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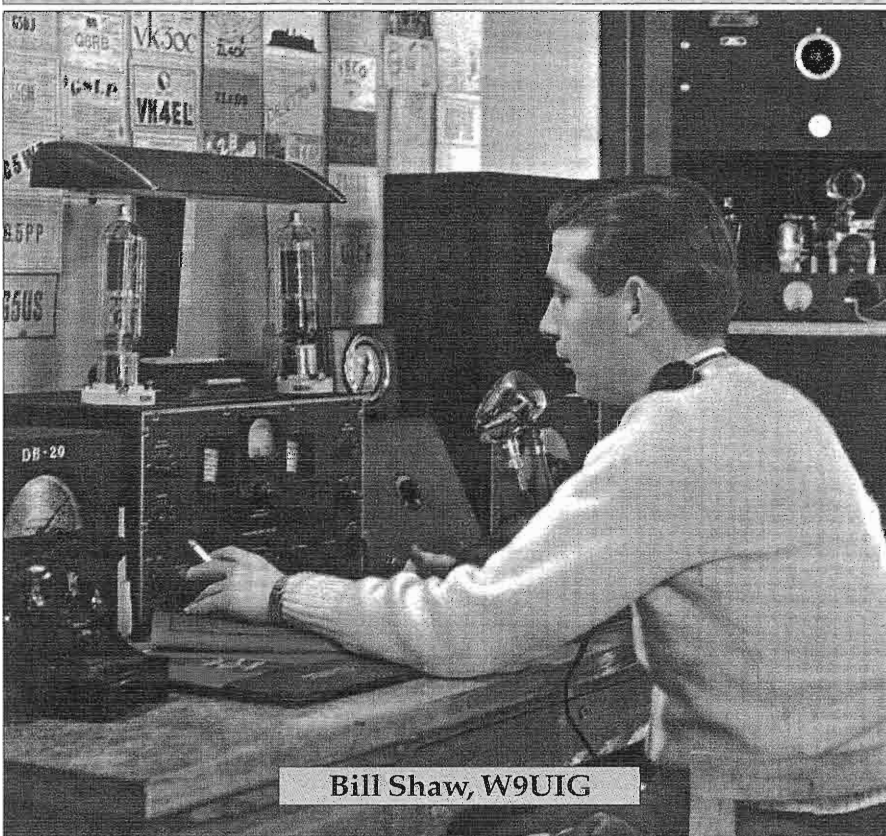
ELECTRIC RADIO

celebrating a bygone era

Number 219 August 2007



Bill Shaw, W9UIG

ELECTRIC RADIO

Published monthly by Symbolic Publishing Company
PO Box 242, Bailey, Colorado 80421-0242
Periodicals postage paid at Cortez, CO
Printed by Southwest Printing Inc., Cortez, CO
USPS no. 004-611
ISSN 1048-3020

Postmaster send address changes to:
Electric Radio
PO Box 242
Bailey, CO 80421-0242

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Electric Radio is all about the restoration, maintenance, and continued use of vintage radio equipment. Founded in May of 1989 by Barry Wiseman (N6CSW), the magazine continues publication for those who appreciate the value of operating vintage equipment and the rich history of radio. It is hoped that the magazine will provide inspiration and encouragement to collectors, restorers and builders. It is dedicated to the generations of radio amateurs, experimenters, and engineers who have preceded us, without whom many features of life, now taken for granted, would not be possible.

We depend on our readers to supply material for ER. Our primary interest is in articles that pertain to vintage equipment and operating with a primary emphasis on AM, but articles on CW, SSB, and shortwave listening are also needed. Photos of hams in their radio shacks are always appreciated. We invite those interested in writing for ER to write, email, or call.

Regular contributors include:
Chuck Teeters (W4MEW), Jim Hanlon (W8KGI), Tom Marcellino (W3BYM), Gary Halverson (K6GLH), David Kuraner (K2DK), Bruce Vaughan (NR5Q), Bob Grinder (K7AK), Larry Will (W3LW), Dave Gordon-Smith (G3UUR), Dale Gagnon (KW1I)

Editor's Comments

Fall Classic Exchange Contest

Howie Holden (WB2AWQ) reminds us that it's time once again to mark your calendars for the fall Classic Exchange contest:

Fall 2007 Classic Exchange "CX"

September 30, 2007: AM, SSB, FM
October 7, 2007: CW
Operating on 160, 80, 40, 20, 15, 10, 6, and 2 Meters

The CX is a no-pressure contest celebrating older commercial and homebrew equipment that was the pride and joy of ham shacks many decades ago. The object is to encourage restoration, operation and enjoyment of classic equipment. You *need not* operate a classic rig to participate. This fall, CX will again be conducted on two successive Sundays. By restricting CX to AM, SSB and FM the first Sunday, we will hopefully avoid the RTTY, DX and other contest QRM in the CW bands. The second Sunday will be CW only. There will be CX recognition for high scores in AM, SSB, and CW as well as overall. Additionally, there will be special honors for all getting into the CX with classic 6 and 2-meter rigs.

When - Where - What

The AM, SSB, FM, contest runs from 1300 UTC, September 30, to 0700 UTC October 1, 2007. The CW CX will run from 1300 UTC October 7 to 0700 UTC October 8, 2007. (Tune WWV to find UTC time.)

Suggested Frequencies

CW: 1.810 3.545 7.045 14.045 21.135 28.050 50.100 144.100 Mc.
AM: 1.890 3.880 7.290 14.286 21.420 29.000 50.300 144.300 Mc.
SSB: 1.885, 3.870 7.280 14.270 21.370 28.390 50.125 144.200 Mc.

Exchange your name, RST, QTH (state US, province for Canada, country for DX), receiver and transmitter manufacturer/model (homebrew, send final amp tube or

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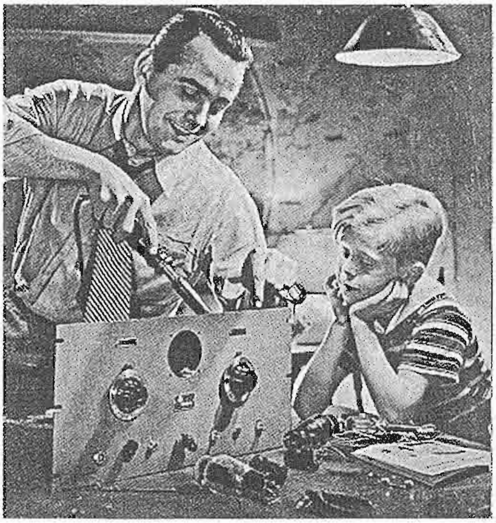
Cover: To kick off the Electric Radio "Honor Your Elmer" contest, we have reproduced the cover of the April 1946 Radio News. This is Bill Shaw, W9UIG, who was among the first hams back on the air after the WWII shutdown. He operated with 500 watts phone using a 3-element beam antenna. His receiver was a Hammarlund HQ-129X. Other equipment included a Meissner Signal Shifter and an RME DB-20 preselector.



Presenting the Electric Radio

Honor Your Elmer

Contest

The Electric Radio "Honor Your Elmer Contest" has begun! It is an opportunity to honor the person who helped and guided your entry into amateur radio and have some fun doing it! As mentioned last month, we've got Mother's Day and Father's Day every year, but what about our Elmers? These folks deserve some recognition and respect too!

Electric Radio is proud to sponsor the first ever (that we know of) contest to honor the Elmer that helped you into our avocation, ham radio. The object is to tell your story and share it with the world. What better way to say "thanks" to the man who helped you become the ham you are today?

The contest rules are simple, just tell the story! 2000 words would be great, but the story is what's important. Because space is limited in the magazine, we'll put the Elmer stories we receive on the ER web site (www.ermag.com) for the next 4 months. At the end of the year, readers can vote for the winning story, and the winner's story will be printed in Electric Radio.

We have lined up some great prizes for the winning stories. Bob Heil at Heil Sound has donated one of his excellent Classic Pro microphones. John Slusser (WF2W) at Radio Daze will be contributing a $100 gift certificate to one of the winners. In addition to these two, other prizes include 1 and 2-year, 1st-class Electric Radio subscriptions. More prizes and gift certificates will be announced next month!

Please do not post your Elmer stories directly on the ER web site, but instead they should be sent to our contact information inside the rear cover. Typewritten entries are fine, but please do not send handwritten stories.

(Comments, From Page 1)

transistor type). The same station may be worked with different equipment combinations on each band and in each mode. Nonparticipating stations may be worked for score if all required information is exchanged.

Scoring

Calculate your score for each mode and total those scores for your overall CX score. For each mode, multiply the total number of complete QSOs (all bands) by your CX multiplier. Complete QSO re-

(Continued On Page 31)

The 1938 National Transmitters
Part 2, The National NTX-30

By Jim Hanlon, W8KGI
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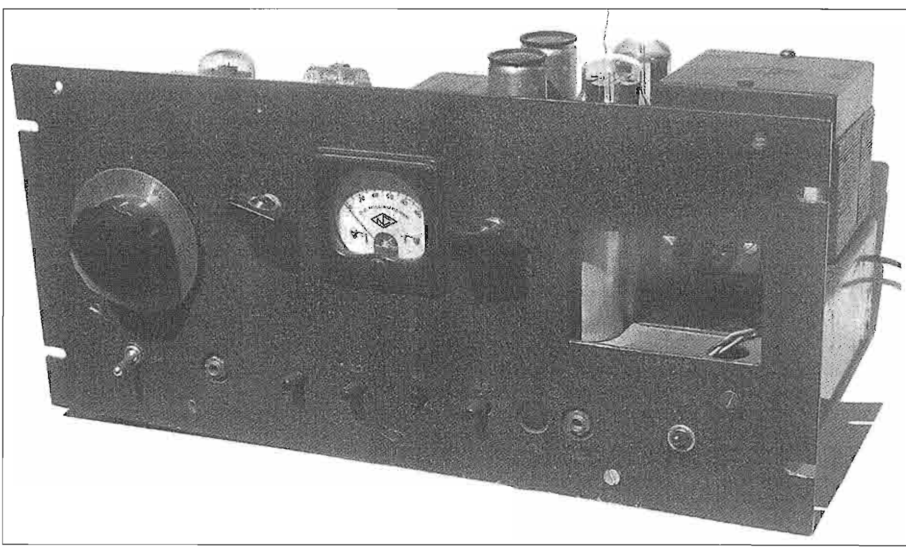
In the first installment of this series, I introduced the line of National Transmitting units first offered in 1938, late in Jim Millen's era as chief engineer at National. The first article described in some detail the NTE Exciter with its 10 watts of audio output and 5+ watts of RF output on 80, 40, 20 and 10 meters or on 80, 20, 10 and 5 meters. This article is about a close relative of the NTE, the NTX-30 Transmitter. The NTE exciter was described in an article by James Millen published in QST, March 1938. In April it was offered to amateurs via the National ad on QST's inside back cover. The NTX-30 first appears in the inside back cover ad of the November QST. Both of these units and their associated NSA speech amplifier and NSM modulator continued to be advertised in QST until January 1941 where an NTX-30/NSM pair is shown along with an HRO in the inside back cover ad.

I've often admired the NTX as I looked at its pictures in QSTs from 1938 to 1940, but I had not even dreamed of ever being lucky enough to have one for my own. Then, out of the blue, Bill Fizette (W2DGB), past president of the AWA and author of the "Communications Receiver" and "Restoring Nice Old Radios" columns of the AWA Journal, offered me a spare NTX and an NSM from his extensive collection. I was thrilled, and in September of 2005 when my wife and I made a trip "back east" to attend my nephew's wedding in Northern Virginia, we made a side trip to the Poconos to visit Bill and pick up the gear. I had brought an extra roll-on suitcase, and I was able to pack the NC101X-sized NTX nicely, surrounding it with my accumulated laundry for padding. When we got



Ready for use, here is a front view of my NTE-30 after refurbishment.

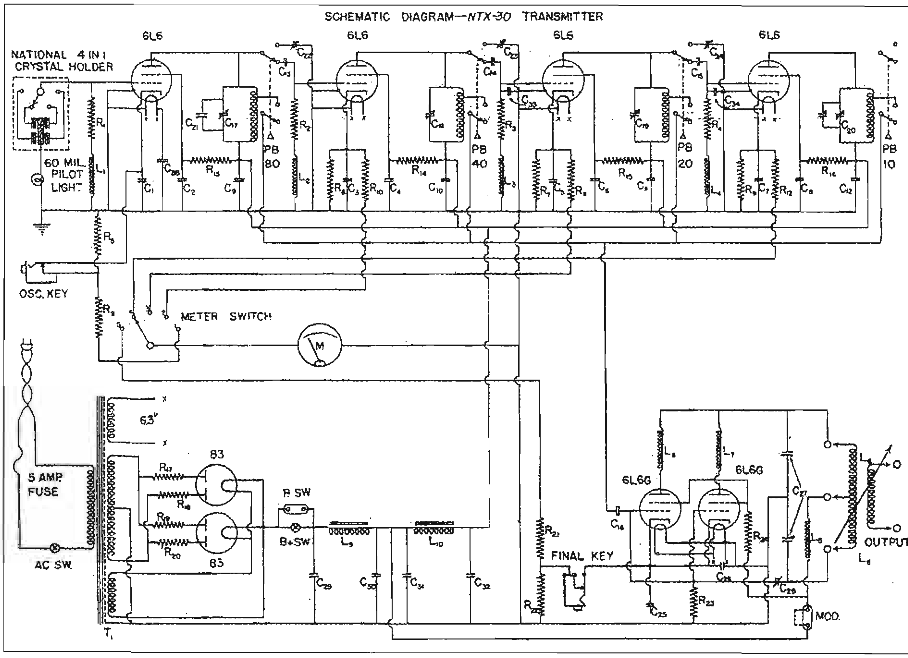


Figure 1: The NTX-30 Schematic

back to Albuquerque there was a little note on that case saying that the airport security guys had opened it for an inspection. Perhaps the X-Ray machine operator was a BA enthusiast and just wanted a peek. The NSM was heavier than the NTX and it wouldn't fit into my available space, so I left it with my wife's cousin Judy in Reading, PA, who packed it up and shipped it to me via Federal Express. Bill had acquired the NSM from Parker Heineman once upon a time at an AWA flea market. It had seen better days, it was dirty, and it had multiple bends and dents in its cabinet and some of the parts under the chassis which didn't have the protection of a bottom plate had been crushed. So, I wasn't too concerned about what additional damage FedEx might do. Luckily, thanks to Judy's good packing, it came through without any additional problems.

Perhaps the biggest thrill of all, though, is the lineage of this particular NTX. According to Bill, it had originally belonged to Otis Eugene "Gene" Simms (W1DXD), James Millen's personal assistant at National, and also at the new James Millen Company. John Nagel (K4KJ), of the AWA, had acquired it from Gene. When John became an SK, Bill obtained the rig. And of course, Bill passed it along to me. So, I am the proud caretaker of a very special NTX that has close ties to Jim Millen and to both of the companies he made so great.

The NTX-30 manual, written by James Millen and Dana Bacon, does an excellent job of explaining what's in the transmitter and why various design choices were made, so I'm going to turn the pen over to them for a few paragraphs. The reader may also want to refer to the schematic of the NTX in **Figure 1** as these gentlemen talk about its details.

"GENERAL DESCRIPTION: The National NTX-30 is an extremely flexible crystal controlled transmitter having an RF output of 30 watts on the 10, 20, 40 and 80 meter amateur bands. It is complete and self-contained for c.w. operation, and terminals are provided for connecting an external modulator for phone use.

"The output stage, which consists of two 6L6Gs connected in parallel, is operated at 300 volts and the normal power input under load is approximately 60 watts. The 30 watt output rating is, therefore, very conservative, and if the output circuit is properly loaded, maximum RF power will be as much as 35 or 40 watts. Excitation to the final amplifier is supplied by any one of the four 6L6 tubes. Three of these tubes are employed as doublers following a crystal controlled oscillator which normally operates in the 3.5 to 4 mc. band. The doublers will, therefore, provide excitation in the 7, 14 and 28 mc. bands and the desired excitation frequency is selected and automatically applied to the final amplifier by means of a low loss push button type switch. ...

"FREQUENCY CONTROL: The crystal oscillator is a conventional circuit wherein the crystal current does not normally exceed a few milliamperes. Under such conditions, there is no possibility of injuring the crystals themselves, but as a further safe-guard a 2 volt 60 ma. pilot light is connected in series with the crystal holder. Normally, this lamp does not light, but if for any reason the crystal current should become excessively high, the lamp will burn out before the crystal could become overheated.

"A special National type 4-in-1 crystal holder (conveniently just the size of a single, shielded can section of an HRO plug-in coil) is supplied as standard equipment. This unit is plugged in horizontally on the front panel so that the crystal selector switch is in the same position as the other panel controls. Any crystal holder which is built to fit in a five prong tube socket can, if the operator desires, be used in place of the 4-in-1 holder, and the arrangement of the circuit is such that a simple tuned circuit can be plugged into the crystal socket if a self-excited oscillator is desired. Such an oscillator will, however, be subject to slight changes in frequency with variation of line voltage since the circuit is of the tuned-plate-tuned-grid type.

"BAND SELECTION: As outlined above, three 6L6 doubler stages follow the crystal oscillator. The outputs of these doublers are on 40, 20 and 10 meters. By simply switching the grid circuit of the final amplifier to the proper tank circuit in the exciter line, and by plugging in the proper output coil, the transmitter, as a whole, may be put on any desired frequency depending, of course, upon the frequency of the crystals.

"The tank condenser of the final amplifier is tuned from the front panel by means of a type "O" dial; it is not necessary to retune the various doubler stages when changing to different frequencies within any of the amateur bands.

"METERING: A dual range, illuminated meter, used in conjunction with a five-position switch, serves to check the plate current and excitation of all stages. The meter itself has a 1 ma. movement and is connected through suitable multiplier resistors to any of the cathode circuits. The multipliers are chosen so that the full scale deflection of the meter is 100 ma. when it is connected to the crystal oscillator, or to any of the doublers; when it is connected to the final amplifier cathode circuit, full scale reading is 500 ma. ...

"The cathode potential method of measurement has, however, several important advantages; if, for instance, a short should occur in any of the plate circuits, the meter will not be harmed. Incidentally, the cathode resistors have a very definite stabilizing effect and protect the various tubes against overload when excitation is removed.

"KEYING: Two key jacks are provided, one in the cathode circuit of the crystal oscillator and one in the cathode circuit of the final amplifier. Keying the final will provide the cleanest signal and is recommended for this reason. Where break operation is desired, it is necessary to key the crystal oscillator, and the panel control of oscillator tuning will be found very convenient in obtaining the exact adjustment necessary to eliminate keying chirps. The operator should remember that it is quite impossible to obtain good oscillator keying in any transmitter if the crystal is the least bit sluggish, or if the holder is improperly adjusted.

"POWER SUPPLY: The NTX-30 is designed to operate online voltages between 105 and 125 at frequencies of either 50 or 60 cycles. Even at a line voltage of 100 volts an RF output of 30 watts is still available. The total power input at 115 volts is about 240 watts. ...

"The B-supply circuits deliver 500 ma at 300 volts and are quite conventional except for the use of parallel rectifier tubes, which are required to rectify the comparatively high current. 600 volt oil impregnated condensers are used in a two section filter, which supplies the oscillator and doubler stages. The final amplifier, which requires less filtering, is connected at the junction of the two chokes. ...

"The primary circuit of the power transformer is fitted with a type 3AG fuse having a rating of five amperes. It is mounted under the chassis."

Millen and Bacon go on to describe the circuit in greater detail, which the ER reader may enjoy if he cares to by further reading the manual. If you need a copy, get in touch with me and I'll make a copy from mine for you.

By the way, if you are wondering as I was, about why in the world the guys at National chose to go with a pair of 6L6s in parallel in the final of the NTX-30, Millen explained that in the "National Ad" on page 75 of QST, November 1938. This is what he said.

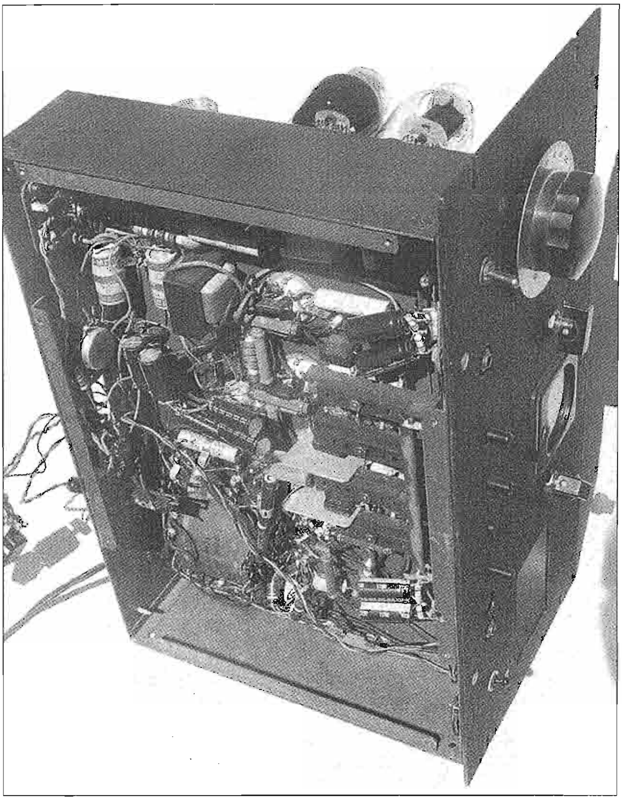
"Most of the men who design National's products are amateurs, which is one reason why they meet amateur problems so squarely. Nevertheless, when we present a new product there are usually a number of amateurs who are very surprised at the design. They tell us they would never have gone about it that way.

