (typically a PI configuration) converts the impedance of the antenna to the proper load impedance for the tube. To do this, the network must be tuned to resonance, meaning the load presented to the tube is purely resistive. The job of the Loading control (the loading capacitor) is to transform the - hopefully close to 50 ohm real - antenna impedance into something that looks close to 3700 ohms at the tube plate. The combination of the correctly set Loading control, inductor and the Tuning control does this. And, as you know from tuning, this is an interactive process. This is because resonance of the matching network is affected by both the Load and Tune controls.

(As an example, let's assume we have a properly adjusted PI network that is resonant and converts 50 to 3700 ohms. If the Load control is "increased" (its capacitance is reduced) and the network re-resonated with the Tune control, the resistive load presented to the tube decreases. So, the tube "loading" is indeed increased. Note that in this example, the inductor remains the same value, so the Q of the circuit is different from the original. By varying the inductor value, the Q could be made to be the same.)

When you are increasing loading (note this because some are confused here), you are actually reducing loading shunt capacitance, and you are shifting the dynamic load line impedance up on the Y-axis (current). This equates to a lower impedance dynamic load line. Remember: Lower capacitance equals increased loading.

More system perspective

Also note that the amplifier ALC circuit detects the RF grid drive level and makes proportional ALC available to the driving transmitter such that there is about 3 db of override authority. This circuit has been factory set – if it has not been monkeyed with – using the (as designed) legal limit derived power output and required drive. If you elect to tune the amplifier above this level, regardless of what other changes have been made, the ALC compression will be more severe and onset too early. This ALC alignment should be changed if you elect to go to higher power output. It should also be noted that changes in screen bias and the subsequent change in amplifier gain will also change the relationship between desired output level and ALC authority. I think you are starting to get the point about making changes without understanding, and taking into account the balance of the "system".

Some other Considerations

Control Yourself

While this may seem a bit unrelated to tuning, the following comments are very relevant and an area where we commonly see confusion and mistakes being made. When you define "Tuning" as the process where you make sure that the amplifier is operating properly, putting out its cleanest signal and not hurting itself, then the following is VERY relevant.

Analog meter movements are essentially an averaging measurement system. They react to waveforms in a way that tends to make them an averaging device. They are made of mechanical parts that have mass, and so they do not give you a real time version of a time varying current or voltage, but rather a delayed (and "squashed") version. This phenomena is related to the "meter ballistics".

In other words, whether you are looking at plate current on your driving rig, on the amp, or at the resulting power output of either, after you tune up in Lock Key and note the resulting drive and amplifier output power, do not expect to ever see those readings again in normal operation.

To the unknowledgeable, or un-indoctrinated, this can result in creeping mic gain – or carrier level – and then over-driving the amplifier with the resulting compromise (sometimes quite severe) of IMD performance and splatter.

If you feel like you are not getting what you expect, go back to Lock Key quickly, or get yourself a peak-reading wattmeter. Saying "Ahhhhhhhhhhhh" into the microphone can often get you to the correct (or close) reading but it just does not sound that great on the air.

About tuning in general

Rule number one when tuning an amplifier – any amplifier: Start at reduced drive and STAY DIPPED, which means the network is adjusted to resonance and the plate current is at minimum.

Sneaking up on the tuning is good. It adds some time to the tuning – maybe, but it helps protect the amplifier and the tube. Always read the manual and follow the directions contained. A 30L-1 for instance has some duty cycle tuning considerations that must be considered when tuning, or you will overheat the tubes.

Then, RESONANCE is next to Godliness.

Consider: The 30S-1 as shipped used the 4CX1000A rated at 1 KW dissipation under optimum cooling conditions. At rated output, and about 300 mA amplifier plate current in Lock Key mode (constant Carrier), the output power will be about 850-900 watts.

Under these conditions, dissipation in the tube is a mere 150 watts. Now consider letting the amplifier get out of resonance (undipped). We all know that the plate current will rise and the power output will fall. Suddenly, power input can be 1200 watts and Pout falls to say 500 watts and the dissipation soars (just as quick as you can turn that knob) to 700 watts. Stay out of dip too long, get the drive a little too high, and that dissipation number can get right up to the limit.

That is why you stay dipped. And, by the way, all of the above assumes you have a 50 ohm antenna being presented to the amp. A quick look at a VSWR table will tell you that, if you are say at 2:1 VSWR (not all that bad), add another about 80 watts into the dissipation result.

Rule number two for a Tetrode amplifier: Tune the amplifier to a tad over-loaded condition. Then, operate at a slightly lower level. This will improve IMD and reduce grid current. That means operating it at a point below where you loaded it to. The 30S-1 manual (read that Warren Bruene) recommends loading to 350 MA in Lock Key and then backing off on the drive in Lock Key until 300 MA plate current is read. Then you leave the driver carrier gain adjust set right there for SSB operation.

The actual tuning

Now that you have some better understanding of what is going on, let's talk turkey.

Tuning is not an overly complicated or difficult process. It should start with reading the manual. I can't emphasize enough how important this is and basically just follow the instructions. But, tuning is summarized here for completeness of this article.

Start by preparing your driver transmitter. Because less than full output power is required to drive the 30S-1 (and the 30L-1), the driver should be set up for lower power output. This involves more than just turning down the mic gain and Pout.

Set the idle current of the 32S-X transmitter, or the KWM-1 or 2, to 50 mA and tune the driver into a dummy load or directly into a good antenna, but load it only to 200 mA in place of the normal 230 mA. The driver is now ready to use with the 30S-1.

Make sure you are using ALC if at all possible as this improves the IMD and protects you from accidental overdrive (and Grid Current).

Bring the amplifier on line and let it warm up until the HV lamp and HV will come on.

Start with the mic gain turned all the way down
Select the band of interest on the 30S-1
Preset the tuning control to the center of the band segment indicated on the lower (difficult to see) part of the dial disk below the logging scale
Set the 30S-1 load control almost all the way to the left (CCW – low numbers)
Place the multimeter switch in the Control Grid Position (Grid Current) & monitor closely during tuning
Go back and forth between Grid Current and Screen Current.
    Allow no Grid Current – Ever
    Try to keep Screen Current under 10 mA – I usually see almost none.
Select Lock Key with the driving rig (You can start with the Tune position, but this is not necessary if the driver is already tuned and you are careful).
Increase the mic gain (carrier control) until you get some indication of 30S-1 plate current rise.
Immediately dip the 30S-1 Plate Tuning.
Increase the amp loading. The plate current should rise and then quickly redip the plate current. You should be seeing some power output.
Repeat steps 8 thru 10 until you reach 350-400 mA of plate current dipped on the 30S-1.
Reduce the drive to get 300-350 mA of plate current. Leave the Loading & Tuning where they were.
Give the amp a break and let it cool taking the driver out of Lock Key. Leave the Mic Gain set where it is. Select the correct sideband on the driver.
You should have seen over 6 dB of ALC indication on the driving rig meter with it set to ALC position. Now, in normal SSB operation, you should see about 6 dB (32S series) or S6 reading on the KWM-1/2 series on voice peaks. You should increase the mic gain slightly (only if you need to) to get these ALC readings.

Note that if you are driving the amplifier to higher than "book" power output, the ALC will be out of calibration. Just leave the mic gain/carrier control alone.

You are now ready to operate. See the above comments about average readings and meter ballistics.

Enjoy!

de Bill, N7OTQ

In Memory of Warren

Continued on Page 23

An Important Step When Aligning S-Line Receivers and Transmitters

by Dick Weber, K5IU

In the 1Q 2014 issue of *The Signal* Don Jackson (W5QN) had an informative article titled "Early HF Receiver Design." On page 23 he had a discussion about double conversion superheterodyne receivers. As part of this, Don mentioned the role of the 1st IF filter in S-Lines: "Note that the bandwidth of the 1st IF filter must be at least as wide as the tuning range for each band selected by the 1st LO crystal. In other words, if each selectable band covers .2 MHz, as in the S-Line, the 1st IF filter must be at least .2 MHz wide, and the 2nd LO must tune over a .2 MHz range."