"There is a very simple reason for this. When an amateur designs a piece of equipment, he wishes to have it work as soon as it is assembled and adjusted. After all, it is not much fun to have to go back to the beginning and do the job over. At National, on the other hand, we do not care very much how long we work on a design. We are quite willing to spend six extra months building six extra models (and often do) if we think we can find a way to give more performance for less of the customers money.

"This makes a lot of difference in the result. And to show how it does, we are going to comment on a typical design – the NTX-30 transmitter. This is appearing on the market just about now, and we expect to see raised eyebrows any minute.

"The story really goes back to the NTE Exciter, because in designing the NTE we planned to use the same exciter system for the NTX-30. This involved no compromise, and had the great advantage of spreading the cost of tools. This made it possible to build a special push switch of low-loss design, for instance, without having it add too much to the cost of either unit.

"The NTX-30 then started with the NTE. The exciter and power supply were there, and there was room on the chassis for the output stage, and space on the panel for controls. We wanted 30 watts of harmonic-free output, and we wanted to get it the more economical way. After much experimenting, the choice limited itself to one of three things. We could use a single 807 operating at high plate volt-



The refurbished NTX now contains modern bypass and filter capacitors.

a separate high voltage filter.

"In the remaining choice – push-pull versus parallel – we also went counter to usual amateur practice. Amateurs avoid operating tubes in parallel because they are considered almost impossible to neutralize and because they are prone to parasitic oscillations. However, experiment showed that both difficulties could be avoided by careful layout and attention to details.

"Such being the case, parallel seemed better than push-pull, for the later required an additional tuned input circuit. This would have made band shifting less convenient, as well as adding to the cost.

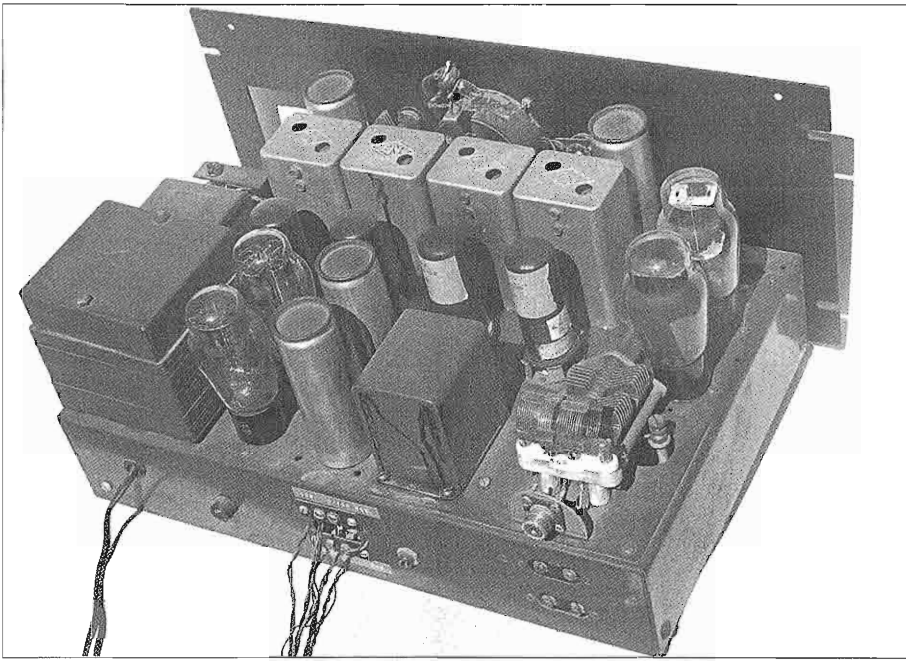
"The trouble with trying to tell a story like this on one page is that so much has to be left out. It does not give a true picture of the work involved. However, it does illustrate the point that we wanted to make – that with lots of time and good equipment, one can often hew a short cut through the woods instead of going the long way around by the highway."

age. Or we could use two 6L6Gs in push-pull or in parallel.

"Most amateurs would have chosen the 807, partly because it is comparatively sure-fire, and partly because high voltages are favored for efficiency. We decided against it, partly because the improvement in efficiency is apt to be in large part imaginary, much of the extra power being in the form of harmonics, due to the high L/C ratio required. Also, the low plate impedance of 6L6s made it possible to maintain full output down to 10 meters. As a matter of fact, the efficiency of the 6L6s was not at all bad, being over 60% even on 10 meters. In this particular case, the 6L6s are actually cheaper also, because the extra tube cost is more than offset by the elimination of

NTX-30 Electrical Restoration

Getting this NTX-30 back on the air, and keeping it there, has been a bit of work, but certainly not too much for such a beautiful rig that is the same age as I am. The first thing I had to do was a general cleaning and inspection. The rig was full of the old-style, body-end-dot resistors and wax-impregnated, wound paper capacitors. I measured the capacitors, and they were either very leaky or just plain shorted. So, I replaced them with a bunch of 630-volt, metalized-



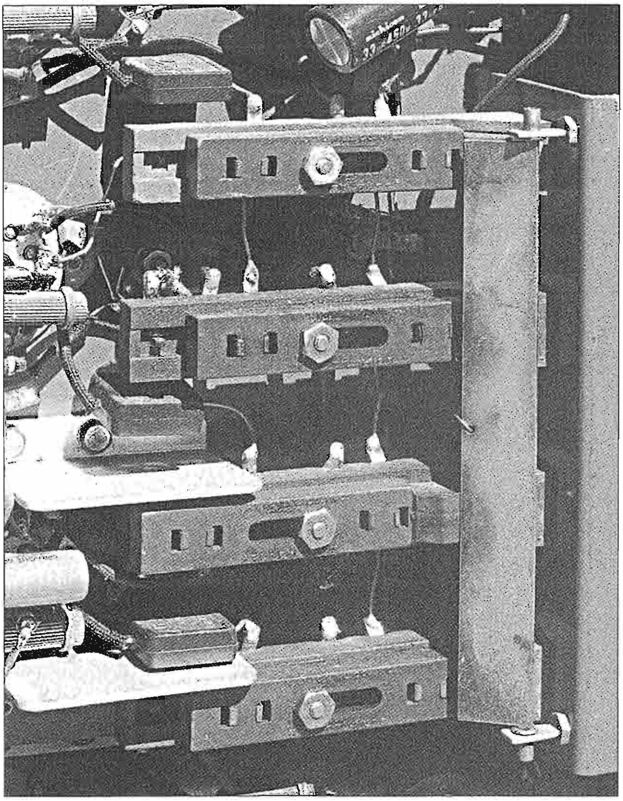
This top-rear view of the NTX shows a full compliment of tubes and a 40-meter plate coil at the lower right. Notice the pilot light hung above the meter and the scotch tape over the slot in the meter's case.

polyester film caps from Mouser Electronics. The four, 4-µfd, 600-volt, oil-filter capacitors were also leaky, so my order also included a handful of replacement electrolytics. I like to be conservative, so I used three pairs of two, 33-µfd, 450-volt rated electrolytics in series with 100-k, 1-watt resistors across each capacitor, to balance the voltage between them, to replace the original filter caps. Bill Fizette reported having problems with the two 83 rectifiers in his rig arcing, or "flashing back" as it was called in the good old days. Bill replaced his 83s with 5Z3s, the high vacuum equivalent. Please excuse me, but I just replaced each rectifier diode with two 1-amp, 1000-volt silicon diodes in series, again acquired easily on the order to Mouser. My junque box supplied the contingent of 6L6s and 6L6Gs required for the NTX and for the NSM modulator. I knew I'd been hoarding those bottles for some good reason.

While I was inside the rig, I found that Gene Simms had built-in a variable, negative-bias supply. Its output is brought out to two screw terminals on the back, but it is not connected to anything in the NTX. So far it's still there, doing no harm and just taking up a little space. Perhaps I'll discover a need for it one of these days.

I also noticed that this rig has a blocked-off hole on the front panel just to the left of the oscillator key jack marked "DUBL." In Doc's NTE, which I covered in the first installment of this series, there is a jack in that hole wired to key the cathode of the first 40-meter doubler stage. Perhaps National initially planned to put a key line in the doubler for the NTX as well, but thought better of it and left it out. This may be one of the early production rigs where the panel still had the port for that jack.

Another indication that this might have



A close-up view of Jack Iver's new bandswitch that shows the machined phenolic parts.

octal socket to bring out filament voltage and B+ for my own VFO.

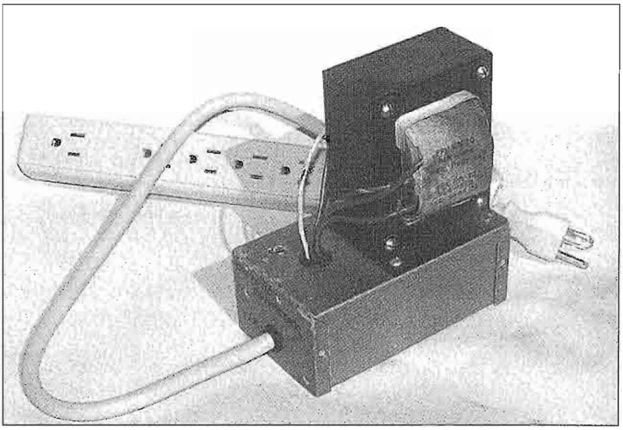
I also noticed, as you can see on the schematic, that both the oscillator and final key ports have both sides off ground. My station control system has one side of the keying leads grounded, so I installed two, small, mercury-wetted relays to do the off-ground keying job for me, and I powered them from a DC supply derived from the power transformer filament winding. I also installed a two-pole relay driven by my external, 24-volt "transmit" control line; one pole across the B+ switch to turn on B+ when I energize the relay and the other pole in the path between the B+ supply and the final plate. With the relay not energized, I can turn on the front panel B+ switch and get power to my VFO and to the oscillator and doubler stages for frequency spotting, but the final stays off.

I must also comment on that new band-switch that Jack Ivers, W1HSV, at National devised for the NTE and NTX. You can see it in the bottom view of the rig. It appears to have been built from pieces that were machine-cut phenolic and metal-stamped parts. It has four, double-pole, double-throw sections linked so that when one push-button switch section is energized the other three are disengaged. Millen wrote in his "New Approach to Amateur Transmitter Design" article, "... we took a chassis, cabinet and other parts normally used to build an NC-100 receiver, and tried to build such a device (the RF. exciter). While from a

been an early model is the pilot light on the meter. Someone just sawed a slot in the top of the meter case and hung a bulb by a wire jig so that it would shine through the slot into the meter. While I was cleaning things, I put a piece of Scotch Tape over the slot so that light can get through but my ubiquitous New Mexico dust cannot.

Gene, or one of the other guys before me, also changed the crystal holder jack and socket to an octal and removed the crystal sockets and switch from the plug-in unit, installing a coax cable for VFO drive in their place. Fortunately he wired the socket so that I could plug in an FT-243 crystal, so I was able to do my initial testing without any further modification. I did add some additional wiring to the circuit point of view the results were reasonably satisfactory, the unit was somewhat of a monstrosity mechanically. Certainly it seemed foolish to shift a large catacomb back and forth for band changing when most of the compartments were empty and the contacts therein were used simply for switching purposes.

"About this time we became very much intrigued by a type of switch used in the telephones now furnished with the Western Electric automatic exchanges. One of our engineering associates, W1HSV, designed a very compact switch using the same principles which would do everything that the shifting catacomb did, and do it much more quickly and conveniently. Around this switch developed the circuit and mechanical arrangement which is the subject of this present discussion ..."

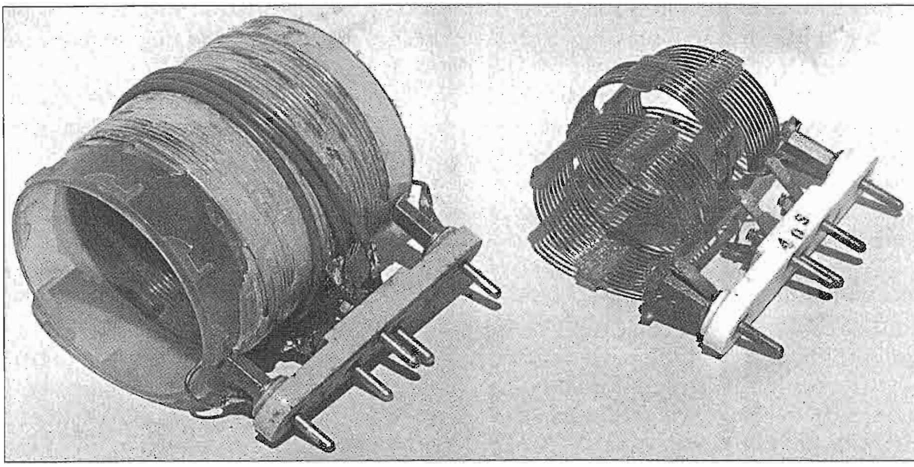


The homebrew "line voltage adjuster" has 120-VAC in and 115-VAC out.

When I first fired the rig up, I tried it out on 40-meter CW since that was the only band for which I had a final-plate coil. I plugged 6L6s into the oscillator and first doubler sockets, 6L6Gs into the final sockets, a crystal into the crystal holder octal socket, and the NTX sprang to life! RF output was in excess of 35 watts into my Heath Cantenna dummy load, and either oscillator or final keying sounded good with no hum, click or chirp. The final neutralized easily following the instructions in the manual (disconnect final B+, tune the final plate for maximum output on an RF indicator 2 volt, 60 ma dial lamp, adjust the neutralizing capacitor for zero output), and there was no sign of instability. The tuning adjustments on the 80-meter oscillator coil and the 40-meter doubler coil were already peaked, so although I checked them I didn't have to make any further adjustments to them.

One thing of concern, however, was that the doubler cathode current was running around 100 ma with the oscillator key up, and with about 460 volts B+ that meant plate dissipation way above the 21 watts a 6L6 is rated for. I couldn't see the glow of the plate through the tube's metal shell, but a piece of paper tape on the shell soon scorched to a dark brown. When I tried the rig on my weekly CW schedule with my friend Mac, WQ8U, it ran OK for about 20 minutes and then suddenly the doubler stopped drawing any current at all. I thought perhaps that the 6L6 had quit, but I was wrong. When I opened the chassis bottom cover, I found that the doubler cathode resistor had unsoldered itself, both leads, and had dropped onto the cover! Boy, that had really over overheated! Obviously, I needed to do something.

I wound up implementing three fixes. First I cut back my 16.5-µF B+ filter-input capacitor to 2 µfd, half the original 4 µfd that National had installed. I also adjusted the AC input voltage down from my 120-volt line to the 115 volts that the NTX was originally designed for, which also resulted in 6.3 volts being measured at the 6L6 filaments. Those measures brought the B+ down to a much more



On the left is a homemade 80-meter coil described in the text, and on the right is a factory-made, National AR-40, 40-meter, swinging-link coil.

reasonable 345 volts. Then, I put an extra 1000 ohms in series with the 40-meter doubler's 300-ohm cathode resistor that, along with the voltage drop, brought the key-up cathode current down to a much more viable 30 ma. There is still a very ample 12.5-mA grid drive to the final, key down, so I'm going to leave these modifications in place. With them, the RF output is just about 30 watts out with 54 watts in, and that's quite satisfactory for me. The little rig also now goes on the air, CW-or-AM phone, and stays there for an indefinite period of time.

To get on 80 and 75 meters I wound my own final plate coil on a pill-bottle form. I had gotten a couple of AR-16 jack bars and pictures of the original AR-16 coils, so I was able to estimate the inductance of the 80-meter coil from its dimensions and number of turns and then to make a coil with that inductance on my available form. I eventually acquired a 20-meter coil for the final, so I plugged a 6L6 into the 20-meter doubler socket and loaded the rig up into my Cantenna. Not surprisingly, the unshielded rig wiped out channels 2 and 4 and gave channel 11 a bad case of herringbones. Channel 5, 7 and 13 were OK. Fortunately, with the rig on 80 and 40, all channels are clear.

It's too bad that the MB-40, 80 to 10 meter multiband tank developed by National around 1950, wasn't available for the NTX in 1938. That would have made it a completely bandswitching transmitter with no coil changing in the final. Had this rig belonged to me when I was a novice in 1952, I would have been sorely tempted to swap out the AR-16 plug-in coils and the plate tank condenser for an MB-40.

You might be interested in my line-voltage adjuster. Rather than dedicate a Variac just to this rig, I put together a minibox holding a transformer that has a center-tapped, 10-volt, 11-amp secondary. The 120-volt primary winding goes across the input line, and half of the secondary goes in series-opposing with the line to the output. That bucks the line voltage down from 120 to the 115 volts that the NTX prefers. If I had used the whole secondary I could have taken it down to 110 volts, or I could have raised the output by 5-or-10 volts if that had been needed. The adjustor output runs to a multi-outlet power strip so that I can plug in the NTX and also its NSM modulator buddy.

A VFO for the NTX

After getting the NTX playing on crystal control, I wanted to go ahead and equip it with a VFO as Gene Simms had apparently done before me. Gene had dismantled the interior of the original Four-in-One crystal holder and just attached a piece of coax cable to the pins in the box leading to the control grid of the oscillator and ground. My first effort was just to connect the output of a Heath VF-1 to this cable. I borrowed a couple of the unused terminals on the octal "crystal socket" to run filament, B+ and keying leads out to the VFO. With the VF-1 running on 160 meters, the NTX 6L6 oscillator stage turned into a doubler and everything worked just fine. The time soon came, however, when I wanted to move the VF-1 over to a brother AT-1, so I needed another VFO for the NTX.

At that point I acquired a Geloso 4/104 VFO from eBay, and I decided to try it with the NTX. The Geloso 4/104 is actually the exciter section of the G 212-TR transmitter, offered by the Geloso company of Milano, Italy and sold also in the United States in the early 1950s. I will describe it in more detail in an upcoming article, but it has a 6CL6 series-tuned Clapp Oscillator driving a 5763 buffer/multiplier. It was intended to drive either an 807 or a 6146, and I decided to give it a try with the NTX.

The tricky thing about the Geloso VFO is that its output is capacitor coupled from an 80-meter, broadband-tuned circuit in the plate of the 5763 buffer. If I just simply coupled that capacitor to the control grid of the NTX oscillator tube, I would get plenty of drive; but I would also set up the NTX oscillator stage to become an oscillator on its own with the VFO output circuit behaving as the "tuned grid" portion of a TGTP oscillator. The Heath VF-1 has a similar output coupling circuit, but it is tuned to 160 meters. Driven by the VF-1, the NTX oscillator stage became a doubler and had no tendency to go into a TGTP mode because its grid and plate circuits were on different bands.

Back in the good old days, there were several approaches to my problem. One of the more creative ones involved transforming the crystal oscillator into a grounded-grid buffer amplifier which would be inherently stable. I didn't want to do that because that would stop it from also being used as a crystal oscillator.

I started off with a "keep it simple, stupid" approach; and the first thing I tried was just to drive the 6L6 oscillator grid from the tuned plate circuit of the VFO's 5763. Sure enough, the 6L6, now wired as a TGTP oscillator, took off and oscillated on its own. But when I cranked in the slug on the 5763 plate coil so that its resonant frequency went down to several hundred kilohertz, below the bottom of 80 meters, the 6L6 settled down. I got lucky, finding that there was still plenty of grid drive for the 6L6 even with the 5763 detuned a bit. So, I have just left this as the VFO-to-NTX interface, and I am careful when I tune the 6L6 "oscillator" plate trimmer on the front panel so as not to create a condition where the 6L6 self oscillates.

The NTX Compared to Other Contemporary Transmitters

Readers of ER may remember that, thanks to my friend Doc, I've had the opportunity to play with several other transmitters from the late 1930s that are at least somewhat comparable to the NTX. These include the Stancor 20P reviewed in ER #206, April 2006, the Hallicrafters HT-6 in ER # 196, September 2005, and the Collins 32RA in ER #214, March 2007. Of these four rigs, the one most readily available these days is the HT-6. That probably reflects the popularity of the HT-6 over the others including the NTX, in their day.

The HT-6, featuring about 25 watts out from its 807 final and including a high-level 6L6 modulator, weighed a husky 65 pounds and sold for just $99. The NTX with comparable power output and weighing 42 pounds, sold for $117; and one needed to add the NSM modulator for another $87 and 51 pounds to get on phone, bringing the overall price to about twice that of the HT-6. Interestingly, with their transmitters as with their receivers, Hallicrafters came in at a lower, $1.52 dollar-per-pound figure than National, at $2.19. Changing crystals and tuning the oscillator plate tank in the HT-6 is a little adventuresome, as you have to lift the lid and work in an area that is only inches away from hot RF and DC on the 807 plate cap and tank coil. But, once you get it set up, you can switch to any one of three, pre-tuned frequencies with the HT-6. The NTX is more convenient and safer for QSY within a band since the crystals can be switched or changed from the front panel and the doublers are all broadband tuned and do not have to be adjusted. One does have to change the plug-in coils in the NTX final to go from one band to another, however. The NSM modulator which I will cover in another article does offer greater flexibility than the modulator in the HT-6 in that it has four audio passband selections and a compressor circuit that allows a high percentage of modulation, but prevents over modulating. Even so, at half the price for a very worthy rig, it is easy to see why more HT-6s were sold than NTX/NSMs.