Prior to Don's comments I had not thought about the actual performance of the 1st IF filter in my S-Line receivers, although I've aligned many of these and a similar filter used in S-Line transmitters. Thanks to Don's article and in view of occasional comments I have heard about "tweaking" the alignment of S-Lines, I found myself motivated to look at the response of this filter. But first some background.

The same basic 1st IF filter is used in the 75S-1 and 75S-3/3B. In addition, a similar filter is used in the 32S-1and 32S-3, so it is not solely used in an S-Line receive chain. For its intended use, this filter needs to provide a pass band with low ripple in the 2.955 to 3.155 MHz range. Regardless of the rig it is used in, the filter must be aligned correctly and is not something that should be "tweaked" as part of a casual alignment as will be shown later. Figures 1 and 2 are partial schematics of a 75S-3 receiver and a 32S-3 transmitter showing these filters.

One thing you will notice in the 32S-3 schematic of Figure 2 is C26 and C23 are highlighted. These capacitors and R27 are used to balance V4. Since these capacitors are in parallel with C24 and C25 respectively, they participate in setting the resonant frequency of T1's primary and become part of the filter. In addition, C29 and C141 are highlighted. Analysis by Don, W5QN, has shown these are used to neutralize V5, a 12AT7 triode. Neutralization of this stage is necessary to reduce the "Miller effect", which decreases its input resistance. Without neutralization, the input resistance is too low for the filter to function properly. Note that the 75S-3/B does not require neutralization of the mixer stage. This is because the 75S-3/B mixer uses a pentode, in which the Miller effect is not as prevalent as in a triode.

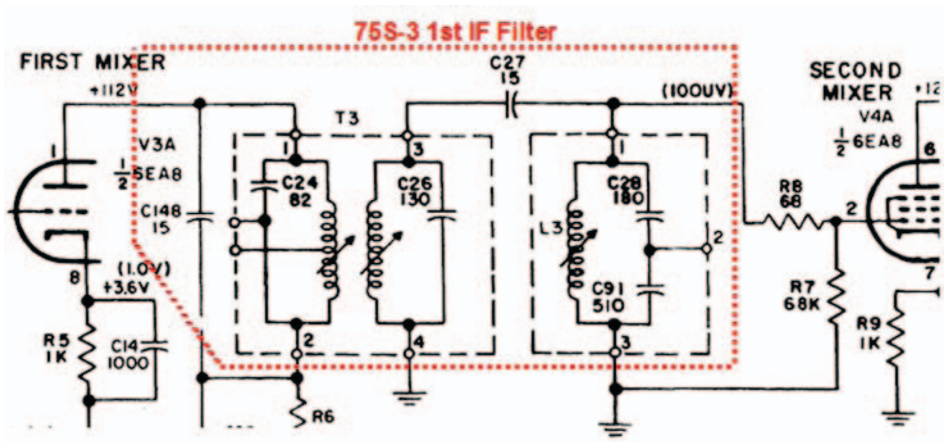


Figure 1 – 75S-3 First IF Filter

The filter is created using three sections: two in one can and the third in a second can. In the 75S-3 and 75S-3B these are T3 and L3 respectively as shown in Figure 1. Together they create a 3-section, coupled resonator, nodal design. T3 consists of two magnetically coupled resonant circuits. During alignment the two circuits in T3 and the capacitively coupled tuned circuit in L3 are each independently tuned to resonance at 3.055 MHz using swamping networks. When the filter consisting of T3 and L3 is properly aligned, the response will typically look like the blue plot in Figure 3.

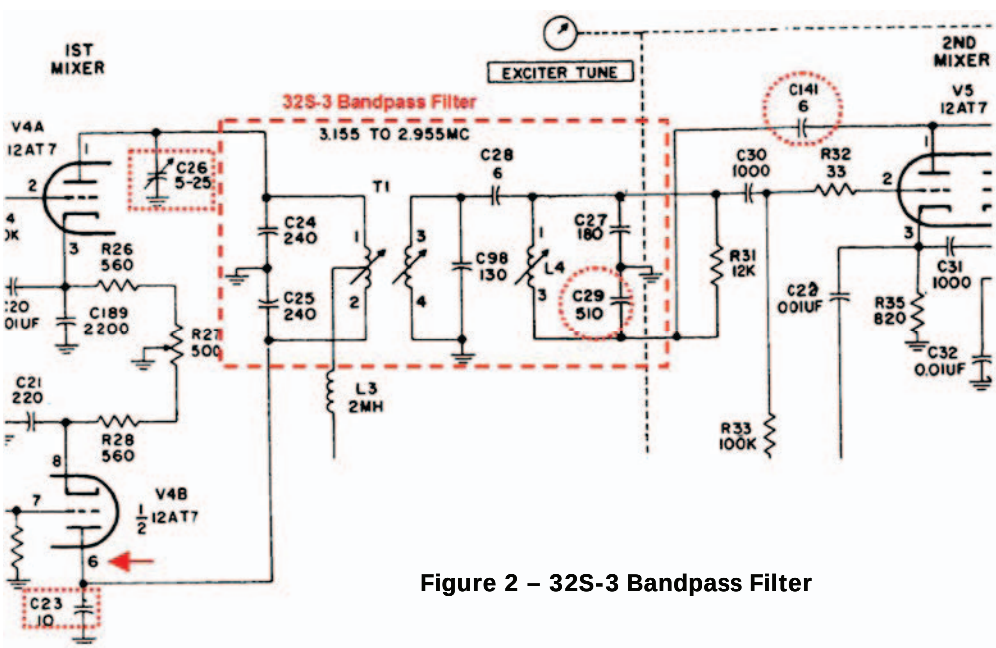


Figure 2 – 32S-3 Bandpass Filter

To measure the response of the 1st IF filter in a 75S-3, I first aligned it using the manual's procedure using an external signal generator. Then I measured its response by putting the band switch in the 3.6 MHz position and removing the crystal (2A) corresponding to this band switch position. I also turned the preselector tuning fully clockwise so the slugs were pulled out the farthest possible. I did this because I was going to inject a signal into the XTAL OSC output jack (J1) in the 2.7 to 3.4 MHz range and wanted to be sure there was no effect on the injected signal's amplitude over the test frequency range caused by the XTAL oscillator's output network. The output of the filter was measured using a VTVM on pin 2 of V4. To be able to read only the output of the 1st IF filter at pin 2, I pulled the PTO's tube so no PTO signal would be fed to V4, which is a mixer ahead of the filter. Figure 3 shows two plots for two different tests.

The first test measured the response of the 1st IF filter when it was aligned using the procedure in the manual, which makes use of swamping networks. The second test was done after the top and bottom slugs of T3 and the single slug of L3 were tuned to give a peak reading without the use of swamping networks. This approach disregards the procedure in the manual and simply tweaks both of the tuned circuits within T3 and the one within L3 for maximum output at 3.055 MHz.

In Figure 3 you can see that when the 1st IF filter is aligned correctly, its response is relatively flat within the desired 200 kHz bandwidth between 2.955 and 3.155 MHz as shown by the blue line. You can also see this is not the case as illustrated by the red line when T3 and L3 are not adjusted using the manual's procedure. For the filter to have the desired response, the two sections in T3 and the single section in L3 have to be resonant at 3.055 MHz. Due to the fact that by design there is coupling between them, you cannot just peak them. What is needed is a way to adjust them individually to resonance at 3.055 MHz with them not acting as if they are coupled. This is where the swamping networks come into play.

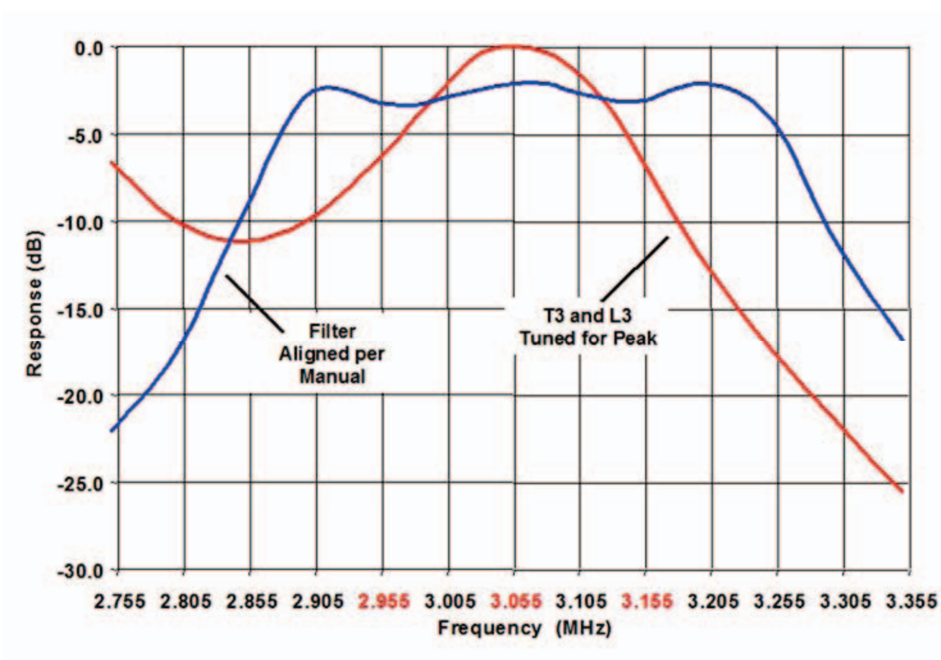


Figure 3 – Measured Response of a 75S-3 First IF Filter When Aligned Correctly and Incorrectly

To tune T3 and L3, a variant of the method published by Milton Dishal in the November 1951 issue of the Proceedings of the I.R.E. titled *Alignment and Adjustment of Synchronously Tuned Multiple-Resonant-Circuit Filters* is used. Dishal's method is an approach that has you detune or short to ground certain filter sections so their interaction or coupling with other sections is negated or minimized. This allows the remaining sections to be tuned. In our case, the alignment procedures for the 75S-1 and 75S-3/3B use two swamping networks to lower the Q of the resonant circuits they are hooked to. This is done so the sections not swamped can be set to resonance at 3.055 MHz without interacting with the swamped filter sections.

The swamping networks are made of a .01 uF capacitor and a 1000-Ohm resistor in series with alligator clips or test hooks on the two, free ends. Figure 5 shows one of the swamping networks I made with test hooks. Using test hooks helps to ensure the network does not make inadvertent electrical contact with other leads or components when temporally installed during alignment.

Fig. 4 – Swamping Network Made with Test Hooks

The alignment procedure in the 75S-1 and 75S-3/3B manuals first starts with swamping networks hooked between terminal 1 of T3 and ground, and terminal 1 of L3 to ground. Doing this lowers the Q of these parallel LC networks and allows the resonator between terminals 3 and 4 of T3 to be set for maximum reading at 3.055 MHz. Adjusting the top slug of T3 does this. The second step is to remove the two swamping networks and hook one from terminal 3 of T3 to ground. Then L3 and the resonator between terminals 1 and 2 of T3 can be adjusted for a peak reading on the S meter. This time the bottom slug of T3 is adjusted as well as the single slug in L3.

Although a similar circuit is used in the 32S-1/3, the alignment procedure in their manuals is somewhat different. The 32S-1/3 procedures use a single swamping network. When aligning a 32S-3, the single swamping network is first installed from terminal 3 of T1 to ground, which swamps T1's secondary. Then L4 and the primary of T1 are adjusted for a peak reading where the primary tuning slug is in the bottom of its can. The next step is to hook the swamping network between terminal 1 of T1 and pin 6 of V4 as indicated by the red arrow in the lower left of Figure 2. Note in this case the swamping network is not hooked to ground. This swamps the primary of T1. Then the secondary of T1 is adjusted for peak using the top slug in T1's can. It would seem there are two ways to align these filters: one using two swamping networks and another using a single one.

The alignment procedure for the 32S-3 uses one swamping network and results in well-defined peaks for each of the adjustments. Out of curiosity, I aligned one of my 32S-3s using two swamping networks following a procedure similar to the one used for S-Line receivers. In this case, well-defined peaks resulted with a response curve essentially identical to the one when one swamping network was used. So there is no need to use an alternate alignment procedure using two networks. However, this procedure is an approximation to the more general requirement for aligning each individual resonator, while decoupled from the others. It results in a reasonably tuned filter only because the L4 resonator has a considerably lower loaded Q than the other two resonators.

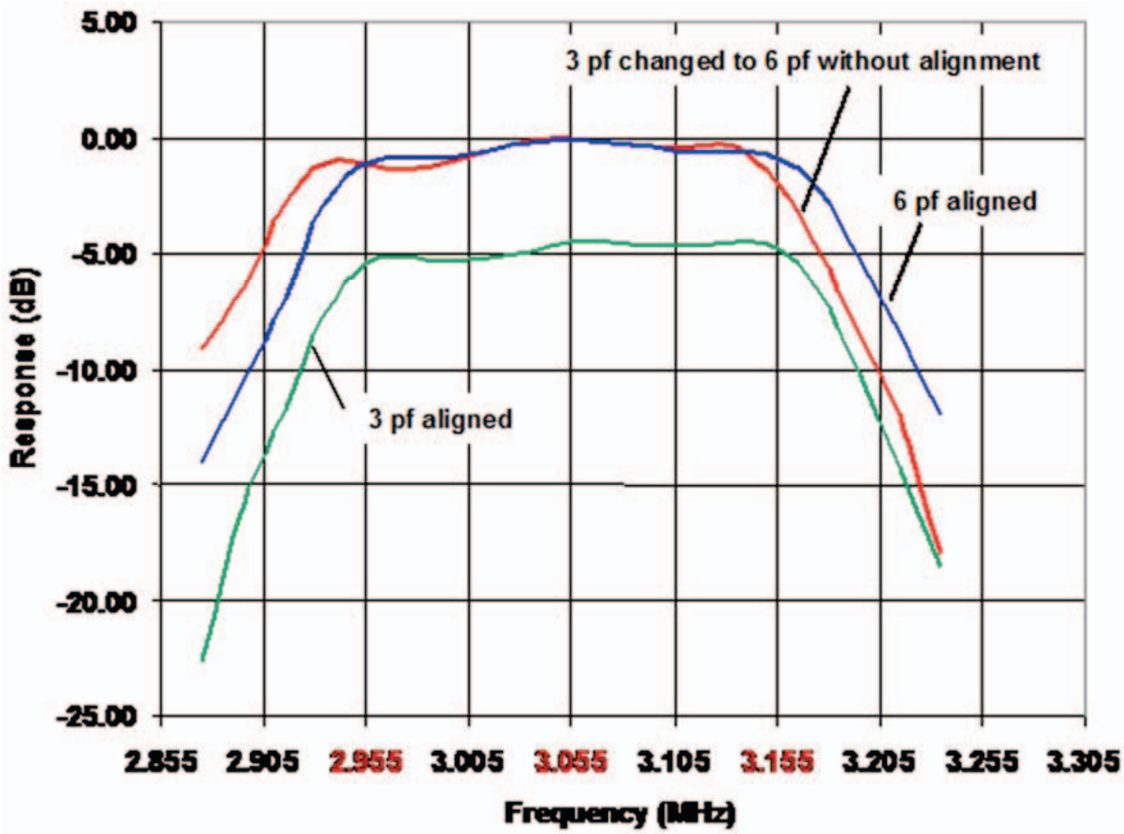


Figure 5 – 32S-3 Bandpass Filter Response is Shown With and Without Capacitor C28 Changed

One of the changes Collins made to the 32S-3's circuit was to change the value of C28 from 3 pf to 6 pf. This was covered as part of 32S-3 Service Bulletin 1 issued August 8, 1967. Several sources say the change results in "better drive," but I was unable to find any information about how much the change helps, if at all. As a result, I used an older 32S-3 where C28 was 3 pf to measure the improvement. Figure 5 shows three 32S-3 bandpass filter response curves. The green and blue curves show the responses when C28 was 3 pf and after it was changed to 6 pf respectively. In both cases the filter was aligned per the manual and results in the improvement of 4-5 dB over the passband. The red curve is for when C28 was changed to 6 pf from 3 pf, but the filter was not realigned. In this case, the response is shifted with a gain improvement in the 3-5 dB range within the passband. If you're going to change C28, you should realign the filter to get the full benefit of the modification.