The Stancor 20P was certainly affordable at only $36.26 as a kit. But, it was much more like a basic rig that a ham of the day might home brew, using all plug-in coils and crystals. Its modulator was just a 6N7, capable of only about 10-watts audio output. That was enough to take care of the 807 final running 20-watts input, but the resulting signal was less than half the power output of the HT-6 or the NTX. I can't find out how much the Stancor weighs right now. It's packed up with the things that Doc is moving to his new house. But even with all of that good Stancor iron inside, it still is a lot easier to move around than the HT-6 or the NTX and NSM.

I don't know what the Collins 32RA sold for, but I suspect it was a lot more than any of the others. It is basically a four fixed-frequency rig intended for commercial service rather than for use on the amateur bands. It also has considerable harmonic output requiring the use of some kind of filter in the output for usage nowadays, whereas the others are usable as is. It weighs in at 120 pounds, so you definitely want to think twice before you put it on an upper shelf in your collection. My 32RA is certainly fun to use on both CW and Phone, but it would not have been real competition in the amateur market for either the HT-6 or the NTX.

My favorite of the four to use on the bands today is the NTX/NSM pair. I've worked through their initial restoration problems to the point where they now are a reliable workhorse rig that I can turn-on and use any time on 80, 75 or 40 meters. The VFO lets the NTX settle down on any clear frequency in either the CW or Phone bands. The NSM's audio and its compressor circuit get very good reports on the air. And when I need a little more power, the NTX/NSM pair does a nice job of driving my Heathkit SB-200 to a carrier output of about 200 watts with the NTX throttled back a bit to a little more than 20-watts output. At that level, the linear output faithfully reproduces the good modulation of its driver. I've had them on the air in particular in the latest Classic Exchange and AWA AM QSO Party events. They are a lot of fun and really put out a good signal on both AM phone and CW.

In the next chapter in this saga, I will describe the NSA speech amplifier. So once again, stay tuned.

ER

The Absolutely Final Final:
40 Years of Linear Amplifier Building Tips from a Prolific Builder, Part 2

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Construction Techniques and Tools

The tools required depend on whether you're going to build several amplifiers, or just an occasional one every couple of years. Here's a short list of tools Cliff considers essential:

Hand Tools

- Nut driver assortment
- Screwdriver assortment
- Screw starter
- Pliers (conventional and gas)
- Wire cutters
- Center punches
- Wood chisel to remove burrs from the aluminum

Saws

- Hack saw
- Sabre saw with metal-cutting blade
- Table saw with 7" nonferrous blade

Files

- Half-round file
- Rat-tail file

Other Tools

- Combination square for determining precise component placement
- Scribe to mark panels
- Fly cutter for large holes
- Greenlee chassis punches
- Taps and tap handles
- Drills from 1/8" to ½"

Cliff's tip for obtaining best results with the fly-cutter: install and secure a panel bearing in the pilot hole. This provides a rigid guide for the fly-cutter shaft and helps avoid drifting.

Another great tip mentioned was the use of templates for common items such as meters, large tube sockets, etc. Cliff has collected these over the years from the panels and chassis of electronic equipment headed for the landfill. He simply cuts out a square surrounding the desired template, then positions and clamps it to the work surface with C-clamps. This insures perfect alignment when drilling holes or cutting a hole for a tube socket or meter and the related mounting screws.

Over the years, Cliff has standardized on the use of sheet-metal screws to assemble the sides, tops, and bottoms of the chassis. He says it avoids the hassles of using lockwashers and nuts on the inside and makes future repairs and modifications much easier. He cautions, however, that one must be careful not to over tighten them and strip the holes. Also, Phillips-head screws are preferred as the likelihood of the screwdriver slipping out of the screw head and scratching the surrounding surface is greatly reduced.

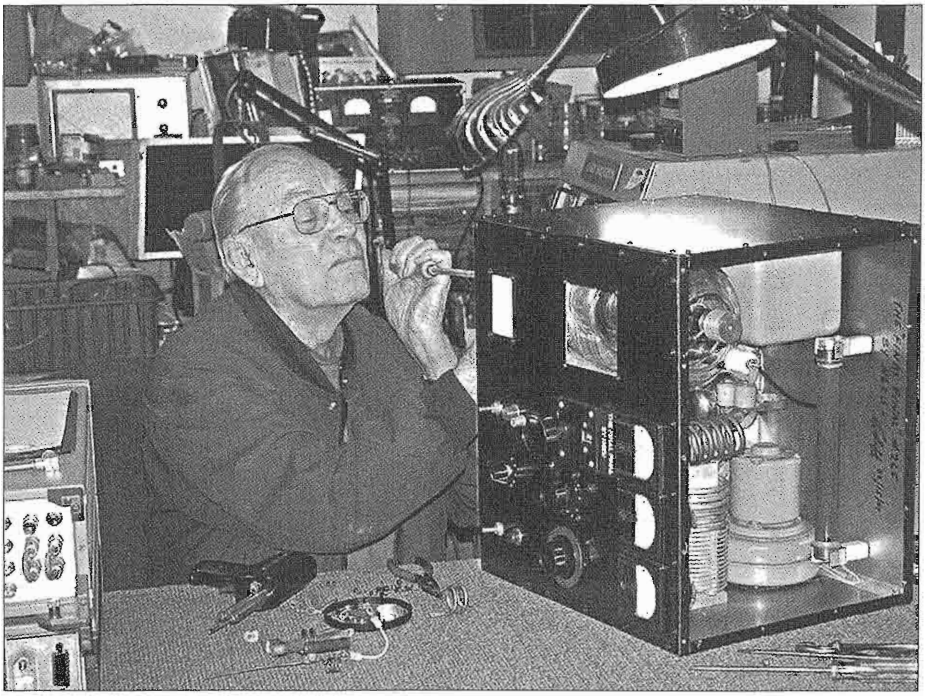
Cliff also pointed out that when mounting components subject to vibration or mechanical stresses, such as the blower, conventional screws with lockwashers and nuts should be used.

Initial Power Up

After construction of the amplifier had been completed, it was time to power it up. Cliff checked the high-voltage power supply and all the AC wiring in the amplifier individually before connecting all the cables.

Amplifier

First, turn on the filament switch and watch for the soft start on the 4-1000A filament. If that looks OK, switch on the HV (again, watch for the soft start) and scan the meters. Only the high voltage meter should register. Next, without applying any drive, key the amplifier. Idling current on the plate current meter should be in the neighborhood of 100 mA, depending on the tube. With our 5 kV of



Installing a Parasitic Choke on the Cathode (Filament)

plate voltage, the tube was dissipating 500 watts of heat, which is right where we needed to be for Class-B operation.

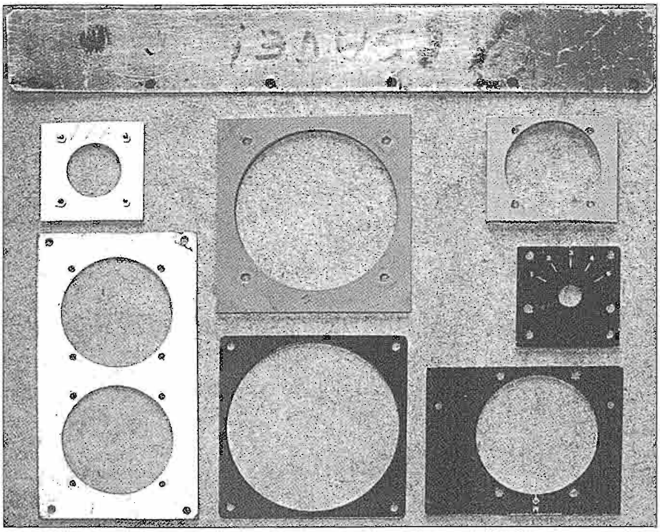
Using an SWR meter in series with the exciter output and amplifier input, tune the amplifier input coils for lowest SWR on each band. A tube-type exciter is the safest bet here, as some potentially high SWR can be encountered while tuning the input coils. Cliff tunes each of the input coils to the center of the band. A power of about 5 watts is usually adequate. A temporarily-placed, non-inductive resistor across the cathode of the tube to ground should also be used to simulate the input impedance of the 4-1000A, which is about 106 ohms. Alternately, this could be done with the power on and without the resistor but in the interest of safety, the power-off procedure is recommended.

Once the input circuits have been tuned, power the amplifier up and apply a low level of drive. Immediately dip the plate. Then, bring up the loading and re-dip the plate until maximum power output is obtained. Check the loading on 75 meters. Our 4-section air variable was about 300 pf shy at maximum capacitance so a 500pf fixed cap was added to obtain the optimum loading capacitance.

Checking for Parasitics

It's unusual that a newly constructed amplifier is completely free of parasitic oscillations. This amplifier proved to be in the "top ten" of the most difficult-to-tame amplifiers that Cliff had ever built. The tube seemed to run really hot as the plate became bright orange almost immediately upon keying the amp. The output-power level wasn't what it should have been and would quickly drop from 500 watts to almost nothing. Looking at the output on a spectrum analyzer revealed there were indeed multiple parasitics that would change frequency with any variation in the tuning and loading controls.

Considerable time was invested in resolving this problem[3]. A number of input



A Sample of Cliff's Templates

His advice: always keep one hand in your pocket, don't wear any jewelry, and wear rubber-soled shoes.

Cliff recalled an incident with one of his amplifiers that easily could have been his last had he not been really lucky. This particular amplifier was getting the final power-on tweaks as he reached around to the rear to tighten a cable. As his hand passed near the high-voltage connector, there was a "zorching" sound and Cliff was knocked against the opposite wall with what felt like the kick of a mean old ornery mule. He saw stars for what seemed like several minutes, but as they faded and he regained his senses, he became aware that he couldn't feel his fingers. As lifted his arm up to look at his hand, he saw that his gold wedding ring had shrunk and was completely black. There was also a big black hole about the size of a dime on the knuckle of his index finger. Cliff reasoned that what had happened is that the strain-relief clamp on the high-voltage connector had shorted to the high-voltage line and, because the entire connector was insulated from the chassis on a Lucite plate, it went unnoticed (in retrospect, he recognized that this was not a good idea).

and output lines were rerouted and a different plate-circuit parasitic choke had to be fabricated in order to stabilize this amplifier. During the process of resolving these problems the installed 4-1000 suddenly showed negative grid current when the amplifier was keyed. This turned out to be the result of an internal filament-to-screen short that was discovered with a Simpson 260 (this gallant soldier was honored for its sacrifice by becoming a memorial table lamp).

Once the parasitic problems were resolved, the amplifier behaved predictably. The color of the tube was just barely a dull red with about 1400 watts output and with about 100 watts of drive. Cliff calculated the efficiency at about 68%.

For additional reading on resolving instability and parasitic problems, the vintage Eimac publication "The Care and Feeding of Power Grid Tubes" is an excellent resource.

Safety versus Luck

Throughout this project, Cliff would routinely underscore the importance of safety when working with the plate voltages 4-1000s like. With a 5000 volt power supply with 15 microfarads (or more) of filtering, there are no second chances.

Realizing that this injury required professional medical attention, he immediately drove himself to the hospital. The wedding ring had to be cut off and the burns had to be treated. As the Asian doctor finished cleaning Cliff's hand, he looked over the top of his black horn rim glasses directly in Cliff's eyes and sternly stated "You gonna git a *brister!*"

Cliff never told that doctor how lucky he was to get only a "brister" as opposed to the alternative. But then again, Cliff's been a lucky guy all his life.

Amplifier Building Questions for Cliff

Q: I'm thinking of using a Variac in the HV power supply. What do you think?

Cliff: There's a common misconception about the use of a Variac. Some guys say they need one to vary the output power level. But, because the plate impedance is directly related to the plate voltage, varying the plate voltage will vary the plate-load impedance. However, the tank-circuit inductance does not change. This results in the tube running hot due to load mismatch. My advice is to leave the plate voltage fixed, optimize the tank impedance to match, and use the drive level to vary the power out.

Q: Regarding parasitics, I don't have a spectrum analyzer. Is there another way to look for them?

Cliff: I've been successful using neon lamps as RF sniffers. Tape an NE2 to the end of a foot-long wooden dowel and poke it around near the various components of the tank circuit while the amplifier is keyed. Normal HF RF glows orange, while VHF parasitics glow a purplish color. You shouldn't see any purple color when the amplifier free of parasitics.

Q: I plan to operate AM with my linear amp. Any special considerations I should make?

Cliff: Continuous-carrier power and high-voltage modulation peaks require that component ratings be up to the job. Your components should have ratings at least four times the nominal carrier power.

Q: I want to build an amplifier, but which tube should I use?"

Cliff: Well, that all depends on how much power you want to run. What do you have on hand? I will offer some general advice, though, and that is stay away from the ceramic tubes unless you really know how the read the meters. With glass tubes, you can immediately see what's going on, while with the ceramics, if there's a problem, you might not know it until it's too late.

Q: My newly-completed amplifier is behaving very strangely. How can I get to the bottom of the problem?

Cliff: Look at the output of the amp on a scope and into a dummy load. Key down and look at the carrier. It should be perfectly flat with no ripple on the signal. If not, start looking for things that could cause any abnormalities that might be present on the carrier. Hum pickup can be caused by DC lines running too close to AC lines, ground loops in the RF input line, etc. Also, when the high voltage is on and the amp is keyed with no drive, there should be <u>*no*</u> grid current. Any grid current indicates either a parasitic oscillation or the amp is not completely "cut off" in the biasing (bias resistor needs to have more resistance).

Q: Do I really need to use 240 on the primary circuit? It's much more convenient to use 120.

Cliff: I recommend using 240 because of the current draw when you're running high power. Unless you have special heavy-gauge 120-volt lines run to your amplifier, you're better off with using 240. With a DC input of 2000 watts, that's 16.6 amps on a 120 volt circuit.

Q: What about resurrecting a swap-meet amplifier as opposed to building from scratch. Wouldn't that save a lot of time?

Cliff: Maybe, maybe not. First, you've gotta wonder, why is it being sold? Did it ever work right? Then there's the whole safety issue – you could be getting a "suicide kit" if you don't take the time to make a careful inspection. On the other hand, if you're just buying it for parts, you might do OK.

Q: Big amplifier parts are getting hard to find. What's your advice?

Cliff: The Internet, swap meets, and swap nets are good places to look. But, perhaps the best is networking with your ham friends.

References:

1: Sutherland, Care And Feeding of Power Grid Tubes, Eimac, 1967 edition, section 4.4.5.

2: Bill Orr, Radio Handbook, 21st Edition, page 7.23.

3: Sutherland, Care And Feeding of Power Grid Tubes, Eimac, 1967 edition, section 3.13.2.

Electric Power Systems and Safety

By: Ray Osterwald, NØDMS,
and Steve Marquie, W8TOW, University of Michigan, National Electrical Code Reference Research and Co-Edit of Text Material

He thought it was dead, but alas,
it was hot.
It's still alive, and he is not.
He knew in his head good practice
well founded,
The circuit's not dead, until it is
grounded.
But this time he hurried, didn't take
time to test it.
He was tired, and cold, and needed
a respite.
A respite he got, for it will be a long one.
One dead and one hot, and he grabbed
the wrong one.
There's been many like him, many
have died.
The cause of their deaths was
"ASSUME-A-CIDE"

–Author Unknown, Contributed by Herman Gibbs, KD8PD

Overview

It is quite common to think about the age of steam power belonging in past times. When we reach for the "On" switch of some kind of modern consumer product we don't think of it as being a steam-powered device, but in reality most of the electrical power doing work in our residences and our businesses has been produced by massive, high-pressure, steam-powered turbine generators. This article is not about electric power generation or electric transmission systems, but it is rather intended to be a broad overview of distribution wiring, with a special emphasis on grounding and wiring safety that we work with all the time in our ham shacks.

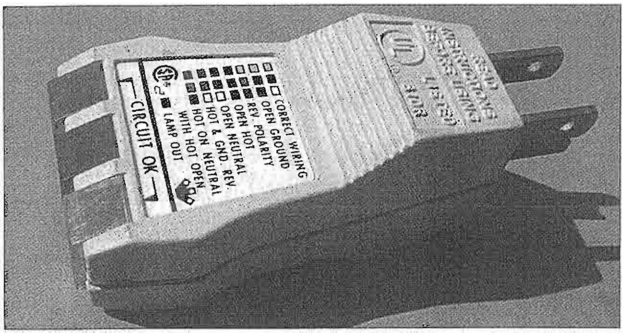
Most hams and experimenters find themselves rebuilding or restoring some device which plugs into an electrical outlet. We hope that by following the suggestions offered in this article you will continue to enjoy the hobby safely!

Safety First

Let's look at grounding practice and electrical safety first to better understand why the electrical codes and wiring practices have been established and why they are important for protection of life and property. That's *your* life and *your* property!

Electrical Wiring Overview

Most residential wiring completed in the last 45 years or so is provided with 3-wire, single-phase branch circuits. If you remove the cover plate from a 120-volt room receptacle there will usually be three wires. Wiring colors may vary according to local codes, but typical colors are one black wire, one white wire, and one green wire. The black wire is the 120-volt "hot" or energized conductor, the white wire is the neutral, and green is the safety ground. The white wire and the green wire are tied together ***only*** at the main electrical service entrance, the location of your breaker panel.[1] If you could follow the wires backwards from a room outlet towards the main breaker panel, you will usually find three types of AC circuits inside the panel. *(It is dangerous to remove the cover from a breaker panel. If you have a chance to watch an electrician working on a panel you can see the other circuits.)* In addition to the 120-volt circuit just discussed that carries hot, neutral, and safety ground, there will also be found a 3-wire, 240-volt circuit with two hot, energized conductors and a safety ground, plus, a 4-wire circuit with two



Checking 120-volt household wiring for proper polarity is easy with a plug-in, neon-light safety tester from a hardware store.

hot energized conductors, a neutral, and a safety ground.

The 3-wire, 240-volt circuit typically supplies current to special 240-volt motor circuits, electric heaters, or air conditioners. As of the 1996 National Electrical Code (NEC) revision, these circuits are no longer allowed to supply residential appliances.[3] Occasionally, these circuits are wired with black, white, and ground. Be careful, because in this case the white wire is energized, and is NOT a neutral wire. The electricians *should have* color-coded it at its destination to indicate that it is an energized conductor.

The 4-wire, 240-volt circuits supply your major appliances such as stoves and dryers. The two energized wires are typically colored red and black, white for neutral, and a bare wire for safety ground.[2]

Do not take any chances, and always use licensed electricians to work on such circuits.[4]

Grounding

The concept of electrical grounding may seem to be confusing, and the reasons for the rules might not make sense the casual observer. They are not "scoff laws." The National Electrical Code (NEC) outlines three main reasons to provide for grounding.[5] The most important of these three is that grounding provides a low-resistance path that facilitates the operation of over-current safety devices such as sensors, fuses, and circuit breakers. The other reasons to have a grounding system are to limit dangerous voltages caused by lightning strikes, line voltage surges, or unintentional contacts between energized conductors of different potentials on the power distribution system provided by the power company. The terms used are confusing, such as "grounding," "grounded," and "neutral." You may wonder, "What the heck is the difference?"

The "grounding conductor" is only supposed to refer to the green-colored safety ground. (Sometimes this will be a bare copper wire, or a green wire with a yellow stripe.)

Here is where some confusion really comes in: The "grounded conductor" refers *only* to the white-colored neutral wire. It is called the "grounded conductor" because it is connected and grounded to a physical copper ground rod *and* the power company's neutral conductor *only* at the building's entrance panel.

Confusing the grounding conductor with the grounded conductor can cause a fatal mistake. You should *never* tie them together. You should *never* use the neutral "grounded conductor" as a safety ground, even though they are tied together inside the breaker panel.[6]

Here is the reason for using these two separate conductors: During normal operation of equipment and normal operations on the power distribution system in, the "grounding conductor," or the green safety ground wire, carries *NO* current. The only time it carries current is during a fault condition. During a fault condition, its required low-resistance path to the source of the power allows safety devices to operate to save someone's life by automatically disconnecting power from the fault. If you defeat the purpose of the safety grounding conductor and the fault is not otherwise removed, thousands of volts can appear between the neutral wire and Earth ground in less than one second. Someone could be electrocuted, or a fire might start! The power company has many over-current devices arranged in series on distribution lines that act in a prearranged sequence of operations during fault conditions.

Neither is the safety grounding system designed to send current through Earth ground. Sending fault current through Earth ground can lead to fatal results because of the differences in potential between two places on the Earth.

In order for a protective device to work as designed during a fault condition, there must be a separate, wired, low-resistance path back to the power company's transformer center tap.[7] This is why you don't want to defeat the safety ground by tying the neutral to the safety ground in your equipment or on your bench. This is why you don't want to put a fuse in the neutral wiring. Both practices can kill. Your safety ground protects you from this serious ground-fault hazard.

Now on to the little matter of our radios. Yes, there is a whole section in the NEC which does apply (You won't be sorry you asked!). Typically, our equipment is inside a metal cabinet. The chassis or rack cabinet must be connected to safety-ground potential.[8] Naturally, the size of the bonding conductor is important, and if the metal rack is on wheels, it is recommended to use heavy braided copper strapping. If the equipment is powered by a transformer with a 600-VAC secondary or greater, the transformer must be grounded, or the center tap of the circuit must be grounded to the enclosure.[9] All "legs" of the circuit must maintain this ground and have no "floating" ground components.

Fusing is just as critical. Each leg of the equipment with individual transformers must be fused accordingly for safety and to provide over-current protection.[10]

These are but a few of the outlined safety regulations required by all to follow, and a complete discussion is outside the scope of this article.

One of the most aggravating problems we have is how to resolve the problem of noisy ground loops that are caused by the separate neutral and the safety ground wires. Some have suggested "lifting" either the neutral or the safety ground wire of modern circuits. In both cases, according to the National Electrical Code, the word is *don't do it*! Per NEC 647.4(A), the solution to ground-loop and common-mode problems should be addressed with isolation transformers.

For power control, the NEC recommendation is to switch both "line" and "neutral" conductors with a suitably-rated switch, leaving the chassis safety ground connected at all times.

As you see, not only does the FCC provide regulation over the amateur, but as end users of commercial electricity, we are obliged to follow the rules of the National Electrical Code. It is common sense. After all, the old QSTs that used to say "SWITCH TO SAFETY" were echoing past tragedies and all the silent keys that chose to not follow these rules. They aren't just suggestions, they will save your life.

Reference:

Fink and Beaty, Standard Handbook for Electrical Engineers, 14th Edition, McGraw-Hill, 2000

NEC References:

1. Article 310-12, NEC
2. Articles 100 & 200, NEC
3. Article 250-5 (b) (4), NEC
4. Article 100-A, NEC
5. Article 250-92, NEC
6. Article 100, NEC
7. Article 250-71 (Bonding), NEC
8. Article 250-57, 250-58, NEC
9. Article 250-59 (a), NEC
10. Article 450-3 (a), NEC

ER

Vintage Linear Amplifiers, Part 2

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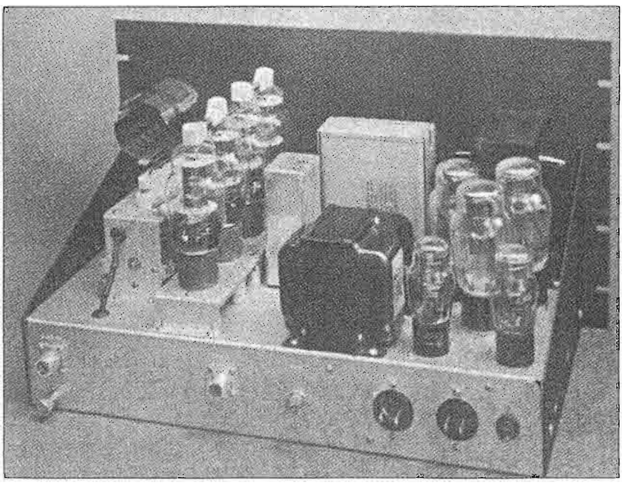
At the beginning of this series, I stated that the tubes don't know, or care, if they are fed audio or RF. In discussing audio modulator stages, we showed how important it was to match and maintain the load from the driver stages to the grids of the modulator. This configuration is push-pull Class AB2 or Class B where the grids draw current over part of the operating cycle. In the case of audio, the design is much more critical in order to minimize distortion products. With RF service, you at least have the output tuned circuit to help reduce any RF harmonics generated. But, you still have the audio distortion products to deal with.

The 1930's-style, push-pull, final RF stage is analogous to its audio counterpart, and if used in linear service, it would be operating in Class AB or B. An example of a push-pull circuit is found in ARRL publications. George Grammer (W1DF) described an AB1, four-1625/807s circuit configured in parallel/push-pull in 1954[1] (more on the W1DF circuit later). Most postwar designs we now use are single-or-paralleled tube circuits, so the analogy of relating push-pull audio output stages and RF-linear amplifiers is a bit hard to accept. Yet, rightly or wrongly, we refer to the single-ended, not push-pull, RF linear as operating in Class AB or B as well. The single-ended audio stage is Class A1 (no grid current) or Class A2 (grid current during part of the cycle).

As far as the faithful reproduction of the input waveform is concerned, the same issue applies whether it's audio or modulated RF. The driving stage should be matched properly for best reproduction with minimum distortion products. And, the impedance/operating bias should not vary over the operating cycle due to grid current being drawn during part of the operating cycle.

With RF amplifiers, a non-tuned broadband input circuit works just fine in Class-C service. It is totally acceptable to couple an external exciter to the Class-C, final-modulated stage of a broadcast transmitter. (The grid circuit is fed, not the cathode.) It would avoid a lot of extra modification to the lower-power stages, and this would most likely insure sufficient drive to the final grids from a more-powerful exciter. In the linear modes, it's acceptable but not ideal. Better fidelity is obtained with a tuned and matched-input circuit at



George Grammer's amplifier from April 1954, QST, using four 1625As in Class AB1, push-pull parallel.

the final grid.

Commercial examples of tuned input include the Heathkit SB-200 and Collins 30L-1. Examples of untuned input include the Dentron Clipperton L and the Gonset 101/201 series. The grid-input impedance is about 120 ohms in most cases. No wonder a modern transceiver designed with a broadband 50-ohm output needs the external impedance match to the cathode circuit of a broadband input for full-driver output.

There are two common tuning methods to match the exciter to the cathode circuit. The first is to build the equivalent of a PI network inside the amplifier at the cathode circuit. The other is to use a parallel-tuned circuit and adjust the input impedance to the cathode via a tap on the coil. The PI network or tuned circuit is coupled to the cathode via a blocking capacitor, see **Figure 1**. A tuned input reduces the drive-power requirements and presents a more constant load to the driver. Therefore, the linearity is superior to a broadband, untuned input.

This is true of Class-C stages as well. Driving a pair of grid-driven 4-400As in a Class-C, plate-modulated (broadcast rig) stage proves the point. The external exciter could only be reduced to 25 watts

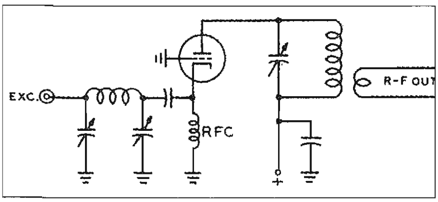


Figure 1A: Components can be fixed or variable.

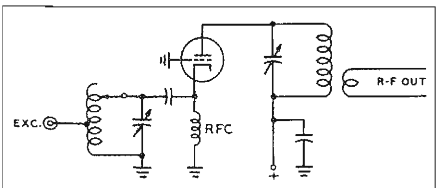


Figure 1B: Low-impedance input matching is with tapped coil.

in the testing configuration setup. The 4-400A input circuit had to be detuned in order to achieve the normally-required grid drive.

The discussion above assumed that the tube is not using an indirectly-heated cathode. External anode devices, of the 3CX and 4CX series, are indirectly heated and do not use a filament choke. Instead, an RF choke is placed in the cathode circuit to ground. However, RF can still get into the filament circuit and the bifilar choke is still often used with bypass capacitors on both sides of the filament.

The Grid-Driven Amplifier

Major differences between the cathode-driven and grid-driven amplifiers include stability and drive requirements. Either configuration can be fed tuned or untuned. However, for situations where the driven tube is drawing grid current, for best fidelity, the input impedance should be matched and not vary, just as in an audio amplifier. A Class-AB2 or Class-B linear should have a tuned input. Linears that draw grid current tend to be Class B because of the greater efficiency.

I found only one commercial amplifier, from a little known manufacturer, claiming to be Class AB2 . I really had to search to find an obscure construction article claiming Class-AB2 operation. George Grammer (W1DF), in his article "The Four-in Line" Linear," published in early ARRL SSB handbooks, claims little advantage with Class AB2. Additionally, he references the article "The Case for the AB1 Linear," QST, April 1954. By virtue of its higher-drive requirements, the cathode-driven linear amplifier is Class B. Because the grounded-grid circuit is being excited with much more power than the grid-excited circuit, the input waveform is not as readily distorted.

There are not many examples of amateur grid-driven HF linear amplifiers. The ubiquitous exciter at 100-watts PEP would force an unnecessary power reduction for the proper input level. The typical use of grid-driven circuits is with equipment where a low-power exciter, of perhaps about 10 watts, is used with amplifiers at the 1-kW level. The circuit would normally operate in Class AB1 for AM and SSB and be driven into Class C for CW and FM. In the early years of SSB, many exciters were in the 1-watt range so the grid-driven linear tended to be more prevalent during that period.

Stability is an issue with grid-driven HF amplifiers and at VHF frequencies, even for the cathode-driven circuits. When feedback is due to interelectrode capacitance, it approaches unity, and the amplifier will oscillate. To offset this effect, a capacitance bridge is created with a small capacitor matching the interelectrode capacitance. Its feedback is 180 degrees out of phase with the internal feedback. Thus the phase "neutralizing capacitor" as the two signals "neutralize" each other. See **Figure 2**.

The need for neutralization increases with operating frequency. An RF amplifier may be perfectly stable at broadcast through the lower-HF spectrum, but as the frequency approaches that where the feedback increases, to match the amplification factor of the circuit, it can become unstable. The grid-driven tetrode, tame at 160 through 40 meters, could easily become an oscillator at 20 meters, and above, without neutralization. Triodes must always be neutralized. The procedure is normally performed at the highest operating frequency.

Still, there is capacitance between all the tube's elements. When they resonate with the lumped inductances of the circuit, a VHF or UHF tuned circuit is formed. If feedback approaches unity at this frequency, the tubes can go into oscillation. To prevent this, it is standard practice to place VHF-suppressor chokes in either the grid or plate circuit as close

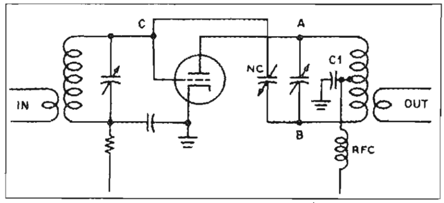


Figure 2A: Triode Neutralization

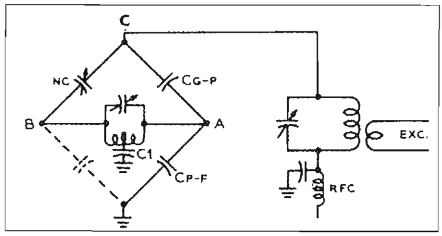


Figure 2B: Bridge Equivalent of Triode Neutralization.

to the tube element as possible. A few turns of wire are wrapped around a low-value resistor of several watts. The wire forms an inductance which is an effective choke at VHF and UHF, but not at HF. Thus, any tendency for parasitic oscillation is suppressed. This is the same feedback issue you are dealing with when trying to keep audio amplifiers stable, not breaking into oscillation.

When making the adjustment, the objective is to get the two 180-degree phased signals at the same amplitude. It is best performed with no voltage present on any of the tube elements, including filament. With the input and output circuits resonated at the operating frequency, a signal generator is placed at the input. An RF voltmeter or well-shielded receiver is coupled to the output. The neutralizing circuit is adjusted for minimum signal feedthrough to the output.

A check of neutralization can be made with the amplifier operating normally. Under power, tune the output circuit through resonance. If there is a change in grid current, the tube is not neutralized. Grid-driven triodes in Class C are more likely to show this characteristic because of the greater grid current involved.

It is easy to conclude that the grounded-grid circuit is best for amateur HF operation. Driving power is perfect for the typical ham exciter. The efficiency of Class B is obtained. The amplifier does not get complicated with grid-voltage supplies, neutralization circuits, and parasitic suppression. And, about 80% of the driving input appears in the output. This is uniquely suited for the amateur service and rarely found outside of amateur equipment.

RF Feedback

The analogy to audio amplifiers continues. The Collins Radio Company developed techniques to include RF-signal feedback within one or several stages. We talked about audio feedback and RF-derived audio feedback with broadcast transmitters in previous articles. The Western Electric WE 451-1 was the example for a grid-modulated, Class-C stage. RF-derived audio feedback was common in pre-WWII broadcast equipment.[2] We are now talking about keeping the feedback signal at the RF level to reduce distortion products from the linear amplifier.

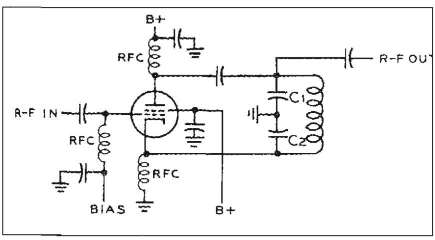


Figure 3: Single-stage RF feedback, FB path is from C2 to Cathode.

Most of us are familiar with the function of the ALC feature in linear amplifiers, which is a feedback control system. The RF feedback technique was used in early SSB systems where the signal was generated at very low level and amplified by several succeeding linear stages. Neutralization and tuning are different from convention. The techniques, apparently, were not easy for the amateur to implement. The only example found of a two-stage amateur construction project was the article "A Two-Stage Linear" by Byron Goodman (W1DX), also in early ARRL SSB publications. It did not include feedback. **Figures 3 and 4** show a simplified circuit for a single and two-stage feedback system.

Byron Goodman's design shows an 807 in Class A, driving push-pull 811As in Class B. The astute reader may recall the rule about driving Class AB2 or B-audio stages from a preceding similar-class stage. Also, recall that just like the audio driver, the RF driver must produce power. The 807 *is* a Class-A, beam-power tube. Thus, there is no distortion.

This is more historical than practical. It does continue to drive home the point that the tubes don't know, or care, if drive power is RF or audio. Next month, we conclude with plate, output circuits, bias and heat issues.

References:

1. George Grammer, "The Case for the AB1 Linear," QST, April 1954, p. 26.

2. F.E. Terman, 1937, Radio Engineering, 2nd edition

Schematics from the Radio Handbook, 15th edition, 1962

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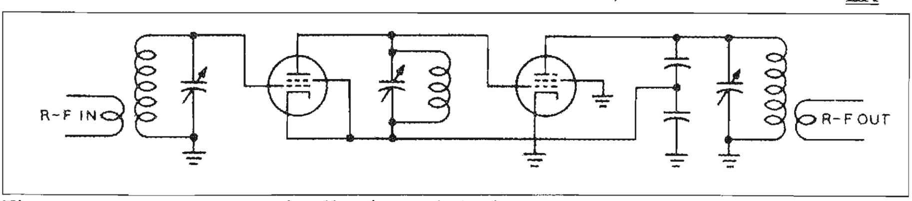

Figure 4: Two-stage RF feedback: Path is from two caps to 1st-stage cathode.

The ART-14 AM Transmitter

By Robert B. Login, AA8A
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Saint Marys, GA 31558

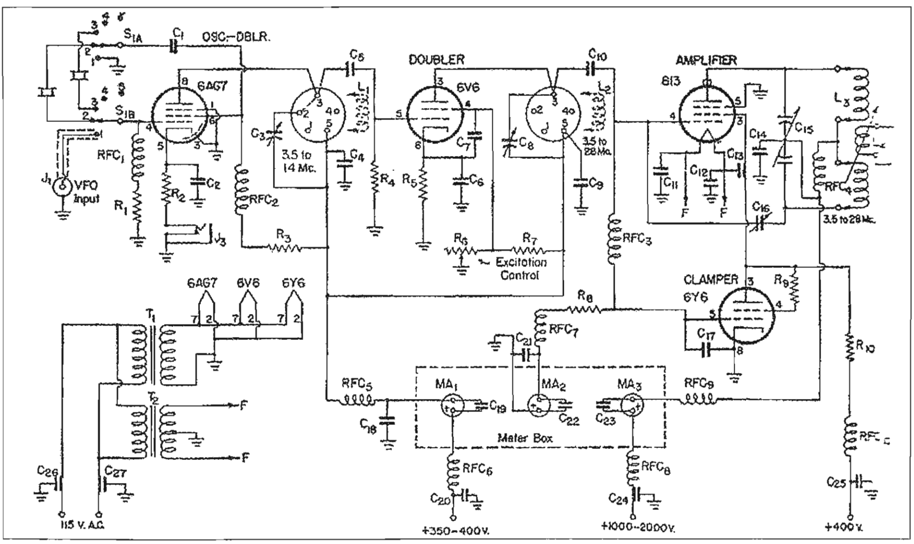
Many hams like me have accumulated significant junk collections that invariably include ART-13 parts. In surveying my treasured parts, I noticed that I had many of the key ART-13 components. I thought that if this was the 1950s, I could roll my own ART-13. Did I need all the motors? No. Did I need that fruity AF deck? No, but the T-202 output transformer could be used to drive 811As. I stripped an old AF deck and kept T-202 and the connector assembly, of which I had both male and female. I could also use the tubes. Looking through my collection of 1950's handbooks, I felt that I could modify an AF-preamp screen modulator that used a 6SJ7 driving a 6J5 inverter, driving a 6V6 output through T-202, and into the grids of a pair of 811As. I would also use the mighty ART-13 modulation transformer, T101.

The rig was coming together in my head and crystallized when I found several 813 rigs described in 1950's handbooks. One in particular struck my fancy because it used all-metal driving and oscillator tubes. This, in my mind, would simplify shielding and hence improve stability. I decided to follow the 813 rig described in the 1953 handbook, which employed a 6AG7 driving a 6V6 doubler, driving a 813. I was especially impressed by the claim that driver neutralization was not required, but no

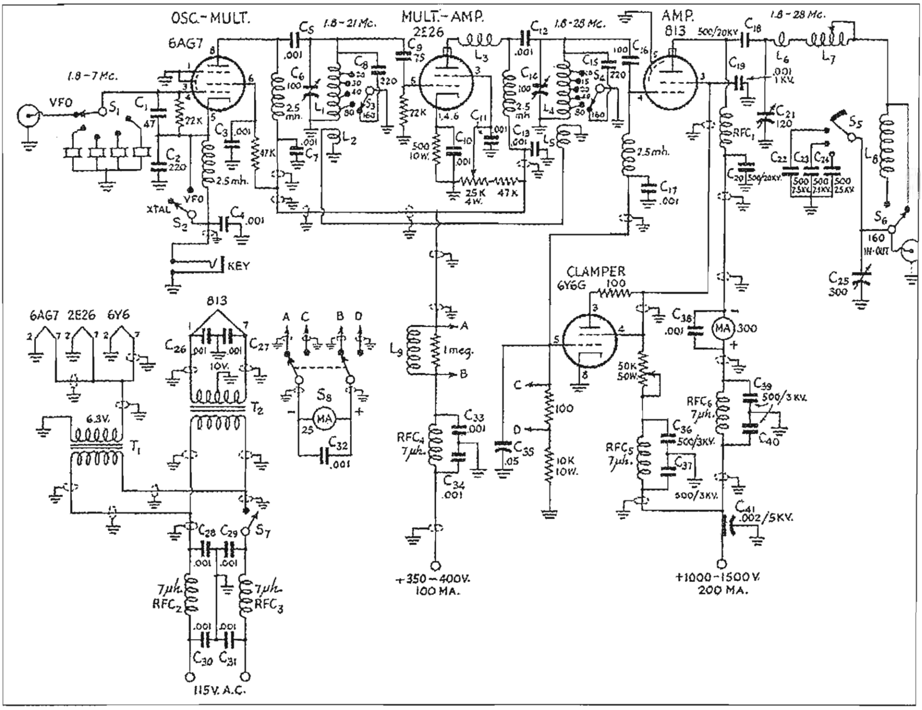
The author's AM station has the homebrew ART-14 transmitter on the right, and Collins 75A-2 and 75A-3 receivers on the left.

Here is a front view of the ART-14 transmitter with the top cover removed. The audio section is at the left, the 811As in the modulator are in the center, and a portion of the PA tank is at the right.

guarantee of stability was made if you deviated from the parts or schematic. If my design stuck to the lower bands (80 and 20 meters), could I avoid neutralization and hence inherent instability problems?



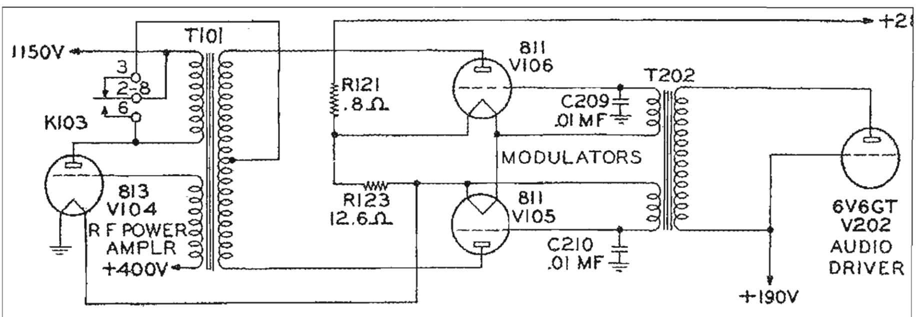
813 Transmitter Schematic from the 1953 ARRL Radio Amateur's Handbook



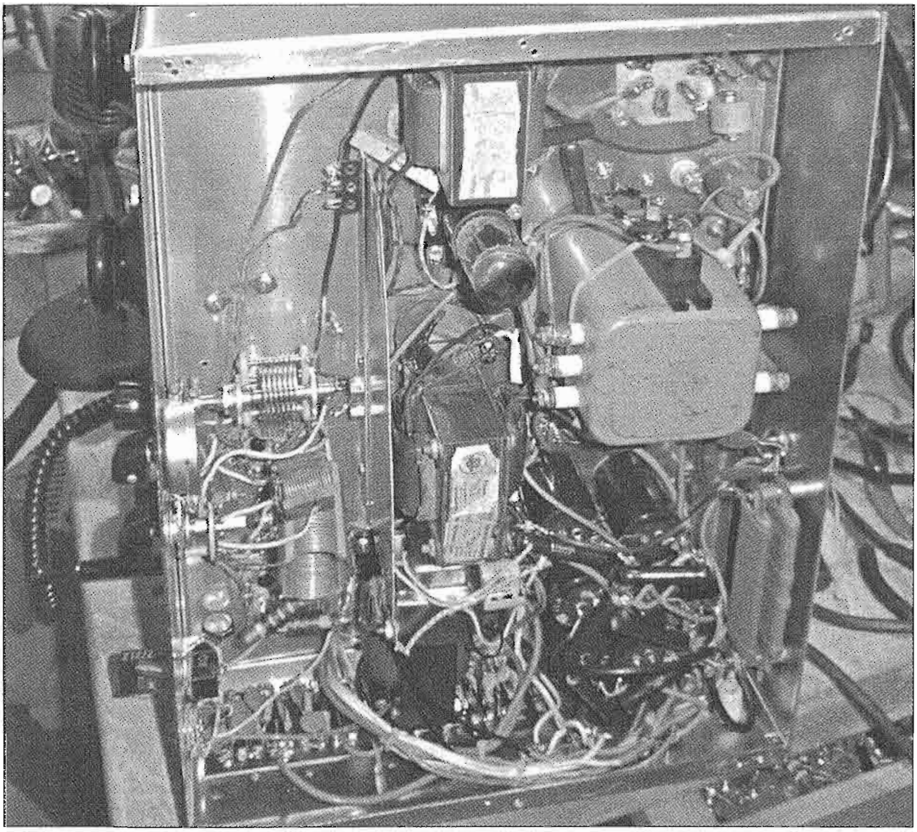
813 transmitter schematic from the 1955 ARRL Radio Amateur's Handbook that has a pi-network output.