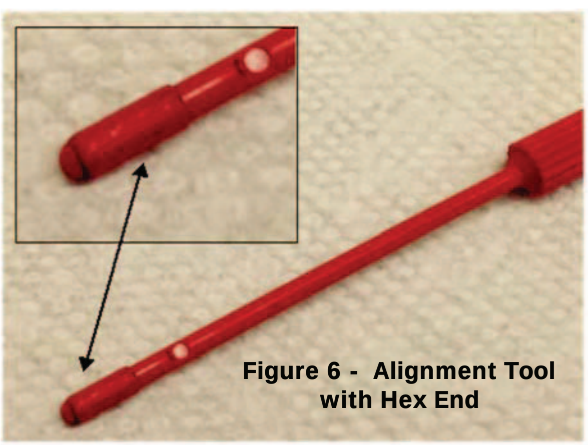


Figure 6 - Alignment Tool with Hex End

I've done this testing using one 32S-3, which begs the question if my results are typical for what you can expect. Don, W5QN, and Bob Jefferis, KF6BC, became interested in this question and used Spice models to show that you should expect about a 5 dB improvement. In addition, Don changed C28 in his 32S-3, which resulted in about a 5 dB increase in gain. So, you will see "better drive."

What started as curiosity brought on by comments in Don's article resulted in showing it is important to follow the alignment procedures in the manuals when aligning these filters and that a short-cut should not be taken. Also the improvement in drive for a 323S-1/3 when C28 is changed to 6 pf from 3 pf is now validated and found to be about 5 dB based on testing and modeling. Of course Collins knew this. But it seems they did not tell anyone the reason for changing C28. The only mention of C28 is step 10 of Service Bulletin 1. This step covers changing C28, but there is no reason given in the bulletin for the change. Also there is no mention the filter should be realigned.

One thing not covered here is the bandpass IF filter in the KWM-2/2A, which is nearly identical to the 32S-3 filter. It too uses an alignment procedure using one swamping network to align the circuits in its T2 and L4. Needless to say, you should follow the manual's alignment procedure.

A note about adjusting the bottom slugs in cans: you do not need to insert an alignment tool into the bottom of the can from the bottom of the chassis to access its bottom slug. In fact, it is difficult to do so because there are components soldered between the can's terminals that cover up the can's bottom access hole. If you use an alignment tool as shown in Figure 6, you can access the bottom slug from the top by having the hex portion of the tool pass through the internal hex feature of the top slug. Then you can engage the bottom slug.

- CCA -

Your CCA - 2015 - First Quarter Report

Orlando Hamcation Report

For the second year the CCA has kicked off its year of multiple events by having a presence at the Orlando Hamcation. Mother Nature blessed us with the best of Florida winter weather – sunny skies and temps topping out at about 70 degrees. Friday the doors opened at noon with a steady stream of visitors at the CCA booth. . . .some just reminiscing about their military service with Collins, retired Collins employees and hams asking about restoration and values. As always, the KWM-2 in the suitcase had its lid opened more times over the weekend than it was probably designed for in a lifetime of service.

Friday night we adjourned to the Golden Corral for a casual dinner and a discussion of the removal of the VOA 821 250,000 transmitter from Delano, California. Since Rod Blocksome - K0DAS and I had both been there for the removal we could share the experience from two different perspectives. Everyone stayed for about an hour after dinner asking questions and sharing ham stories.

The doors opened early Saturday to equally fine weather. The crowds were down somewhat from Friday since it was Valentines Day. I guess it is a rare XYL who shares their spouse with a hamfest on Valentine's day! There was, however a steady stream of visitors at the table and special thanks to Rod and Barry – W0IY for their help in manning the booth giving me a chance to browse the flea market. There were not a lot of Collins out there but what was there seemed to be in really nice condition. Seems that the Hamcation is about 1/3 the size of Dayton – I highly recommend you putting it on your short list of hamfests to attend if you have not been. I, for one, am looking forward to returning next year. . de Scott

Collins Model 821 & VOA Preservation Project

We continue to progress with the AWA and the other members of the recovery team in getting this transmitter and its service with the Voice of America in Delano documented and the displays set up in the AWA museum in New York. You can visit their website for more details but the fund raising is progressing and the work on setting up the physical displays has started.

They are having a really bad winter back there but they are working diligently on getting the transmitter display set up and meeting the June deadline for having it sited and on display. It has been moved from the storage building in New York to the AWA Museum building where it will be on display.

We still need support in the way of fund raising and we are going to be providing support in the way of personnel when it comes time to actually install that monster again. Please, if you are as passionate as we are about using this wonderful display to influence coming generations of hams and students, lend your support by donating what ever you are comfortable with. Every little (or big) bit helps and we still have a ways to go to reach the level of donations necessary to build out the displays.

Net Operation Update

Well, after a burst of marginal contacts and some interest in getting the 10 meter net going again, it looks like we will not be running that net in the near future. The conditions are just too marginal.

Scan to see more about the CCA

There has however been some renewed interest in getting a 15 meter AM net started and we have a volunteer to start the operation. This would start with a one-time event to see how it goes. Then, if there is sufficient interest, we would do it again a month later. The plan is to see how that goes, and if enough folks are getting involved - both as participants and as net controls, - then we would consider having the net become a regular weekly net one evening a week. W3DA is the volunteer to get it going and we are looking for your feedback on interest level and also names of those who have higher power rigs and would consider becoming a net control if the net becomes a regular. Abe does not have email, so please send your comments to either Bill Carns or Scott Kerr. . de Bill

First Wednesday 75 meter AM Net news...

After many years of service as net control for the Central time zone Jim Shoemaker (W0NKL) is retiring. His great AM signal can still be heard most mornings around 8:00 am on 3.885 kc. Thanks Jim, for all of your years of service to the CCA.

We tried a new scheme for the Central time zone this past March 1st First Wednesday. Ken (W0HRO) started the net at 7:00 pm and worked Zeros, Eights and Nines and handed it off to Mason (K5YHX) at 7:30 to work Texas and Oklahoma. Then we went back to Ken at Eight pm and then finally Mark (K5YGC) at 8:30 to wrap it up. The band was noisy but, despite that, many stations had an opportunity to check in from both the north and south. We had to QSY in the middle of the net so we will try to pick the Central time zone frequency carefully for the next one. We plan on continuing this type of "multiple" net controls so that everyone has a shot at checking in. Thanks to everyone that participated and we welcome the new NCO's! . . . . . . de Larry Saletzki (WA9VRH)

Exciting Breaking News !

The CCA has a new presence on Facebook. This will not be your normal Facebook page - but will be used to link to the CCA website and allow us, and YOU, to create a virtual CCA Member's museum where all of our shacks can be on display. The data, and material will be linked and searchable so that you can find a shack for a particular person and also find shacks with particular pieces of equipment. Also, if you allow "Public" viewing of your page, this will allow the general public to see what you, and we, are about and get a better idea of what we are doing to preserve this fine equipment. Watch our website and the reflector for how you can participate and use this new feature.

See page 26 for our updated Events Calendar.