I also found a 813 project in the 1955 ARRL handbook that illustrated a pi-net output circuit. Now, I don't want this article to be construed as detailed plans for my rig, as these projects end up using whatever parts are available; therefore, there is little chance for duplication. I'm not an electrical engineer, so I need projects to follow, but I feel I know enough to make the parts I have "work."

One of the great advantages of the modern era are the solid-state, capacitor-input power supplies. No one during the '50s was able to build a power supply



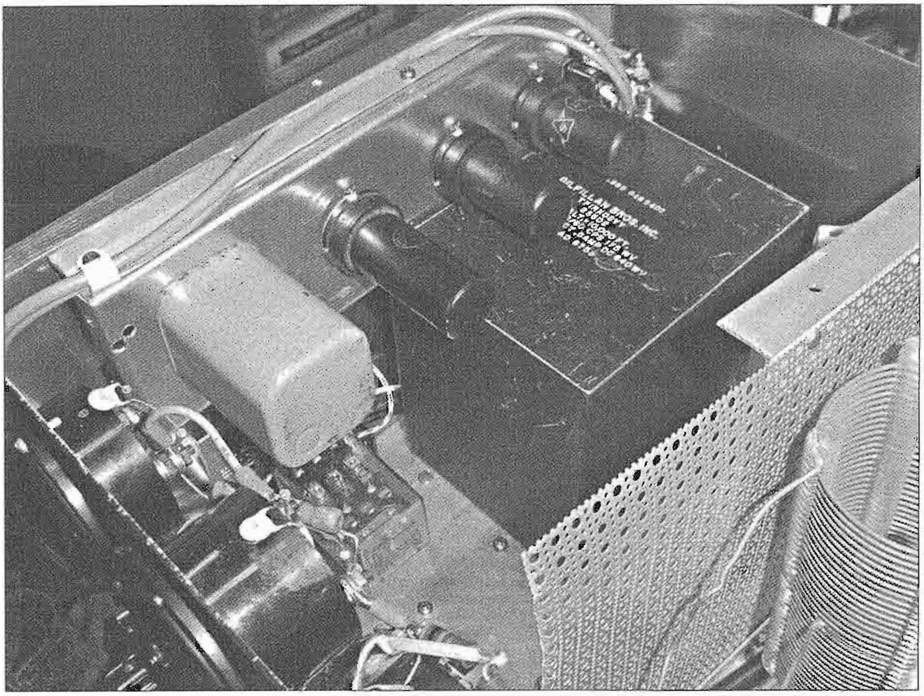
This is a simplified schematic of the AN/ART-13 modulator section. The center taps from the secondary of T202 are connected to the filaments in order to acquire bias for the 811s.



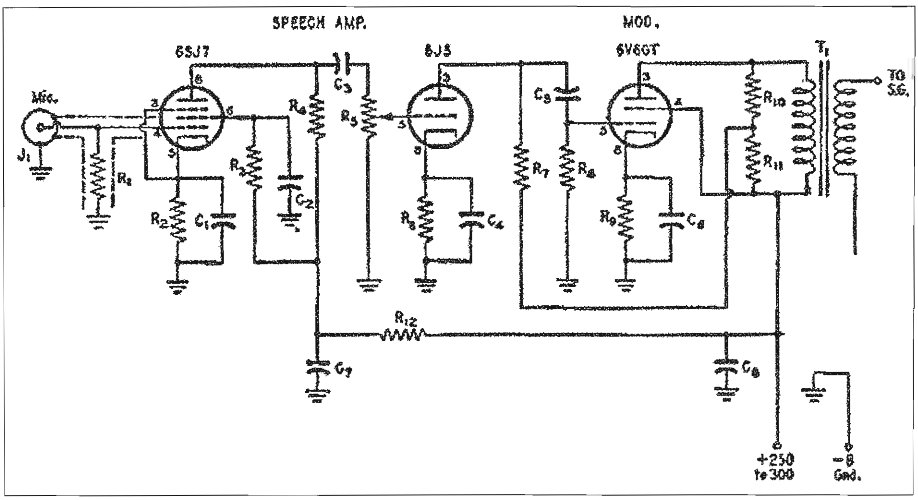
The bottom-chassis view shows the AN/ART-13 modulation transformer at the upper-center right side. Just to the left of the mod transformer is a 6Y6 clamper, and below the mod iron are the power-supply parts. To the left are the oscillator and driver circuits.

similar to what you can do today with modern rectifiers! It would boggle the minds of '50s homebrewers to build a bridge supply with large-capacitor input, sans filter chokes. The 813 is a wonderful tube in that it will work well with a variety of voltages so that the selection of a suitable plate transformer is quite flexible. Just make sure it can handle the load. With diodes, one can boost the voltage if necessary. Amateur service is intermittent and hence transformers rated for continuous service will produce, say, 25 to 50 percent more power for the ham. As a final comment here, let me say that I'm no purest when it comes to vintage home brewing and I like to use modern devices while keeping the essence of vintage alive! Modern rectifiers allow you to do away with two thirds of the iron that plagued our forefathers!

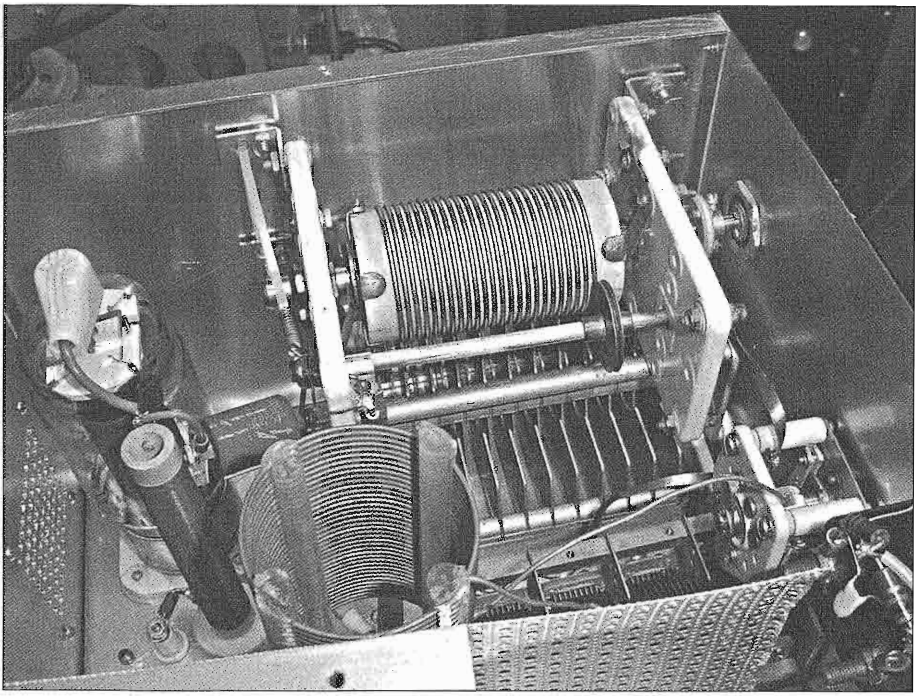
Too bad you can't get rid of the filament transformers. The 813 takes 5 amps at 10 volts while the 811As require 8 amps at 6.3 volts, and the other tubes need 6 amps at 6.3 volts. This required three filament transformers. I found a plate transformer rated at 1000 VCT at 500 mA, continuous. When added to the filament and modulation transformers, boatanchor weight status was achieved! If it was really 1953, with the 2.5-volt



This is a close-up view of the speech amplifier subchassis made from aluminum angle, with the AN/ART-13 T-202 to the left of the three metal tubes. The PTT relay is below T202, and the plate transformer is below the tubes.



A speech amplifier (that was originally a screen modulator) from the 1953 ARRL Handbook was used. It was modified in that "T1" is now "T202" from the AN/ART-13 schematic, page 27, lower. Secondary contacts, originally running to the 811 filaments, are now grounded for use with 811As.



With the cover removed, the PA section is showing. The 813 and its plate choke are at the left, and the coil is in the lower center. Other parts are to the right.

rectifier transformers and the chokes, the Terminator would be needed to lift it!

I bought one of K3IWK's cabinet kits to house the rig. I used sheet-metal screws to put the cabinet together. Using chassis punches and the Dremel® tool, I was able to cut most of the holes. I used circular-saw blades to cut the meter holes. Because I had no detailed plans, I hoped that my assortment of parts would fit in the cabinet and look good. As you can see from the pictures, the part locations were determined by necessity. The rig appears like a functional work and looks homebrew. I think it looks pretty good.

I mounted the preamp on a piece of aluminum angle that fits directly above the plate transformer. I used the salvaged ART-13 connector so that this unit could be easily removed for servicing. K6AD's protection circuit was used on the mod transformer just to make sure that it wouldn't burn out (ER #154, March 2002). I used shielded cable wherever I could, especially in most of the above-chassis wiring to the meters, etc. Except for the plate, all transformers are mounted below the chassis. The driver section is shielded from the final, as is the 811A modulators.

I had a good supply of Ohmite Z-1 plate chokes that I used in several of the power leads. The power supply is of the "economy" design using a bridge for the plate and the center tap for the other voltages through 50-watt dropping resistors. Metering is in the B+ line to the oscillator/driver, but is in the filament center-tap return for the 813 and 811As, and is selected with a toggle switch. Drive to the 813 is metered in the grid circuit of that tube. The 6AG7 oscillator is run straight through with no plate-tank circuit (replaced with a 2.5-mH choke) because of stability. Experimenting with tuned circuits was a disaster that caused feedback and unstable oscillations. I decided I didn't need the extra power, or the doubling, as the 6V6 would do that job. Since I was interested in 160 through 20, I could double a 40-meter crystal, so there was no need for doing this in the oscillator stage. This arrangement is very stable. I used whatever coil stock I had in the 6V6 tank and depended on my grid-dip meter to find the sweet spot. This is a real pain and I'm sure I could benefit from some training here, but after much trial and error I got the driver to work. I did much the same with the 813 tank. The plate choke is from a ART-13. I used a 24-VDC relay for PTT, putting AC on the plate transformer to activate the rig. I probably have too much capacitance in the power supply, or not enough bleeder, because there is a brief howl when I go to receive as the oscillator remains on while the filter caps discharge. I need an improvement here.

Finally, the day came to fire her up. I used a Variac to test the voltages without the tubes. They looked reasonable without a load, so I installed the tubes and brought the voltage up again. I started with a 7290-crystal and could hear the oscillator in a nearby receiver. Some more voltage, and the oscillator/813 grid meters started to read. My wattmeter showed some output, so I started playing around with the variable inductor and final tuning. Power came up, but there was arcing in the final. I saw the arcing and found a fitting too close to ground and fixed it. Once again I raised the voltage and tuned, etc., and now the wattmeter peaked at 150 watts out! I raised the gain in the modulator and spoke, the meter jumped around like it should, but touching the mic caused the power to surge, as if I had a feedback-howl problem. The microphone was changed, and the problem disappeared. This one still has to be figured out.

Using the ART-14 on the air is a pleasure. After numerous contacts on both 40 & 75, I'm convinced that the audio is of good quality. Not bad for sixty-year-old transformers!

Well, that's it. I am still thinking about improvements, but for now I want to enjoy using this rig on the air. *ER*

(Comments, From Page 2)

quires successful exchange of name, QTH, RST, type of transmitter and type of receiver. CX multiplier is the total age in years old of all receivers and transmitters you used in that mode. Each receiver and transmitter must be used in a minimum of three complete QSOs to be counted in the multiplier. If the equipment is homebrew, count it as a minimum of 25 years old unless actual construction date or date of its construction article is older. Transceivers score as separate receivers and transmitters of equal age. Send everything to J.D. "Mac" Mac Aulay, WQ8U, at wq8u@nc.rr.com, or mail to: WQ8U, 104 W Queen St. Hillsborough, NC 27278.

Department of Corrections

The N6ZU amplifier schematic on page 19 of ER #218 has some errors. The schematic implies that AC neutral and safety ground are tied together, which is a safety violation. The 240-VAC line should only power the 240V transformer primary circuits. Either a 4-wire, 240-VAC circuit should be run to the amplifier chassis, or a separate 120-volt circuit with a neutral should be used to power the blower motor and the relay power supply. Also, the .01 filament bypass caps are on the wrong side of the filament transformer and RY2 needs a 240µF electrolytic cap across it.

Cliff Kurtz also has some additional information about the schematic: "This is not intended to be a beginner's project. The filament and plate transformers ob-

(Continued On Page 38)

The Five-Tube Regenerative Receiver

By John E. Burke, WØENE
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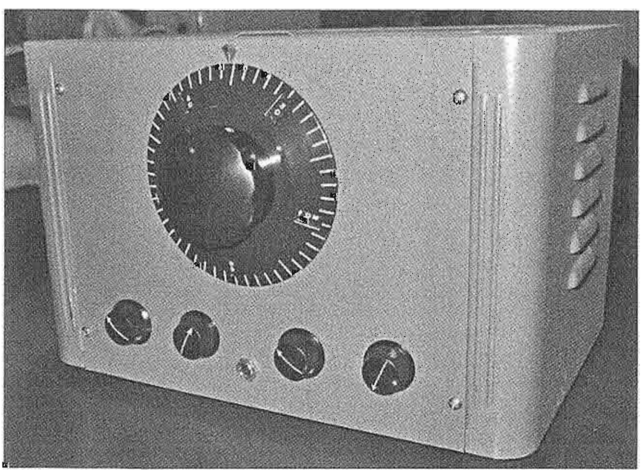
Ever find yourself getting tired of the same old thing? Are you in the middle of your umpteenth major boatanchor restoration and looking for something simple and interesting to build? Well, I found myself in that situation about two years ago. "WWII Paraset Resistance Radio" by Michael Janis (KE3OQ) in ER #179 was just what I was looking for. After building it and working the bugs out, I rediscovered "Ham Radio!"

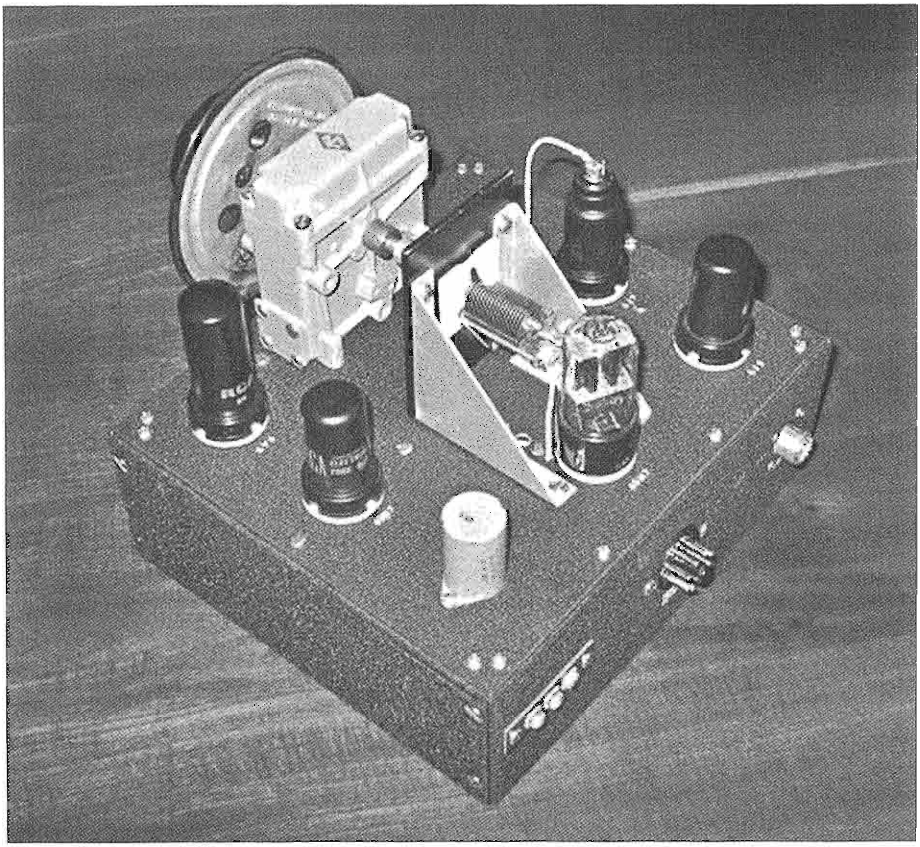
You remember the adventure of being a Novice, the excitement of making a new contact, getting your homebrew transmitter to work, and crystal control. This was back in the days when hams actually tuned above and below their transmit frequency to listen for a reply!

All of this reminded me of a project that I have been planning for years, a matching transmitter and receiver in the classic homebrew tradition. Nothing fancy, just good performance and usable on the ham bands of today.

Several years ago I purchased a pair of small Bud equipment cabinets from Leeds Electronics just for such a project. And, I have been collecting National PW dials and gear drives that needed to be put to good use. So, after deciding to build the receiver first, I looked for a design that would do the PW dial justice. Having built superhets in the past and operated the Paraset, I decided on a regen. A search of the Internet turned up "A Three Tube Regenerodyne Receiver" by Gary Johanson, WD4NKA. His design had most of the features I was looking for. It uses a 3-MHz "IF" frequency for good stability, is a simple, straightforward design, and I had most of the parts in my junk box. The mixer/converter provides the much-needed isolation between the regenerative detector and the antenna. And, the conversion oscillator is crystal controlled for better stability on the higher frequencies. I settled on a modified version of Gary's design and added bandswitching for 160 through 20 meters, and an audio amplifier.


Front View of the Completed Receiver

The receiver is a classic regenerative detector with a crystal-controlled converter on the front end and an audio amplifier to drive a speaker. The RF converter consists of a 6J7-mixer stage and a 6J5 Pierce crystal oscillator. The converter provides signal conversion from the selected band down to a variable regenerative intermediate frequency. L2 has a bandswitched tap that shorts out the top 22

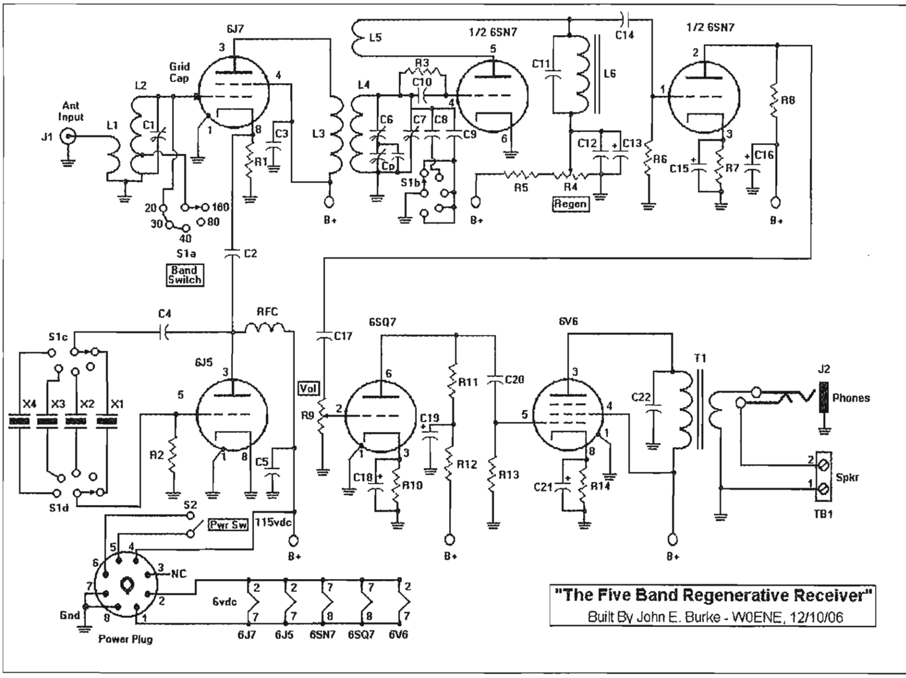


Top-Rear View of the Receiver, Out of Its Bud Cabinet

turns of the inductor on 40, 30 and 20 meters. The frequencies for the conversion crystals were chosen purely by availability from my junk box and Nebraska Surplus. The crystals are mounted in sockets that are soldered directly to the terminals of two of the wafers on the bandswitch. Due to the exceptional bandspread and calibration of the National PW dial, the oddball frequencies haven't been a problem. I intend to make a calibration chart similar to those used on the HROs and install it on the underside of the cabinet lid.

On the 160, 40, 30, and 20 meter bands the variable intermediate frequency range is approximately 2.6 to 3.0 MHz. For 80-meter operation the frequency range is shifted up by capacitor C9 to cover approximately 3.2 to 3.9 MHz. During 80-meter operation, the 6J5 crystal oscillator is disabled allowing the 6J7 mixer to act as a RF amplifier. No provision was made to reduce the mixer stage gain on 80 meters. This requires C1 to be detuned to prevent overload of the detector.

The capacitance values for the detector were chosen using rough calculation and experimentation. C6 is the main-tuning capacitor. C7 is a trimmer used to adjust the lower-band edge during alignment. Cp is used to adjust the bandspread and is padded with a 20-pf NPO ceramic. C8 and C9 are used to allow switching be-

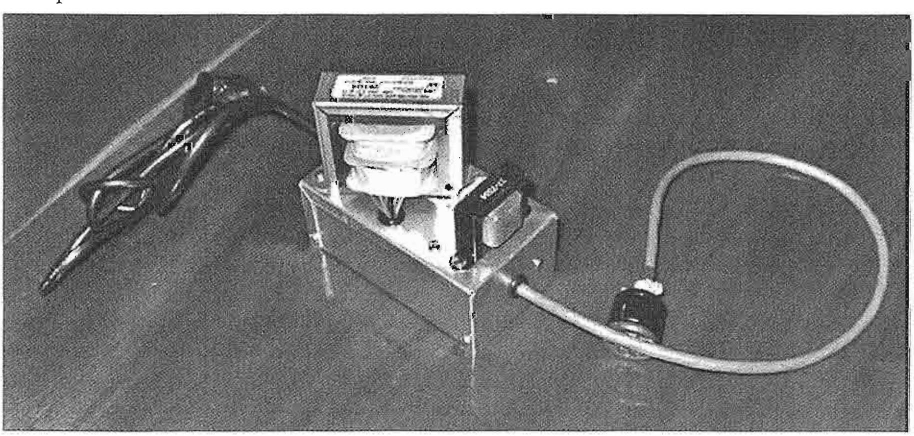


Complete Schematic of the Five-Band Regenerative Receiver

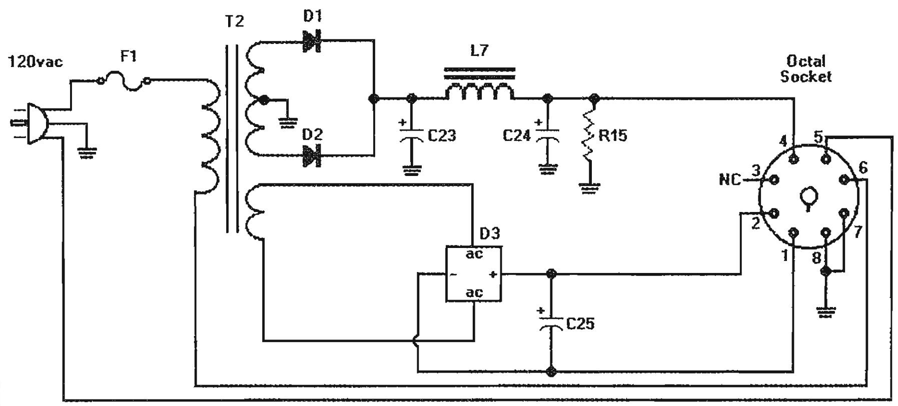
tween the two different intermediate frequencies. The design could be simplified a little, but at this point it works well and is very stable. I opted to "leave well enough alone."

The audio circuit is straightforward and provides plenty of clean audio to drive the speaker. C11 was added to reduce the highs in the output, which helps reduce operator fatigue when using headphones.

A separate power supply provides the 115-volt B+ and 6-volt filament voltages. The high-voltage rectifiers are bypassed with .001-µF capacitors to prevent tunable-hum modulation in the detected



The external power supply for the receiver is built in a small minibox.



Power Supply for "The Five Tube Regenerative Receiver"
By John Burke, W0ENE 12/10/06

Parts List

C1 - 365 pf broadcast variable
C2, C3, C4, C5, C12, C14, - .01 uf
C6 - 140 pf, Hammarlund HF-140
C7 - 30 pf Trimmer
Cp - 11-75 pf w/ 20 pf N750 padder
C8 - 36 pf sm
C9 - 100 pf sm
C10 - 100 pf sm
C11 - 470 pf
C13, C16, - 47 uf, 160v
C15 - 25 uf, 50v
C17, C20, - .001uf
C18 - 5.6uf, 50v
C19, C21, - 4.7 uf, 250v
C23, C24 - 30uf, 250v
C25 - 1000 uf, 50v

D1, D2 - 1000 piv, 2amp diode
D3 - 50v 8 amp bridge rectifier

F1 - 1 1/2 amp 250v fuse

L1 - 4 turns No. 22, closewound below L2
L2 - 30 turns No. 22, closewound on 1 1/2" dia form, tapped 8 turns from ground end
L3 - 20 turns closewound over L4
L4 - 20 turns No. 26, closewound on 1 1/2" dia form
L5 - 4 turns closewound 1/2" above L4
L6 - UTC H-3 transformer secondary
L7 - 4 hy. 50 ma. filter choke, Triad C-4X

R1 - 2K, 1/2w
R2 - 100K, 1.2w
R3 - 2.2 meg, 1/2w
R4 - 25K pot, 2w
R5 - 5100, 1w
R6 - 510K, 1/2w
R7, R10 - 1k, 1/2w
R8 - 100k, 1/2w
R9 - 500k pot, 2w audio taper
R11, R12, - 47k, 1/2w
R13 - 470k, 1/2w
R14 - 390, 1w
R15 - 20k, 20w

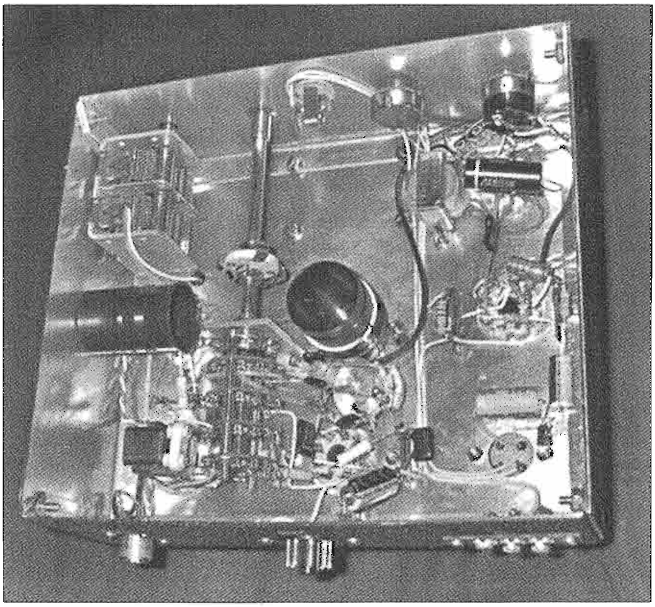
RFC - 1 to 2.5 mh 50 ma

T1 - 5K to 8 ohm 5w audio output transformer
T2 - 250v ct 130ma, 6.3v 2 amp power transformer
Hammond pn. - 261G6

X1 - 4.8 mhz type HC-6
X2 - 10.0 mhz type HC-6
X3 - 13.355 mhz type HC-6
X4 - 17.0 mhz type HC-6

Here is the power supply schematic and complete parts list of the receiver. Capacitor C-22 should be .1µf, 400 VDC.

signal that comes from the detector. I encountered this problem while building my Paraset receiver. The answer to this problem came from a 1947 Handbook! The filament supply introduced considerable hum in the audio output during initial testing. The filament leads are twisted together and run close to the chassis around the inside edges. All of the other wiring is run across the chassis and as far from the filament leads as possible. The audio-signal runs are



Bottom View Showing Component Locations

panel are, from left to right, the RF preselector, bandswitch, regen control, and the volume control with power switch.

Initial testing on my 80-meter loop was a pleasant surprise. The receiver's performance exceeded my expectations. The sensitivity compares favorably with most superhets I have used. I have also noticed that regens seem to be less susceptible to atmospheric and man-made noise. The stability is excellent. It tends to stay on frequency for hours. The audio quality gives my National HRO-50T a run for its money. I use it to monitor the Sunday-morning Florida AM net. The best test came when I worked Hawaii on 40-meter CW during SKN. Now for the down side! The selectivity is still not great, even with the RF stage ahead of the detector. The RF preselector has to be detuned considerably to prevent detector overload on 80 meters. The lack of any automatic gain control can be a little annoying when listening to AM signals with heavy QSB. I will say that the extra isolation from the antenna has prevented strong signals from capturing the detector oscillator. And, I should have built it to include 15 and 10 meters too! It's still a regen and acts like one, but it is much improved over others I have listened too. All in all, it's been a great project and is fun to operate. And now, on to the matching transmitter. Maybe it will be a 6AG7 oscillator driving an 807 PA? I'll get back to the R-390/URR restoration eventually. ER

shielded with miniature coax (RG-174). However, these precautions were not enough to reduce the hum to an acceptable level. After trying all of the usual fixes, I added the diode bridge, D3, to provide DC voltage to the filaments. That, coupled with the addition of C13 and C15, cured the problem.

Construction of the receiver is straightforward. The chassis was custom made to take advantage of as much space in the Bud cabinet as possible. The sides and top were fabricated with the help of my old Navy buddy Jack Absalom (KF4YIO). I lost my access to a fully-equipped machine shop, one of the unspoken hazards of retirement! Fortunately, Jack had two sets of chassis parts made to cover future construction of a matching transmitter. With exception of the crystals and a few resistors, most of the parts came out of my junk box. The power supply is built into a separate minibox and is connected to the receiver through an octal plug on the back of the receiver chassis. The controls on the front

Villard Negative-Cycle Inversion

By David Muskoph, W8XO
and George Heidelman, K8RRH
8757 Brittany Dr.
Cincinnati, OH 45242

The concept of single sideband and double sideband (reduced carrier) was developed in the late 1940s by Professor O.G. Villard, Jr. (W6QYT) and associates at Stanford University. Further work was done by Dr. John Costas of General Electric Company in the 1950s, with an emphasis on the diversity advantage of double-sideband transmission and reception as compared to single-sideband techniques.

What is known today as "Villard modulation" was written up in a June 1947 QST article, by Villard, describing the plate-modulated, Class-C final amplifier at W6YX, the Stanford University station. The amplifier at W6YX was a push-pull, 250-TH rig with two HK-254 tubes connected in inverse parallel. A "basic" two-tube circuit was also shown. The object of the W6YX design was to pre-

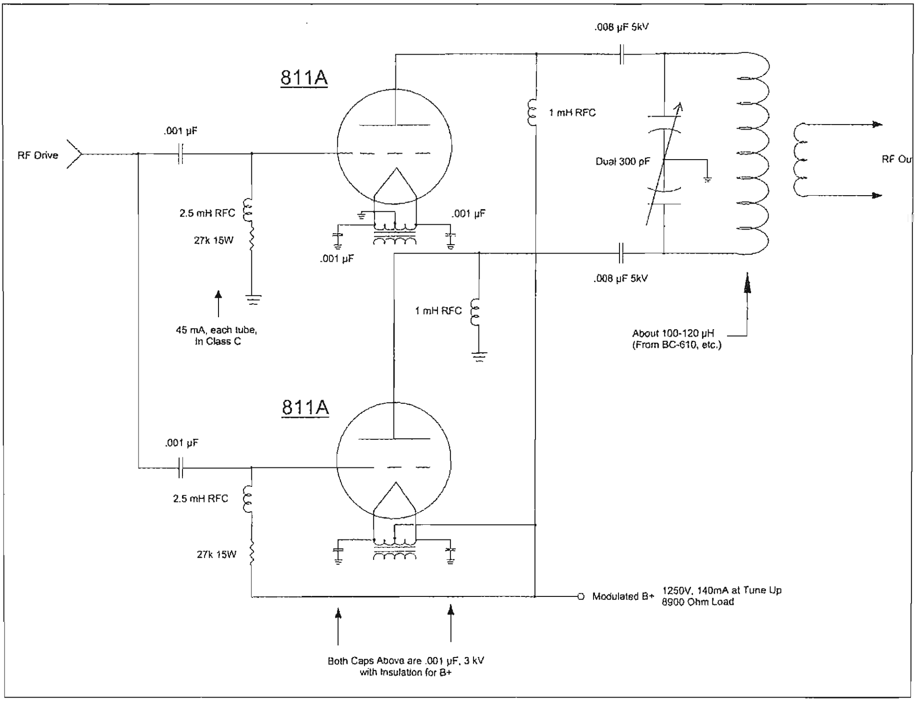


Figure 1: An example of Villard negative-cycle inversion using 811A tubes is shown. Note that separate filament transformers are used, and the primary wiring is not shown. The upper transformer is conventional, but the lower transformer must be insulated from the transmitter chassis with high-voltage methods, such as porcelain insulators, because of having modulated B+ on the secondary. The two tubes act like a mixer in that one is conducting while the other is cut off.

vent over modulation on negative-voice peaks. This idea was taken to its limits by Fred Doughty, W3PHL, in the 1960s, with the object of giving SSB a run for its money (and it did!).

W3PHL used the basic Villard circuit with two similar tubes connected in inverse parallel. This requires that either the final-amplifier tank circuits are push-pull, while the other is parallel connected. The result is a high-level balanced modulator, or mixer, which allows carrier insertion by unbalancing the system. The higher the B+ voltage, the larger the carrier becomes. At that point in time, amateur power measurements were made by the plate-input method, i.e., DC plate volts multiplied by plate current. As all good AM'ers know, the final-amplifier plate current meter shouldn't change under modulation. This is because a DC meter does not respond to the AC modulating current and FCC rules required the use of DC meters in the B+ line feeding the final. W3PHL realized that with the W6YX circuit, you could modulate very heavily and not exceed the FCC rules. Why, you could even ground one end of the of the modulation transformer secondary and run no DC input at all. In fact, there was no power limit, as documented by FCC correspondence about the system. This all changed when power measurement began to look at output power in more recent years.

A number of other individuals tried the system in the 1960s and 1970s. Around 1970, K8CRJ/K4KXL (SK), Don Pasley and Curt Gamble, (K8IBQ/WØALC), modified Johnson Viking I transmitters by placing a second 4D32 in the final. In this case, the grids were in push-pull and the final was parallel connected. Others, including K8BBI/W8XO, built 811A rigs which ran little or no carrier and several hundred watts of audio. These transmitters all worked very well; much better than with negative-cycle loaded Taylor modulation, or other controlled-carrier schemes.

The basic two-tube circuit is not hard to build, see **Figure 1**. Just use the standard tube-table information and an ARRL Handbook design for one tube. The second tube uses the same constants, but is connected "upside down," i.e., plate voltage is fed to the filament (cathode) and the plate (anode) is grounded through a suitable RF choke and a blocking capacitor in the lead to the tank.

This does mean the filament transformer for the "upside down" tube must be able to withstand the peak plate voltage under modulation. In some cases, this may mean insulating the filament transformer case from ground and feeding it with two transformers connected back-to-back.

Either the grid tank or plate tank must be push-pull connected while the other is parallel connected. One feature of this design is that if two of the same-type tubes are used, say 250-THs, the circuit is self neutralizing.

Does this approach have application today? It is hard to say. It is impossible to over modulate in the classic sense. However, you can overdrive it and cause just as much splatter. It is a stable circuit. It takes care of over-modulation peaks, runs at Class-C efficiency, and uses a standard modulator design. The requirement for push-pull connection in one tank may make multibanding difficult, but doable. Anyway, it's something to look at if you're building a new high-level AM rig. ER

(Comments From Page 31)

viously should have 240V primaries. The HV secondary should be 3500VAC to get 5000V DC with a capacitor-input filter and no choke. The parasitic choke in the plate lead is critical and must be found by experiment. It turned out to be 2 turns, ¾" diameter, spaced 3/8" a 20-ohm carbon resistor. Plate chokes must have the right inductance and current rating, and be the right physical configuration (length vs. diameter). Ceramic pillars, ¾" diameter and 5 inches long work well, using No. 26 enameled wire." ER

Old Buzzard George!

George Mouridian, W1GAC, SK

By Dan Brown, W1DAN
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Natick, MA 01760
w1dan@arrl.net

George Mouridian, W1GAC, passed away Thursday, February 15th, 2007, at the age of 91 after a long illness. He was a staple in the Northeast AM scene for over 70 years!

I met George in the early 1990s after I moved to the eastern Massachusetts area from New Orleans. After setting up my ham station, I heard W1GAC on 75 meters AM and soon worked him, but never got to know him well. One day, about 10 years ago, Paul WA3VJB asked me to interview him on a tape recorder he had sent George a few years earlier. I started asking George on the air if I could do the interview for Paul, but he resisted. Eventually, in the winter of 2004, George finally agreed to let me stop by and interview him. After that interview, I started occasionally visiting him, shopping for him, doing errands, and listening to his stories. On the air, hams called him "Old Buzzard George" as an honor to his long-winded transmissions and his advanced age. Being somewhat of a loner, George's ham radio operation was his main connection to society. He was an independent and interesting person. George had a good memory, often told a good story (some with "enhancements" to the truth) and had what some would call a "crusty" side because he could be nice one minute and belligerent the next. What I liked

George Mouridian (W1GAC) at his homebrew station that was in Framingham, Massachusetts, and in daily use.

about George was his design and construction of compact radios. Each radio's layout was well thought out and some of the most compact gear I have seen.

Early Years

George was born in Avon, Massachusetts in December of 1915 to Lucy and Avak Mouridian of Turkey. His parents were Turkish Armenians that escaped the genocide of 1915. In the U.S., Lucy was a landlord in Hopkinton and Avak was a shoemaker and later a poultry farmer. While he was a grammar school student in Brockton, George worked as a railway station telegraph operator in the summer time. In 1932, when he was 17 years, old George obtained his Class-B license and became a ham with the call of W1GAC. As a teenager, George and his family moved to Bear Hill in Hopkinton, Massachusetts, and there he built his first transmitter that used a single 112-A tube as a Hartley oscillator on a bread board. He also built a homemade regenerative receiver. In 1933, he worked for a short stint at the WBZ-AM transmitter then located in Millis; and in 1934 he worked on his father's poultry farm in Hopkinton which he said paid more money than WBZ. George then obtained his First-Class license and studied law at Northeastern University, but did not graduate. In 1936, he earned his Associates Degree in electrical engineering from Eastern Radio Institute in Boston.

War!

George was inducted into the army in August of 1941. He landed with the 5th Air Force in Melbourne, Australia, as a radio operator, then went to Perth, then to Catherine and finally to Darwin–as he told me–to "clean up" after the Japanese attacks. He then landed at night in Port Moresby, New Guinea, where he helped set up and operate as Chief for the first Army radio station that communicated with headquarters in Brisbane and Sydney. While in Australia, George traveled the Australian coast repairing ship board and land-based radios. He also supervised radio communication along the roads being built for the American advance. George was there for two and one-half years and used HF frequencies between 40 and 80 meters for communications. Also, on his spare time, George occasionally filled up a jeep with extra sea rations and gave them to the starving local residents in Papua, New Guinea.

In the military, George earned the status of Technical Sergeant and was at sea when Pearl Harbor was attacked. While in the jungle, he got a conjunctivitis infection that badly shrunk his eyes, which eventually recovered. Because of his asthma, George became a Disabled American Veteran (DAV) in 1945 at the end of World War II at the age of 30.

Settling Down and Working

In 1948, W1GAC built a homebrew ham station for his new home which he used until his death. George also obtained a Master's State Technician's license and started business from his home.

During the 1950s and 1960s, George mainly repaired television sets, but his business also included radio repair, communications contracting, and engineering and broadcast consulting. From 1967 to 1969 he worked at WKOX AM radio in Framingham as a transmitter engineer and worked at WSRO AM radio in 1981. All this time, he was an avid ham-radio builder.

Let's Build!

One of his proudest achievements occurred in the early 1950s when George designed and built a mobile transmitter called the "Mighty Mo," which was featured in the December 1951 QST magazine. This crystal-controlled transmitter had a 6C4 oscillator and 2E26 final, providing about 12-watts input on 75, 20 and 10 meters. The speech amp used a 9003 mic preamp and had a 6K6 modulator.

Later, he updated the Mighty Mo, which he called the "Mighty Mo Senior," now featuring a more-powerful 6146 instead of a 2E26 final and providing 40-watts input. The oscillator was a 6BF5

George Mouridian's mobile transmitters that were featured in QST, "Mighty Mo" and "Mighty Mo Senior" were still in his basement.

beam-power pentode. The audio lineup was a 6AK5 speech amp driving a pair of 6BF5s. The construction article for the Mighty Mo Senior appeared in the August 1954 QST. Both the Mighty Mo and the Senior had an 8-year stint in the "ARRL Mobile Manual." George received many letters from builders of the QST articles asking for troubleshooting help. He did not answer many, as he thought the rig was too simple and the builder should be able to get it going himself.

In 1957, at home, he had built one of his smallest rigs yet, a rig for the kitchen which had a crystal oscillator feeding a 2E26 final running about 5 watts, combined with a simple receiver all packaged within about a 8-inch cube.