The Service Line

Bucking the 516F-2

by Don Jackson, W5QN

Introduction

Many of us have the issue of relatively high AC line voltage in our shacks, and would like to investigate the possibilities of lowering that voltage closer to the nominal 115VAC our Collins equipment is specified for. Certainly, Variacs (variable autotransformers) are a possibility, but somewhat expensive if a great deal of power must be supplied. Other possibilities include standard isolating transformers or “bucking” transformers to lower the voltage. There are many forms of bucking transformers and the most effective approach often depends on the nature of the load the transformer must feed. There is a lot of discussions about modifying the 516F-2 power supply by wiring the filament windings in such a manner that the secondary output voltages are lowered. This is only possible in 516F-2 supplies in which the vacuum tube rectifiers have been replaced by solid state rectifiers. If tubes are still part of the design, the filament windings are not available for use.

Transformer Fundamentals

To start, let’s review a few fundamental relationships for ideal transformers. The fundamental relationship between transformer winding voltages and the number of turns on the windings is the following:

$$Vsec = Vpri*Nsec/Npri \qquad \text{(Equation 1)}$$

Throughout the article, V represents the voltage across a winding, and N the number of turns on the winding. We will only be addressing ideal transformers, neglecting any copper or core losses as well as imperfect coupling between windings. Fortunately, these imperfections generally have only minor impact on the actual performance of a well-designed modern transformer.

Although not generally important in the design of most power supply transformers, the concept of “phase” is crucial in designing a “buck” or “boost” transformer configuration. Phase, usually quantified in units of degrees, is a measure of the time offset in two sinusoidal waveforms. Two waveforms that are synchronized (their peaks and valleys occur at the same instant in time) are said to be “in-phase”, with a phase shift of zero degrees. Two waveforms in which the positive peak of one occurs at the same time as the negative peak of the other are said to be “reverse-phase”, with a phase shift of 180 degrees. In a transformer, the phase of a secondary voltage, relative to the primary voltage, can be switched from “in-phase” to “reverse-phase” by simply swapping the leads of the secondary winding.

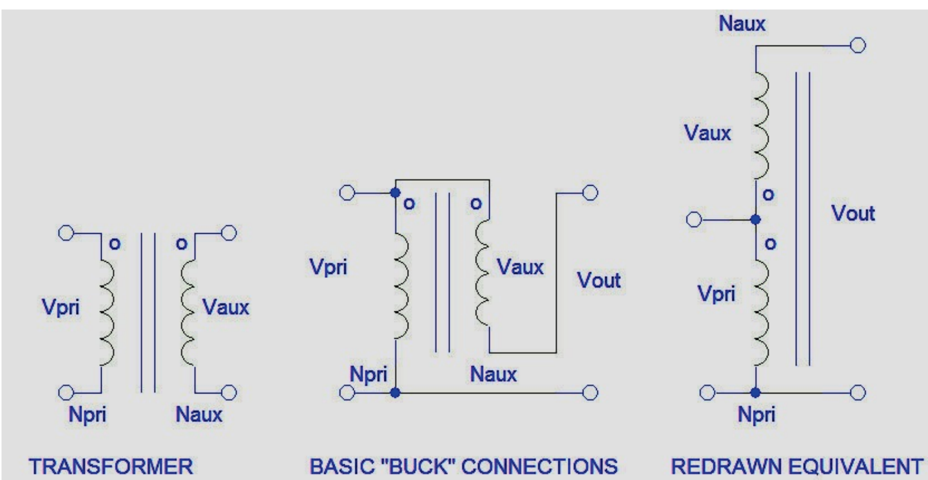


Figure 1 – Basic “Buck” Connection

This in-phase and reverse-phase characteristic leads us to the following. Voltages connected in series “in-phase” will add, while voltages connected in series “reverse phase” will subtract. A corollary to this is that if two windings are in-phase, the series combination of the windings will have an equivalent number of turns equal to the sum of the turns on the individual windings. Similarly, if two windings are reverse-phase, the series combination of the windings will have an equivalent number of turns equal to the difference of the turns on the individual windings. In a schematic diagram, phasing of the windings is typically indicated by “dots” on the transformer windings. Dots usually only appear on transformer diagrams when phasing is important to the application. With buck/boost circuits, it is important.

The Basic Buck Transformer Configuration

Let’s look at how a standard transformer is connected to create the basic “buck” configuration that many folks are familiar with. Figure 1 shows the transition.

Notice the “dots” indicating the phase of each winding. In simple terms, it means that the sine wave volatages appearing at the “dots” (referenced to the non-dot lead of the winding) of the two windings will reach their positive peak values at the same instant in time.

Connecting Vpri and Vaux windings in series in-phase requires that the “dot” lead of one winding be connected to the “non-dot” lead of the other voltage. If this were the case, Vout would be the sum of Vpri and Vaux. However, note in Figure 1 that the Vpri and Vaux windings have their “dot” leads connected together, creating a “reverse-phase” condition. In this case, Vout is the difference of Vpri and Vaux. Later in this article, I’ll describe a method of determining the phase of a pair of windings.

So, in the basic bucking circuit of Figure 1, the relationship of Vout to Vpri is very simple. We can see that the primary winding and auxiliary windings are connected in series reverse-phase. Therefore, Vout = Vpri – Vaux.   No problem there.

Modifying the 516F-2

Here is where it gets more complicated. There is plenty of room for confusion here, so bear with me on this. Unfortunately, you cannot configure the 516F-2 transformer to mimic the basic buck arrangement of Figure 1. The primary supply voltage and filament windings cannot be connected in a way that behaves exactly like our basic bucking circuit. I leave proof of this to the reader.

Nevertheless, there is a way to connect unused filament windings of the 516F-2 transformer in a manner that reduces the output voltage of the secondary windings. The connections for doing this are shown in Figure 2.

Take careful note of the phase of the filament windings in relation to the primary winding. They are wired in-phase, which means that the dot wire of the filament winding is connected to the non-dot wire of the primary winding. What the heck is going on here? This is the opposite of the basic buck circuit. This may appear intuitively incorrect, since it appears we are adding the filament voltage to the primary voltage. Fight off that urge to go with your intuition! The difference stems from the fact that the input line voltage is applied across the series set of primary and filament windings. In the circuit of Figure 1, the line voltage is applied only to the primary winding.

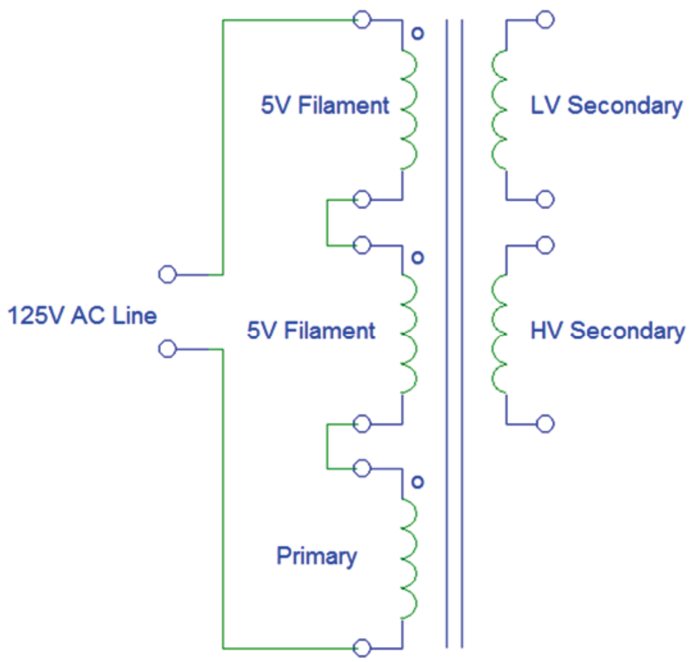


Figure 2 – Simplified 516F-2 Transformer Buck Connections

With the arrangement of Figure 2 we achieve the desired secondary voltage reduction, but the analysis method for determining Vout is different from that of Figure 1. The concept of subtracting the filament voltage from the primary voltage that worked for Figure 1, does not, in the general case, work for the arrangement of Figure 2. An analysis method that allows an accurate calculation of the secondary voltages (for any value of filament voltage) requires using the basic turns ratio relationships discussed in the Transformer Fundamentals section.