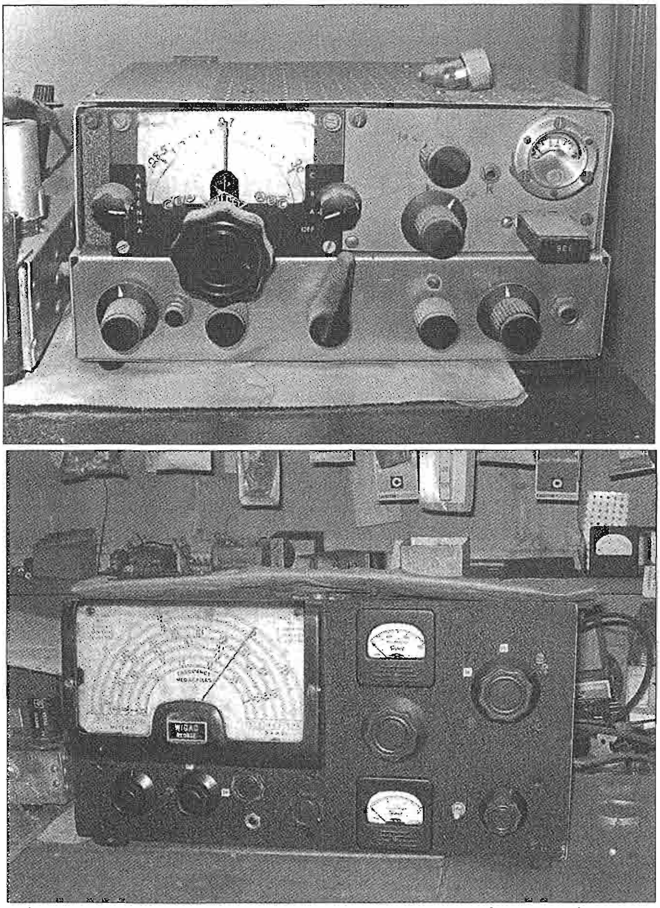
George's construction efforts did not stop there. He also built an 813 rig modulated by a pair of 811s (which he used with a Collins 75A-2 receiver). The transmitter had an Italian-made Geloso VFO and also could be crystal controlled. Unlike most other 813 rigs, this transmitter was small and you could easily lift the power supply and RF deck for transport. George also built a small 10-and-15-meter transceiver that was used along with the 813 rig and 75A-2 as he operated as VP5GM at the Auxiliary Air Force base on Grand Turk Island in 1959.

There, George worked for RCA maintaining teletype communications equipment and helped track pre-Apollo test flights that left Cape Canaveral, Florida. Later, at home, he also built an 833-linear amp as well as constructed transistorized QRP rigs in the early 1960s. Some of his gear had "questionable" wiring and construction and none of it was fused, but it all worked!

His Main Station

George's main station consisted of a small homebrew superhet receiver that used a miniature 6CW4 Nuvistor front end, a 6CW4 mixer, an 8-kc IF filter, a National PW dial for tuning the VFO and a 6V6 audio-output stage.

His transmitter used a separate 6V6 VFO or an internal crystal and had an 829B final that was modulated by a pair of 807Ws feeding an ART-13 modulation transformer. The modulator stage had



Above is the equipment that W1GAC used operating DX as VP5GM. Top photo is his 10 and 15-meter transceiver, and below is the 813 transmitter he used with a Collins 75A-2 receiver.

about 15 dB of negative feedback and used two 9-volt batteries in series for modulator bias.

His 75-meter antenna was an inverted-vee fed by RG-59 coax. George once told me the antenna has been up for 50 years! I tend to agree, as the mast for the inverted vee is pretty rusted now. He also used a 10-meter, three-element beam when the band was open. George used this station along with his kitchen rig until he became hospital bound in 2006.

In the 1960s, George kept up to date studying and using new tubes, such as the Compactrons, as well as his early adoption of transistors. Construction of RF circuits became second nature for him and he believed that 50 to 100 watts is all you needed.

Public Service and Faust Gonset

W1GAC won an ARRL Public Service Award for assisting in the August 1955 Northeast floods.

George was a charter member of the Framingham Amateur Radio Association and was a town Civil Defense member in 1957. He was a fan of the Gonset converters, especially the Super 6 and had a working relationship with Faust Gonset where he helped to improve Gonset's design of the Sideband Engineer's SBE-33 transceiver, the first transceiver that used bidirectional amplifier stages, which was an invention of Mr. Gonset. George promoted the SBE-33 in the Framingham area when it came out. George told me that Faust gave George an SBE-33, serial number 3, which he said he used in his car for many years; however the SBE-33 I found in his workshop is not serial number 3. Bob (K1REC) thinks George may have sold the original SBE-33. Some of George's improvements in the SBE-33 were incorporated in the release of the popular SBE-34. After George passed away, we tried to find any letters of correspondence from Mr. Gonset, but they were thrown away.

The Old Buzzard's Net

In 1946, the Old Buzzard's Net was started by W1BEJ in Scarborough, Maine, by W1NPE in Vermont, and by other hams. It is the longest-running AM net in existence, still meeting daily at 10:00 AM on 3945 kc. (This was the traditional coffee time.) George became a staple on the net and checked in from his home, camp, or mobile every day. This net still meets every weekday. Listen for Charlie (W1EIZ), Paul (W1ECO), Bob (N2NIR), Art (W1UJJ), Bob (K1REC), and other regulars.

Father Time

For many years, George had trouble breathing because of asthma. George often complained about being winded and his arthritis many times slowed him down. George also had a bad leg that kept him from working in his basement workshop. Sometimes, he would not show up on the air and I knew he was just too tired. Many of the hams on the Old Buzzard's Net would be actively looking out for him. I am impressed that he was still active and doing well into his late eighties.

A couple of days after he passed, there was a very small service where only a few people attended. George was buried next to his wife in their plot in Saxonville. After he died, I placed a Silent Key notice on W2INR's web site (www.amfone.net) to let the ham AM community know of his passing. The web site immediately received many replies, which have been read over one thousand times!

Picking Up the Pieces

After his passing, his nephew Dennis and brother Jim called and asked me if I wanted his radio gear and other radio memorabilia. They were clearing the house out quickly for sale. I invited one of George's long time friends, Bob, (K1REC) to pick up some gear and I hi-tailed it over there. Over a few days and car loads, we had picked up pretty much all his amateur radio equipment, log books, QSL cards, parts and accessories. I am glad we saved the gear. We now have all of the equipment mentioned here, and more items, including a small movie collection and World War II newspaper clippings that Mary assembled in scrap books about local men in the war. If we had not picked up this stuff, it would have all been tossed in the dumpster! Much other good stuff was tossed. It is sad no one else in his family or the ham community had any interest in the gear or memorabilia. My goal is to learn about and operate the gear, tell people about George, and pass some of his stuff around to his friends.

In preparing for this article, I studied many of George's personal documents, photos, and of course the equipment he made. I also learned more by talking to friends and relatives, especially Georgina Duffy, who told me many details about George. However, even more is to be learned by chatting on the radio with his ham friends. Being a "young" AM'er (I am 45-years old), I appreciate the efforts George and other "Old Buzzard" homebrewers have gone through to craft a radio. George's flavor of ham-radio construction is being lost as time passes.

I have attempted to tell an accurate story about W1GAC, one of the few remaining hams who started running AM at the beginning of the ham AM mode in the 1930s. Hundreds of hams knew George by his call sign or his voice and a number of new AM'ers talked to George as one of their earliest contacts. My sincere thanks to Paul (WA3VJB) for the thoughtfulness to have George on tape and starting me on this journey, as well as his continued support. Also, thanks go to Bob (K1REC) for picking up some of his gear and history; to Dennis and Jim for the access to his gear and a some good stories. I hope George would be proud of both his accomplishments as well as our preserving his hard earned efforts. Farewell "Old Buzzard George."

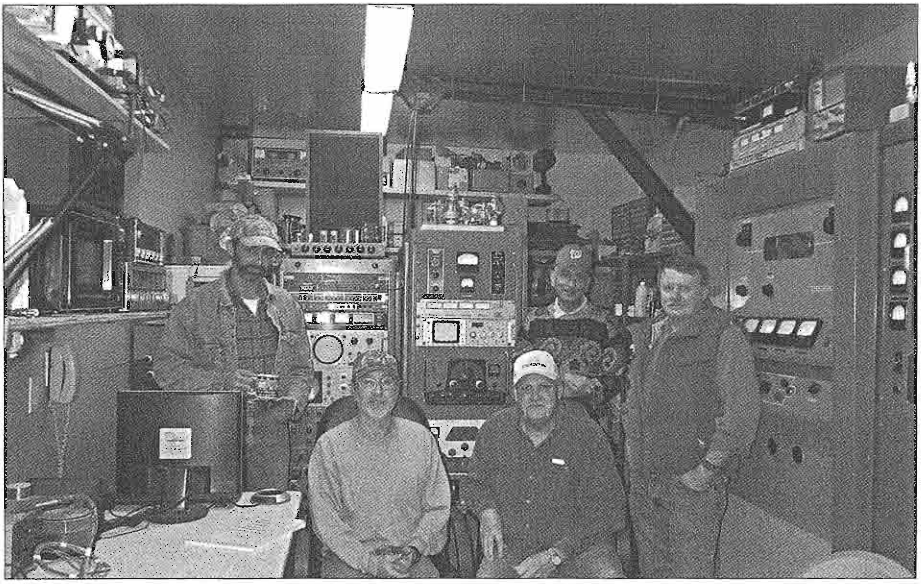
[Editor's note: Dan has a much longer version, with many more great photos than we've had room for. Contact him for the full version.]

ER

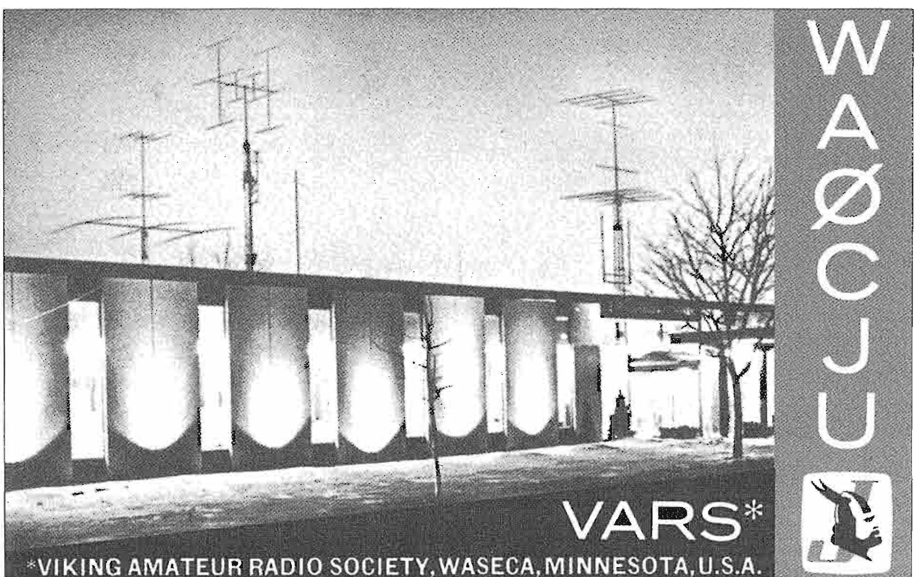
PHOTOS

Editor's Note: "Thank You" to everyone who has recently sent in photos, and please keep "those cards and letters " coming in so I can run the photo column on a regular basis!

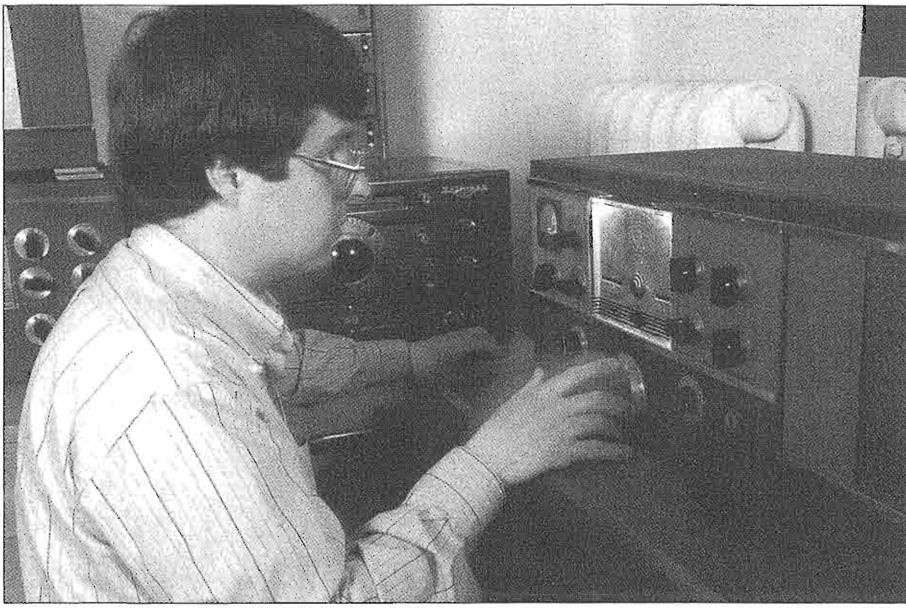
On Saturday July 14th, many vintage radio operators that call themselves the "Widebanders" got together for a picnic at Butch Schartau's (KØBS) lake home in Pepin, Wisconsin, hosted by KØBS & KØBKA. They had friends attending from many states, including Wisconsin, Minnesota, Iowa, South Dakota, and even Mississippi! Great fun was had by all. Pictured Top, Left to Right: WØPR, Larry; WØLPG, Val; WØWG; Mike, KØBKA; Ed Matt (Jeff's son); KAØZYD, Jeff; WØZR, Tom. Stairs: WB5WUX, George; WJ9Y, Marlin; KB9R, Joe. Second Row: W9DKB, Dale; W9GDW, Duke; NØBYH, Tim; WØBVR, Bill; WAØTZJ, Roger; KØEOO, Dennis; W9LWC, Wally; KØBS, Butch. Bottom Row: N9OB, Barry; WØDRU, Smitty; WØVMC, Robert; K9XH, John; K4ESQ, Hugh. (Photo by Sue Eide, KB9EUP)



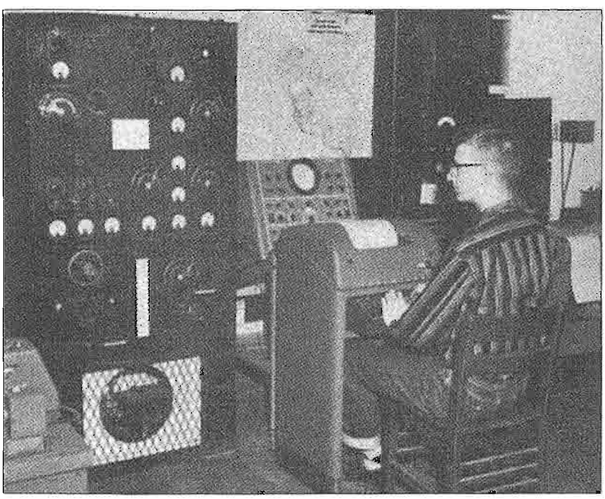
The "7290 Gangsters" are a group of AM'ers around the Eastern US coast. They met at Mike and Patty McElhinny's home last fall, and are pictured in the top row, left to right: Mike McElhinny (WN3B), Tom Marcellino (W3BYM), Scott Mathewson (WA3FFC). Seated: Frank Hagan (WC3E) and Marty Greksa (W3MTG).



During brighter times in Waseca, Minnesota, the ham club at E.F. Johnson, VARS, offered great looking, colorful QSL cards in exchange for contacts on the bands. The card above was sent in by Bill Knish (W9ALD)

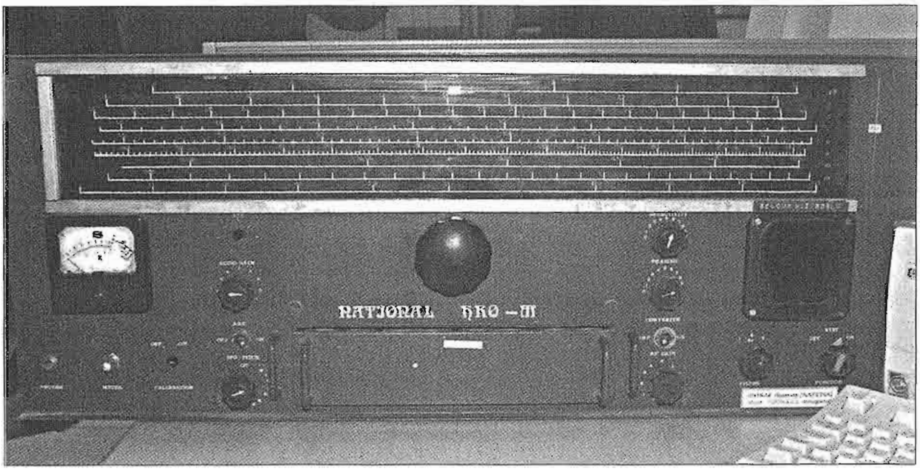


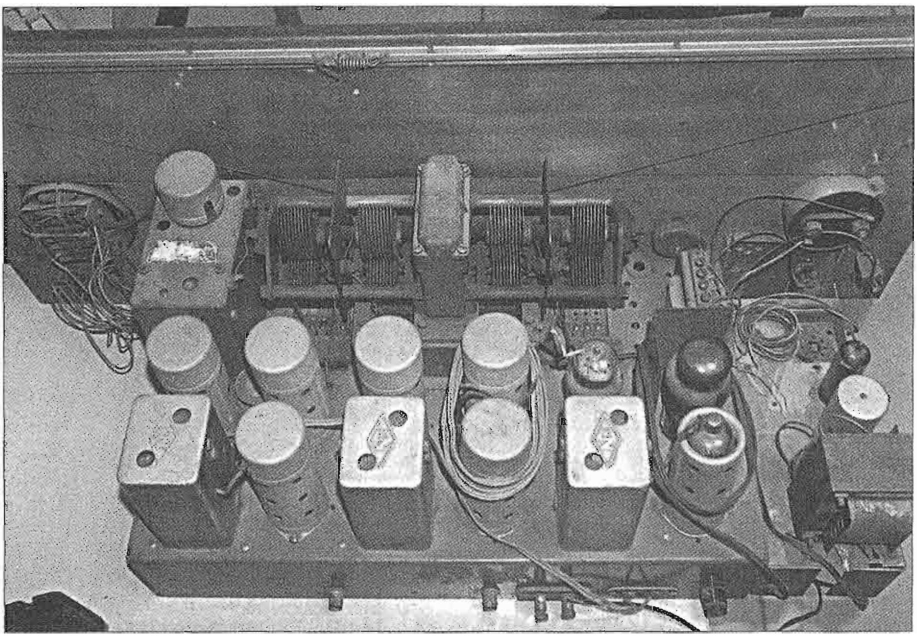
Taken several years ago, Dan Brown (W1DAN), the author of this month's article about George Mouridian, is shown tuning around the bands on his National NC-2-40-D receiver.



The photo to the left shows Jim Haynes (W6JVE), back in 1957 when he was K5KIB, operating W5YM at the University of Arkansas ham club station. As Jim describes the photo: "On the left is the BC-325 transmitter. This was a predecessor to the SCR-199 radio that employed the BC-610 transmitter. In the middle is the Teletype Model 28 KSR and an oscilloscope used as a tuning indicator for RTTY. On the right it is hard to see a tall cabinet rack containing an old Super Pro receiver and the RTTY terminal unit and controls."

Thanks to Al Santangelo (VE3AJM) for sending updated info about the photo on page 42, ER #218. The station is CFS Alert, VE8TU, on the northeast tip of Ellesmere Island, in the Canadian Arctic. Taken in 1964, it was a key asset in the UKUSA network of SIGINT collection stations It supported Canadian signals intelligence, search and rescue missions in the Arctic regions, and radio-direction finding activities.





While travelling in Europe recently, Grayson Evans (KJ7UM) found the mysterious receiver above at a ham gathering in Turkey. Grayson, at first, thought it was made by National. Although labeled "National HRO III" on the front panel, closer inspection revealed that it is probably a clever homebrew. Grayson mentions, "...the thing that looks like a CRT on the right is really a band indicator. Different lights go on behind band legends depending on which plug-in coil set is in use. A fellow said he reprinted the slide rule scale because it was faded. He also said the knobs aren't original. I think someone took a real HRO receiver and put a new front panel and a slide-rule dial, added a new 220-volt power supply and added the band indicator." Notice the mix of octal-based and miniature tube types. *ER*

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FOR SALE: Telegraph key assembly model AN/FRT-15A. Is a J-37 on phenolic base with a bakelite cover and cord, $50. German Baumuster: T.1 key, $50. Norbert Wokasch, WAØKJE, 3312 W. Bijou, Colorado Springs, CO 80904 719-633-5661

FOR SALE: Military radios, power supplies, transmitter: pick up only. Charles Filer, 305-293-9524, 2808 Patterson Ave, Key West, FL 33040

FOR SALE: HW-101 w/HP-23 supply $175. TR-3-w/HP-23 supply $195. SB-100 w/HP-23 and SB-600 spkr $250. SB-300 and SB-400 pair $300. All items plus shipping. Ken Sands K8TFD ken.sands@juno.com 734-453-7658

FOR SALE: Collins 51J-4 HF receiver, very nice condx, restored by Howard Mills. 64-foot Rohn self-supporting tower w/ tilt-over base. Please call Virgil, W4OLJ, 423-404-8000

FOR SALE: Military microphones: M-80C, unused in mil packing, $20 for two each, postpaid. Tom, KJ7AV, 9764 W. Elmhurst Pl., Littleton, CO 80128, 303-979-6135

FOR SALE: Johnson Ranger I, totally restored to turbo specs, complete cosmetic restoration, plug & play, ready to go. $1,250 + shipping. Valiant II, turbo, complete restoration as above, $1,650 + shipping. Dee Almquist, W4PNT, 540-480-7179, 57 Chris's Cir, Crimora, VA 24431

FOR SALE: Technical Books & CDs. Harold Kinley (WA4GIB), 204 Tanglewylde Dr., Spartanburg, SC 29301 www.radiotechnologies.net

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FOR SALE: Johnson Navigator for skilled restorer. Complete except for meter. Original manual, EFJ correspondence. $200 + shipping. Globe Champion modulation and PS iron. Cheap but heavy! John Curtis, WØCAR, 3146 South Franklin Street, Englewood, CO 80113-3019. 303-273-3887. W0CAR@arrl.net.