Calculating the Secondary Voltages in the 516F-2

Let's assign V and N values to each of the 4 windings in Figure 2. You may ask how we can determine the actual number of turns of each winding. The answer is that we don't need to know the actual number of turns on the winding. All we need is to ensure that each N is in proper ratio to the others. This is extremely easy since the ratios for N are the same as for V. To make it even simpler, for the purposes of analysis, let's assign a value for N that is equal to V for each winding. Assuming some approximate secondary voltages, here are our values for each winding:

Vpri = 115V and Npri = 115 turns
Vfil = 10V and Nfil = 10 turns
Vsec1 = 275V and Nsec1 = 275 turns
Vsec2 = 800V and Nsec2 = 800 turns

Armed with the above values and the concepts in the Transformer Fundamentals section, let's calculate the secondary output voltages using our fundamental transformer relationship in Equation 1.

Vsec = Vpri*Nsec/Npri (Equation 1)

First, let's look at Vsec1, which in a normal configuration has an output of 275V. We see from Figure 2 that the primary and filament windings are in series in-phase. This means the series combination of the primary and filament windings has (Npri + Nfil) turns, or (115 + 10) = 125 turns. All the other quantities in Equation 1 remain the same. Therefore, we calculate Vsec1 to be:

Vsec1 = Vpri*Nsec1/(Npri + Nfil) = 115*275/(115+10) = 253V

Similarly:

Vsec2 = Vpri*Nsec2/(Npri + Nfil) = 115*800/(115+10) = 736V

It is important to note what happens if we wire the primary winding and filament windings in series reverse-phase. In this case, the "dot" wires of each winding would be connected together. In this configuration, the resulting series combination of the primary and filament windings has (Npr -Nfil) = 115-10 = 105 turns. The resulting secondary voltages are increased, or boosted. For example:

Vsec1 = Vpri*Nsec1/(Npri - Nfil) = 115*275/(115-10) = 301.2V

Determining the Proper Phases

Obviously, you want to get the primary and filament phases right in order to produce the desired reduction of the secondary voltages. How do we do this since the transformer wires are not marked with "dots"? A good method is described by Rod Blocksome, K0DAS, and Barry Buelow, W0IY, in the instructions for their 516F-2 modification kit. Both Barry and Rod are retired Collins engineers. The kit has a number of features, and includes a separate PCB. One of the kit options is to wire the 516F-2 in the manner described in this article, resulting in reduction of the secondary voltages. You can find a description of the kit at https://sites.google.com/site/radiofarmprojects/home/collins-516f-2.

With Rod and Barry's permission, I've paraphrased their phasing method to apply to a 516F-2 that is in original condition, with no modifications other than the addition of plug-in solid state rectifiers. The method is basically a "try it and see what you get" approach. It is assumed that the 516F-2 primaries are connected for 115VAC operation.

In order to perform the modification, you must break the connection from the low side of the AC input line, allowing the filament windings to be connected in series with the primary winding. This means you need to install a new terminal. I leave the mechanical aspects of implementing the new terminal ("TP" in Figure 3 below) up to you.

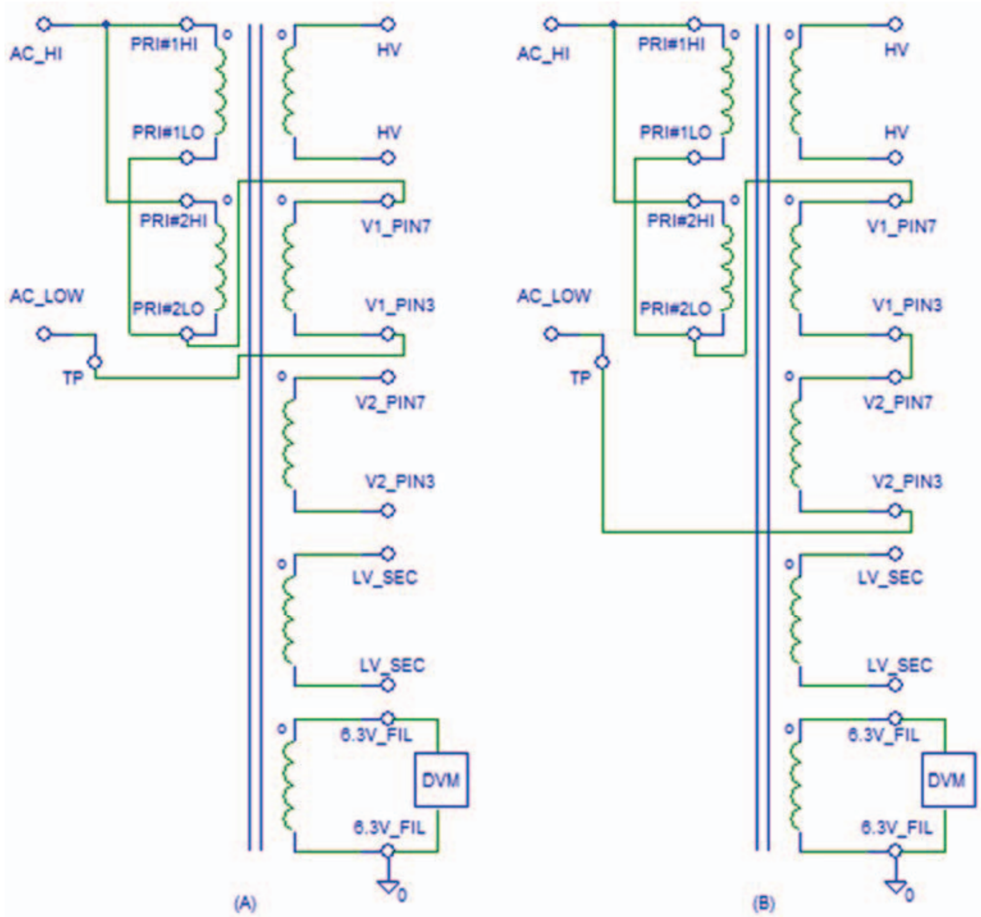


Figure 3 – Determining the Phase of the Windings

Here is the step-by-step procedure:

1. Start with AC power to the 516F-2 removed, the radio off and the 516F-2 plugged into the radio as in normal operation. Be sure to remove the plug-in solid state rectifiers.
2. To reduce shock hazard, place electrical tape over pins 4 and 6 of V1 and V2.
3. Cut the filament wires on pins 2 and 8 of both V1 and V2. Reconnect them to unused pins 3 and 7 on their respective sockets. Move the wires to the closest adjacent pin, 2 to 3, and 8 to 7.
4. Connect a DVM (set to measure AC) to measure the 6.3V filament voltage available at output pins 8 and 9, referenced to chassis ground.
5. Plug the 516F-2 into an AC outlet, and turn the radio on. Record the reading on the DVM, which should read approximately 6.3V, or higher, depending on the AC input voltage. Record this voltage.
6. Turn the radio off, and unplug the AC line from the 516F-2.
7. Refer to Figure 3(A). Disconnect the low side of the AC input line (white wire) from its original terminal (PRI#2LO in Figure 3) and connect it to TP, your newly installed terminal.
8. Connect a wire from PRI#2LO to V1-pin 7.
9. Connect a wire from terminal TP to V1-pin 3.
10. Plug the 516F-2 into an AC outlet, and turn the radio on. Record the reading on the DVM, which will read either higher or lower than the reading obtained in step 5. If the reading is lower than in step 5, you have the correct phasing of the V1 filament. If the reading is higher, swap the filament leads to obtain the correct phasing. If it is necessary to swap the leads, check the DVM reading to ensure the DVM now reads lower than the reading of step 5. Record this lower reading.
11. Turn the radio off, and unplug the AC line from the 516F-2.
12. Refer to Figure 3(B). Identify the wire you connected from TP to V1-pin 3. Disconnect the end going to V1-pin 3 and connect it to V2-pin 3.
13. Connect a wire from V1-pin 3 to V2-pin 7.
14. Plug the 516F-2 into an AC outlet, and turn the radio on. Record the reading on the DVM, which will read either higher or lower than the reading obtained in step 10. If the reading is lower than in step 10, you have the correct phasing of the V2 filament. If the reading is higher, swap the filament leads to obtain the correct phasing. If it is necessary to swap the leads, check the DVM reading to ensure it now reads lower than the reading of step 10.

This completes the phasing procedure. All wiring is now in its properly phased configuration. Turn the radio off and re-install the solid state rectifiers.

Summary and Comments

If you have modified your 516F-2 with solid state rectifiers, making the filament windings available for other use, you can wire the transformer in a way that reduces the secondary voltages. You may wish to do this to compensate for high AC line voltage in the shack.

Proper phasing of the series connection of the primary and filament windings is important. An in-phase connection yields the desired reduction in secondary voltage, while swapping the filament leads will boost the secondary voltages. You will want to get this right.

The wiring method for the 516F-2 appears intuitively incorrect when compared to a basic buck transformer design. In the basic buck design, the primary and filament are connected reverse-phase, while the 516F-2 requires them to be connected in-phase.

Since the 516F-2 wiring scheme is substantially different from that of a basic buck transformer, proper analysis of the two circuits is different. Using the analysis method that is entirely valid for the basic buck transformer circuit (Vout=Vpri+Vaux) yields a decent approximation in the 516F-2 circuit since the filament voltage is small compared to the primary voltage. However, if the filament voltage exceeds about 10% of the primary voltage, the accuracy of the calculation rapidly degrades, eventually producing absurdly large errors. In order to get precise predictions for the 516F-2 circuit arrangement in this article, you must use the analysis method based on turns ratios. This method is accurate for any value of filament voltage.

The issue of sufficient filament winding voltage isolation has come up in the past. To allay these fears, here is a quote from the W0IY/K0DAS 516F-2 kit website:

"There have been some concerns expressed regarding the use of the filament windings to "buck" the primary. In particular the isolation of the filament windings. In the tube version, the filaments operate with the full rectified voltage applied (800V or 300V). The winding insulation must withstand this high voltage and has for MANY years. Therefore, using the winding with 110VAC is much lower voltage than the original circuit."

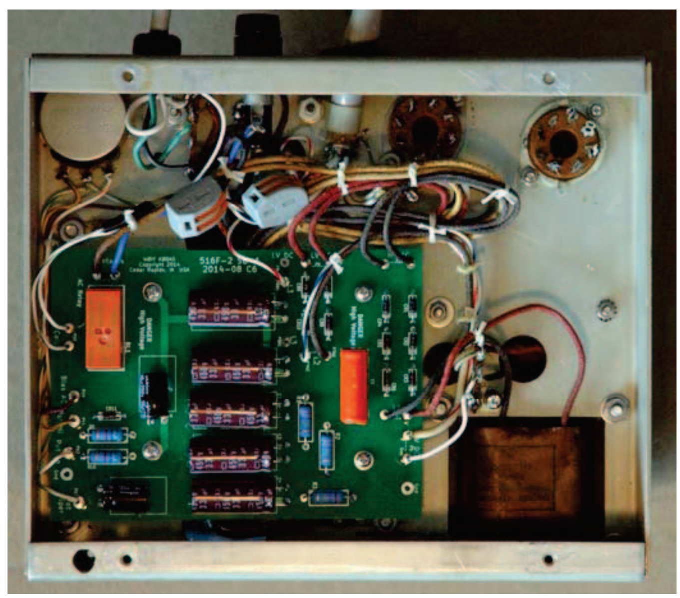
Above all, be careful while digging around in the 516F-2 power supply. There are potentially lethal voltages in there and we don't want to lose anyone! Take it slow and be safe.

Cheers,
Don, W5QN

- CCA -

Farm Products 516F-2 Update Board Kit—A product Review

Everyone knows, I am sure, that I like – and our general CCA perspective is - to keep everything as original as possible when it comes to repairing our Collins. Also, the CCA and the *Signal Magazine* have long had a policy of not advertising related products to remain as objective as possible. We have done a number of product reviews in the past, but even those have been rare. There are many support kits available from some very good suppliers. Numerous 30L-1 overhaul board kits come to mind as well as cap kits and products to support the 516F-2 S-Line power supply.



Every once in a while, something so nice and well done comes down the pipe and just can't be ignored. Lord only knows how many 516F-2s there are out there. I do know that "the Budster", K7RMT, repaired and recapped/relay converted over 500 units in the approximately 25 years that he worked on them in Wimberley. Bottom line, there are a lot out there. And, while you all know my feelings about trying to keep them original – even the caps – the days are counting up on those filter caps and more and more need replacing. Also, the S-Line power switch needs to be "protected" in some way or another. This can be done with an external switched power strip, or it can be done with an added under power supply chassis relay. In addition, the opportunity to solid state the supply comes up more and more and does have some merits including freeing up the filament winding for the rectifiers so that they can be used for bucking down a high house line voltage.

The kit, as mentioned above, has many options to suit your personal philosophy and needs. If this is your cup of tea, it is a good one. The conversion is completely reversible and very professionally done by two retired Rockwell Collins engineers who started ***Farm Radio Products***.

See their website at for more details and availability: **https://sites.google.com/site/radiofarmprojects/home/collins-516f-2**

The CCA will have info on this board at their booth in Dayton in May and *Farm Radio Products* will have a booth (#2404-2405) which is just down the ramp from the Ice Arena area. You can purchase the kit there if you so desire. In addition, they have donated one kit to us which will be one of the door prizes at the Friday night dinner and social gathering. See you there.

In the Collins Shack

Time Travel with K0CXX

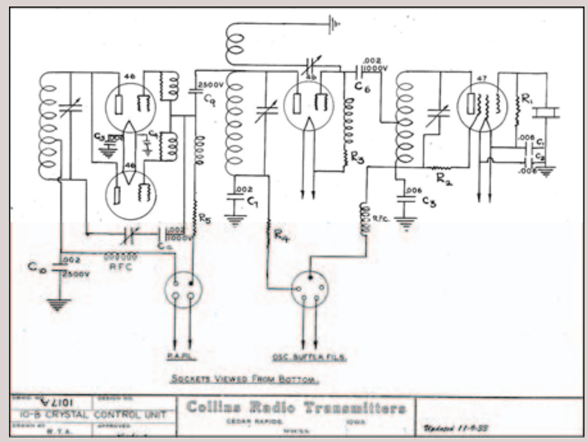
Representing the 1930s - An Early Collins Radio 10B Exciter

The 10A and 10B were developed in 1934 and produced between 1935 & '39. They were intended to be built-in exciters for the 150W series of transmitter (10A) and the 32A/B transmitters (10B).

They consisted of a plug-in crystal, a Type #47 Cunningham Oscillator, a Cunningham Type #46 Buffer, Two parallel Type #46 Output tubes and plug-in coils for the frequency used.

Neutralization was provided for the parallel output tubes. The 10A & 10B could also be purchased separately and it is believed that such is the case with this 10B example. These exciters are extremely rare. Volume was not high in the very early days at Collins and the survival rated is low due to the Bakelite panel and natural attrition. These units were basically hand made when Collins employees numbered in the 10s.

The flashier metal dial knobs were an optional feature adding $10 dollars to the original price. This unit was shipped and retains the, now rarer, Bakelite flange knobs. Output power was in the range of 10-20 watts. It is impossible to tell more exactly when this unit was made. Best guess is 1935.



Life was simpler then!

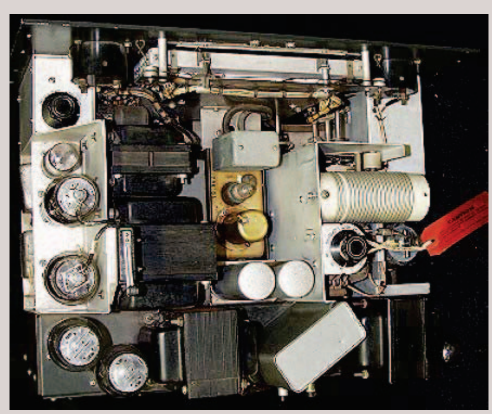
Representing the 1940s - What better than the 32V-1
Our First AM Transmitter after the War

The 32V-1 was introduced in November of 1946 and was one of the first commercial products to go into production after the war. Much had changed during those 5 years and amateur radio reaped the benefits of the rapid technology evolution during the war. At 100 watts out (carrier) AM and covering all the ham bands with PTO precision and flexibility, this was a significant step forward in all communication.

The products still carried the look and feel (and the weight) of the war products and they were, to say the least, ROBUST.

Collecting these and operating them are definitely for the younger generation.

The mating 75A-1 receiver, shown to the right of the V-1 is still a coveted and strong performer.



The 1950s brought more change and SSB - What to Choose?
Sideband and the First Transceiver - The KWM-1

It is only appropriate here to show, not the production unit, but the prototype. This is unit E10 produced in a batch of 20 that were used to evaluate the new design and let key customers play with them. This one, fortunately never went back to the factory and survives today in Wimberley. It is notable for its early (Bourns 10 turn) knobs, the single lock on the crystal deck, the early script Collins logo and its side facing connector. These all changed as it went to production.

Gene Senti, the designer, became frustrated with the requirements of tuning and synchronizing the Gold Dust Twins. He thought he could do it with one PTO (and tuning knob). He was right.

In his basement, as a winter project in 1957, Gene played with and interconnected the various chassis elements of a 75A-4 and a prototype linear amplifier. The result was a very ugly functional prototype of the KWM-1 which he then showed to Art Collins.

Art, with great enthusiasm, perceived the impact of this radio on mobile operation and ordered an immediate Green Room effort that resulted in the very prompt development of the KWM-1 prototype as you see it here. A last minute edict from Art to change the connector to the back side so it could slide in and out of a rack mount resulted in the connector change. The KWM-1 was introduced in early 1957 not long after the intro of the Gold Dust Twins in 1955. One only needs to compare this little marvel to the almost 200 pounds of radios on the preceding page to see what 10 years can do.

The 1960s brought more change and more evolution in the Collins SSB amateur offering - The 60s brought us the S-Line

While technically the 60s started with the winged emblem, by the mid 60s, Collins had chosen a new logo which was slowly being adopted. The wonderful S-Line had emerged in very late 1959 and was well on its way into production by 1960. The S-Line ran in production well into the 70s and some components saw manufacturing runs even in the 80s. This was, and still is, one of the longest running communication product lines in US history.

While overtly, the S-Line was developed as a low cost solution to SSB for the amateur, in fact, they missed their targets enough with the S-Line (boosted to a KW by the 30S-1) that Gene Senti - again frustrated - retired to his basement and developed the mighty 30L-1. Now they had a BIG winner.

Here we see the full range of the offering ranging across time from the 75S-1 Line on the top to and through to the 75S-3B/C line with the 32S-3 and the 30L-1 on the bottom. On the right is the KWM-2A driving a 30S-1.

Testimony to the quality of this product offering is their service in huge quantities in Viet Nam after the government came to Art and asked him to manufacture a mil spec version. Art said no, they will do just fine as they stand. It was one of the few times he ever said no to the government. In fact, they went on to serve our military up through the Gulf War. They have even been used in military helicopters.

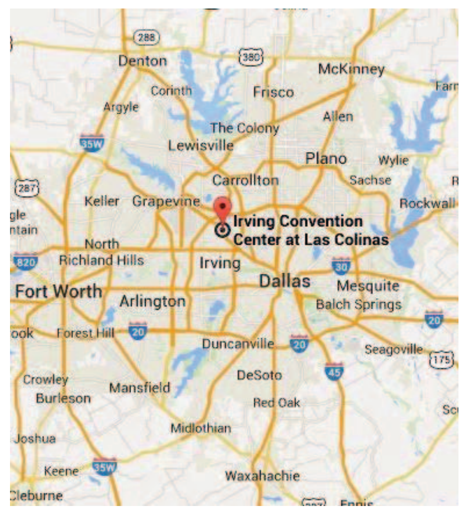
The 1980s saw the end of Amateur Radio at Collins - by then Rockwell Collins & The KWM-380 Family represents the end of the line (Below)

CCA EVENTS CALENDAR – 2015

<u>Orlando, Florida – HamCation</u> - **February 13 – 15** **Second Annual – 2015 - Meeting & Dinner**

<u>Dayton Hamvention – 2015</u> - **May 15 – 17** **CCA Annual Meeting & Banquet**

<u>Dallas/Ft. Worth/Irving HamCom & Dinner</u> – 2015 - June 12 -13 (Ham-Com has moved)



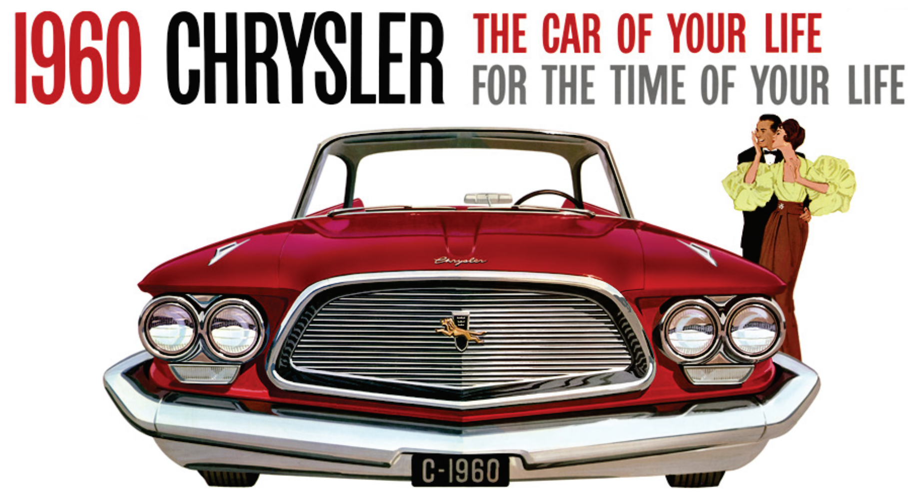
<u>AWA Convention</u> - **August 11-15, 2015**

a Collins Partner Convention with Dinner & Forum talks

Don't miss the fun! & See our Website for More Info

<u>California Party Time – Southern California - 2015</u> – Fall – Event Booth & Dinner

The CCA will have a booth at an event in Southern California to be announced


1960 CHRYSLER
THE CAR OF YOUR LIFE
FOR THE TIME OF YOUR LIFE
C-1960


Budweiser
where there's life...there's Bud.


Be really refreshed! Cool off with Coke! Only Coca-Cola gives you the cheerful lift that's bright and lively...the cold crisp taste that deeply satisfies! No wonder Coke refreshes you best!
FOR THE PAUSE THAT REFRESHES


Kodak
sallyedelsteincollage.com

COLLINS 30S-1 *for the loudest, clearest signal on the air*

the 30S-1 linear amplifier *features*

- QUICK AND ACCURATE TUNING.
- INSTANT SWITCHING BETWEEN LOW AND FULL KILOWATT POWER.
- AUTOMATIC LOAD CONTROL ASSURES STEADY SIGNAL.
- RF FEEDBACK PROVIDES CLEAN SIGNAL.
- EFFICIENT COOLING-FAN SYSTEM IS BARELY AUDIBLE.
- SIMPLE AND DIRECT CONNECTION FROM 30S-1 TO EXCITER AND STATION CONTROL UNIT.
- PROTECTIVE CIRCUITRY PREVENTS DAMAGE TO TUBES OR OTHER COMPONENTS DUE TO MISTUNING.

You can have that steady, strong and clean signal — the mark of the accomplished ham — by adding Collins 30S-1 to your station. Visit your Collins Distributor. Find out how easy it is to own the finest of linear amplifiers — Collins 30S-1 — the linear amplifier for the advanced ham.

COLLINS