FOR SALE: Triplett 3432A signal generator- $ 20, RCA marker generator WR99, $20. Simpson 260, $20. Heath IM-11-$20. Carter Elliott, WD4AYS, 1460 Pinedale Rd., Charlottesville, VA 22901 434-979-7383 celliott14@earthlink.net

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MANUALS FOR SALE FOR YOU: Drawers full of vintage manuals, call me on 828-298-1847 for quality reproductions or email me at olg77tr@bellsouth.net. Web: www.w4qcfmanuals.com. I'm John, W4QCF, 66 Willowbrook Rd., Asheville, NC 28805. Licensed 1949.

FOR SALE: New Collins handles for transmitters 32V, KWS-1, KW-1. Replace those beat up and gouged front panel handles on your Collins A-line gear! Handles are finished in high gloss epoxy. Uses existing screws. $20 each. Include $37.50 per pair for priority mail shipping. Please order via EMAIL: w3hm@frontiernet.net or by phone, 304-876-6483, or by regular mail with money order to: W3HM Radio Labs, 570 Acorn Circle, Harpers Ferry, WV 25425

FOR SALE/TRADE: Original manuals: Heathkit, Hammarlund, National, Johnson, WRL, Hallicrafters, Drake, Collins, EICO, B&W, Knight. Al, NI4Q, POB 690098, Orlando, FL 32869 407-351-5536 ni4q@juno.com

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FOR SALE: Ham, CB, and test equipment, all older tube-type gear. Send for list. Ed, WA7DAX, 1649 E. Stratford Ave., Salt Lake City, UT 84106. 801-484-5853

SERVICE FOR SALE: Quality repair of your vintage radios. Work is guaranteed. Check website for info: www.westonelectronics.com Jim Weston, K4COD, PO Box 294, Concord, GA 30206, 770-884-3202

FOR SALE: B&W 5100A. Central Electronics 200V. Johnson Ranger. Johnson Viking II. Hamarlund SP600 with original case. Drake B Line. All are working and are very good to excellent condition. Local pickup in Sacramento preferred/will ship, Frank, KBØW/6, 916-635-4442 fdellechaie@sbcglobal.net

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FOR SALE: Hammarlund clock reproductions, 12 hour (easier to read) or 24 hour, specify, $35 each, shipped. Rob Hummel, WA9ZTY, 202 Midvale Dr, Marshall WI, 53559-9616

FOR SALE: QSTs Cheap, 1924 to 1990! Attn Mobile Operators: 100A alternator, 14.5 VDC in, 12V out, with 120V 10A pwr sply. Also 3 phase 2200V 1 kw transformer. $100 for all + shpg. 350uF 330V capacitors .50 ea. Rudy, W2ZIA, 716-937-9279.

FOR SALE Sprague Orange Drop capacitors New/NOS. Many values/ voltages. 50% off retail. Mix or match values. eMail for complete list. gg136@aol.com

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FOR SALE: KWM-2 CDs. All original material, not a copy of the manual. High resolution color pictures which will really help locate parts, plus much more. For more information visit my web page at http://www.heavymetalradios.com/ or E-Mail me at boatanchors@comcast.net, DW Holtman, WB7SSN

FOR SALE: New, universal power supply for Elmac, Gonset, Harvey Wells, others. SASE for brochure. Harold Smith, W4PQW, 1435 Bush St., Pensacola, Fl. 32534 850-476 8107 w4pqw@cox.net

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FOR SALE: Chinese Army type 65 hand crank generators for 102E radio sets. Ken, KD6B, kd6b@bendbroadband.com 541-923-1013, POB 310, Redmond, OR 97756

FOR SALE: "Unique Radio Parts", LLC. www.wa9tgt.com (Replacement parts for "Drake" radio equipment)

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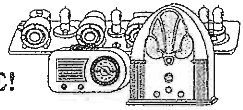

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FOR SALE: Atwater-Kent dual speed tuner repair kit. Complete details at www.adamsradio.com Adams Manufacturing CO., POB 1005, Lincoln Park, MI 48146

FOR SALE: Galena crystals and/or parts to make your own crystal radio. Also have radio tubes. Len Gardner, 458 Two Mile Creek Rd, Tonawanda, NY 14150, radiolen@att.net

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FOR SALE: Telephone Filters, suppress >1MHz interference, plug in, 1/$7, 2/$11, 3/$14, 4/$16.75, shipped U.S. Brian Harris WA5UEK 3521 Teakwood Lane, Plano TX 75075 brian.k.harris@philips.com 214-763-5977

FOR SALE: Military whip antennas NOS, $40. WANTED: R-392 receiver. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777, 989-595-6483

DRAKE PARTS FOR SALE: New spun inlays for the B Line or TR4 main knob. $6. Also sell new pointer knobs. Alan, KC9YS, 630-879-1132 after 7pm.

FOR SALE: Radio parts and hardware. Some are 60 years young! Free flyer, USA only. Bigelow Electronics, POB 125, Bluffton, OH 45817-0125

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QSLs FOR SALE: Your old QSL card? Search by call free, buy find at $3.50 ppd. Chuck, NZ5M, nz5m@arrl.net

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SERVICE FOR SALE: Let's get that old radio of yours working again! Antique Radio Repair - All Makes- Also Transistor Radio Repair. Tom Senne, N5KCL, 937-865-5213 http://tomsradiorepair.bizland.com

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FOR SALE: DRAKE TR-7/TR-7A/R-7/R-7A service kit. Includes 13 extender boards and digital jumper card. $64.60 includes postage. See http://pweb.amerion.com/~w7avk, Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net 509-766-7277.

FOR SALE/TRADE: Transmitting/Receiving tubes, new and used. LSASE or email for list. WANTED: Taylor 204A, 211, TR40M and Eimac 500T. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS. 66213. PH: 913-782-6455, Email: jwalker83@kc.rr.com

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DRAKE OWNERS: New Sylvania 6JB6, same date code, tubes for sale. Price: $23 ea. Call Dick at 207-490-5870

HALLICRAFTERS SERVICE MANUALS: Ham, SWL, CB, Consumer, Military. Need your model number. Write or email. Ardco Electronics, PO Box 24, Palos Park IL, 60464, wa9gob@aol.com 708-361-9012 www.Ardcoelectronics.com

FOR SALE: FT243 Crystals: 1000, 1822, 1880, 1942.5, 3530, 3535, 3540, 3545, 3550, 3625, 3675, 3735, 3800, 3825, 3870, 4325, 4335, 4340, 7040, 7050, 7123, 7140, 7143, 8400, 10106, 28238, 28258, 28571 kHz more. 100kHz, 455kHz HC51U wire leads. Some FT171B, HC6U Crystals. Contact af4k@hotmail.com or send SASE to Brian Carling, AF4K, 117 Sterling Pine Street, Sanford, FL 32773 or call 407-323-4178 http://www.af4k.com/crystals.htm

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FOR SALE: QRP transmitter kits. Step-by-step instructions. Wood model, up to 5 watts 40/80M $15. "Tunatin" one watt 40M $10. You furnish crystal and power. Robert Larson, 1325 Ridgeway, Medford, OR 97504 w7lng@arrl.net

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DRAKE INFO FOR SALE: Drake C-Line Service Information. Hi-Res Color photos of boards and chassis with parts identified. CD also includes Hi-Res scans of R-4C and T-4XC manuals, various version schematics and more. Garey Barrell, k4oah@mindspring.com 4126 Howell Ferry Rd, Duluth, GA 30096. 404-641-2717

DRAKE SERVICE FOR SALE: R.L. Drake repair and reconditioning, most models including TR-7's, 35 years experience. Jeff Covelli, WA8SAJ, Telephone 440-951-6406 or email: wa8saj@ncweb.com

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NOTICE: Visit Radioing.com, dedicated to traditional ham radio & vintage radio resources. Let's Radio! Charlie, W5AM. www.radioing.com.

SERVICE FOR SALE: Repair of tube and solid state 1930 to 1975 radio equipment, auto, shortwave and older amateur gear. Please contact Ken Hubbard, KA9WRN, at 608-362-1896 or write Vintage Radio Service, POB 792, Beloit, WI 53512-0792.

SERVICE FOR SALE: Repair, upgrade, performance modification of tube comm. & test equip. Accepting most military, all Collins & Drake, & better efforts from others. Laboratory performance documentation on request. Work guaranteed. Chuck Felton, KDØZS, Felton Electronic Design, 1115 S. Greeley Hwy, Cheyenne, WY 82007. 307-634-5858 feltondesign@yahoo.com

BOOKS FOR SALE: Lots of old radio & related books. Please contact Eugene Rippen, WB6SZS, www.muchstuff.com

FOR SALE: Tubes tested good globe 200A $8.50, 201A $14, 226 $8, 227 $9. Write or e-mail: tubes@qwest.net for price lists or see www.fathauer.com. Slightly weak tubes guaranteed to work in early radios 1/2 regular price. George H. Fathauer & Assoc., 123 N. Centennial Way, Ste. 105, Mesa, AZ 85201. 480-968-7686 or toll free 877-307-1414

SERVICE FOR SALE: Authorized repairs and sales of all types of amateur radio, communications, and test equipment. Please call Land Air Communications, 718-847-3090, visit our web site: www.landaircom.com. We have over 3,000 items in inventory and carry all types of communications parts.

BOOKS FOR SALE: Radio books, magazines, catalogs, manuals (copies), radios, hi-fi, parts. Send 2 stamp, LSASE. David Crowell, KA1EDP, 40 Briarwood Rd., North Scituate, RI 02857. ka1edp@juno.com

JOHNSON PARTS: New Ranger 1, Valiant 1, & Navigator plastic dials, freq numbers in green, with all the holes just like orig.-$17.50 ppd. Bruce Kryder, W4LWW, 277 Mallory Station Dr., Ste. 109, Franklin, TN 37067. b.kpvt@provisiontools.com

FOR SALE: FT243 CRYSTALS: 1885, 1915, 1925, 1945, 1985, 3870, 3875, 3880, 3885, 3890, 7143, 7280, 7285, 7290, 7293 kHz, more. Contact af4k@hotmail.com or send SASE to Brian Carling, AF4K, 117 Sterling Pine Street, Sanford, FL 32773 or call 407-323-4178 http://www.af4k.com/crystals.htm

ACCESSORIES FOR SALE: Spun Aluminum Knob Inlays for most Boatanchors. Collins Dial Drum Overlays. Dakaware Knobs. Charlie Talbott, 13192

Pinnacle Lane, Leesburg VA 20176-6146. 540-822-5643, k3ich@arrl.net

ACCESSORIES FOR SALE: KWM2/S-line metal logo pins. Meatball or winged. Excellent replica of the original. Put one on your hat, badge, or replace a missing logo on your panel, $6.25 shipped. W6ZZ, 1362 Via Rancho Pkwy, Escondido, CA 92029. 760-747-8710, w6zz@cox.net

FOR SALE: Vintage electronics at Alameda Antique Mall, 9837 Alameda Genoa in Houston. Visit www.RadioWorld-OnLine.com Carl Blomstran, POB 890473, Houston, TX 77289

PLANS FOR SALE: Build your own "Midget" bug replication by KØYQX, ca 1918, featured by K4TWJ in CQ Magazine, May '98. 10 detailed blueprints. FAX: 507-345-8626 or mobeng@hickorytech.net

ACCESSORY FOR SALE: RIT for Collins KWM-2/2A; No modifications needed. $79.95 SASE for details. John Webb, W1ETC, Box 747, Amherst NH 03031 w1etc@adelphia.net

PARTS FOR SALE: Aluminum heat dissipating plate and grid connectors for all 3, 4 and T series Eimac tubes including 3-500Z, 4-1000, 304T's and others. Alan Price, fixer7526@wmconnect.com

WANTED: Morrow Receiver and/or Morrow Transmitter and /or Morrow AC Power Supply. Contact Pat, W1DLW, at Boopat@gis.net

TREASURES FROM THE CLOSET! Go to www.cjpworld.com/micromart to find some unique items many hams would lust for! Gus, WA, 360-699-0038 gus@wa-net.com

SERVICE FOR SALE: I build hot-rod receivers: R-390A, SP-600, R-388/51J. NC-183D and transmitters: Valiant, DX-100, T-4X-A-B, HT-32, AF-67. 51J-4 filter replacements, R390A Hi-fi AM $245.00 ea. Chuck Felton, KDØZS, Wyoming, 307-634-5858, feltondesign@yahoo.com

WANTED: R-392 receiver to go with my T-195 xmtr. Also S-meter for SX-28 rcvr. Jimmy Weaver, KB5WLB, 1007 E Bridges, Wynn, AR 72396 870-238-8328

WANTED: Drake 2NT Transmitter. Call William at 507-835-8127 or email vendors@mchsi.com

WANTED: Any complete, unmodified, operational Hallicrafters HT series linear. Prefer HT33B. Carl, w3brx@aol.com 717-852-3223

WANTED: DX-100 complete or parts rig for restoration. Chuck Milton, W4MIL, 58 Barrington Dr., Palm Coast, FL 32137 386-446-8571

WANTED: Dead or Alive! Harvey Wells APS-90 power supply for T-90 transmitter. K1MD, Richard San Antonio, san.antonio@cox.net or 401-732-4026

WANTED-1953 callbook. FOR SALE: Spectronics Digital Display DD-1, w/cable $30, as-is. Sam, W5WAX, 918-683-2370 or k5sw@sbcglobal.net

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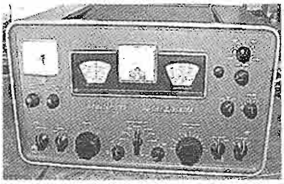

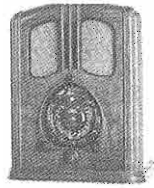

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WANTED: Pilot TV-37, 3" TV. Please call or write Dave Ishmael, WA6VVL, 2222 Sycamore Ave., Tustin, CA, 92780 714-573-0901 daveishmael@cox.net

WANTED: National 1-10 or 1-10A RF section, or complete parts unit. Ivan, WA6SWA, 703-237-9511, ihxxv@cox.net

WANTED: Hallicrafters SX-117 rcvr, restorable or parts unit. Still need bias and filament xfmr for HT32, A or B model. John, W8JKS, 740-998-4518

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Everett Hoard
PO Box 218
Lehr, ND 58460

Phone: 701-378-2341 FAX: 701-378-2551, email: frntcap@bektel.com

WANTED: Info/manual CU-1280/FRD (Sylvania). R. Sitz, 5210 14th St. W. #57, Bradenton, FL 34207

WANTED: QSL cards from Antarctic scientific, military and expedition stations. Also, any old magazine articles relating to ham radio activities in Antarctica. Harry Schools, K3HS, 2511 S. 20th St. #3, Philadelphia, PA 19145

WANTED: Used HF receivers of all types in very good to extra good condition. Jim, 43 Burnham St., Apt A2, Belmont, MA 02478

WANTED: Collins Service Bulletins for 651S-1 HF Receiver. Contact mmoss@mindspring.com

WANTED: National AN/FRR-24 receiver components and info. See http://www.virhistory.com/ham/frr24.htm Nick, KD4CPL, nick@3rdtech.com 919-929-4342 (NC)

WANTED: Someone with a collection of Short Wave Craft, Radio Craft from the 1930s to collaborate on a series of articles

on a substantial collection of original items from that time period. Please call Chuck, WØIUH, 320-277-3242

WANTED: James Millen plug in oscillator coils for Millen 90881 linear amplifier, Millen parts #s 43011, 43015, 43021, 43041 and 43081. Gary K2PVC; gschonwald @earthlink.net 917-359-8826

WANTED: Technical Materiel Corp (TMC) power supplies PS4 (low voltage and bias) and PS5 (high voltage) for the TMC PAL 1K kilowatt linear amplifier, also known as the RFD or RFA. Gary K2PVC; gschonwald@earthlink.net 917-359-8826

WANTED: Squires-Sanders SS-1R and SS-1V. Bob, WØYVA. 703-450-7049; robert@isquare.com

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WANTED: Hallicrafters HT33 with salvageable power supply. The RF section is not required to be useable, need a power supply to contribute to one that is. Gary Schonwald K2PVC. gschonwald@earthlink.net phone: 917-359-8826

WANTED: Technical Materiel Corp rack mounted antenna tuner and RF /SWR meters to be used with the 350-watt or 1000-watt TMC linear amplifiers. Will consider other TMC transmitting equipment and accessories for collection and on-air use. Gary Schonwald K2PVC. gschonwald@earthlink.net phone: 917-359-8826

WANTED: Meter movement for Western Electric transconductance tube tester KS-15750. Walter Hughes, WB4FPD, 6 Academy Ct., Berryville, VA 22611 540-955-2635

WANTED: Vacuum Tubes: 279A, 212E, 249B, 258B, 271A, 242A, C120, C100A, 804, RK20, CK70, GL805, C201, ZB-120, 802. Components for rebuilding Collins 30J RF output deck, including Cardwell or equivalent dual section variable 440 pF and 240 pF capacitors. Components for Collins 12H /12N speech input console, including preamplifiers and program amplifiers. Rod, W5CZ, 303-324-2725, rodperala@aol.com

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WANTED: Will buy SP-600 and some other Hammarlund equipment, working, not, or incomplete. Al, W8UT, anchor@ec.rr.com 252-636-0837

WANTED: Pearce-Simpson manual/ schematics for VHF marine radio, model "Catalina", JR Linden, K7PUR, PO Box 4927, Cave Creek, AZ 85327, jrlinden@usa.net

WANTED: Clean National Select-O-Ject, NC-183DTS and Heath VX-1. Contact Ric at c6ani@arrl.net.

WANTED: Early QSL cards from my Grandfather, Hal Smith (SK). His calls were KH6KA, K6YJR, K6OQE. Gladly reimburse postage plus modest finder's fee! Phil Wilson, 1355 Big Otter Dr, Blue Ridge, VA 24064 k6cra@arrl.net

WANTED: National NTE-30 Transmitter. Any condition, any price! I love National. Sylvia Thompson, n1vj@hotmail.com 33 Lawton Foster Rd., Hopkinton, RI 02833. 401-377-4912.

WANTED: One of my "KN8GCC" QSLs from the mid-1950s. Tom Root, 1508 Henry Court, Flushing, MI 48433, wb8uuj@arrl.net 810-659-5404.

WANTED: Any TMC equipment or manuals, what have you? Will buy or trade. Brent Bailey,109 Belcourt Dr., Greenwood, SC.29649, 864-227-6292, brentw2@earthlink.net

WANTED: Seeking unbuilt Heathkits, Knight kits. Gene Peroni, POB 7164, St. Davids, PA 19087. 215-806-2005

WANTED: PRESS WIRELESS, NY: Photos, information wanted on Hicksville, Baldwin, Little Neck, Centereach, Northville facilities. George Flanagan, 42 Cygnet Dr., Smithtown, NY 11787 w2krm@optonline.net 631-360-9011

WANTED: Postcards of old wireless stations; QSL cards showing pre-WWII ham shacks/equip. George, W2KRM, NY, 631-360-9011, w2krm@optonline.net

WANTED: Top prices paid for globe shape radio tubes, new or used. Send for buy list or send your list for offers. Write or e-mail: tubes@qwest.net. See www.fathauer.com or send for catalog of tubes for sale. George H. Fathauer & Assoc., 123 N. Centennial Way, Ste 105, Mesa AZ 85201. 480-968-7686, Call toll free 877-307-1414

WANTED: Manuals, manuals, and manuals for radio-related equipment to buy or swap. Catalog available. Pete Markavage, WA2CWA, 27 Walling St., Sayreville, NJ 08872. 732-238-8964

WANTED: Searching for RME CT-100 or 3R9 xmtrs and info about them. David Edsall, W1TDD, 156 Sunset Ave., Amherst, MA 01002. 413-549-0349, dedsall@crocker.com

WANTED: WW II German, Japanese, Italian, French equipment, tubes, manuals and parts. Bob Graham, 2105 NW 3Oth, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

WANTED: QSL card from W9QLY, Frank (Mac) Maruna, from 1956 or before. WILL PAY TOP DOLLAR. Don Barsema, KC8WBM, 1458 Byron SE, Grand Rapids, MI 49506, 616-451-9874

WANTED: Top dollar paid for WWII radios, PRC-1, PRC-5, AR-11, SSTR-1, SSTR-5, British B2, need pts for PRS-1 mine detector. Steve Bartkowski, 708-863-3090

WANTED: TCS & TBY Navy radios. Ken Kolthoff, K8AXH, PO Box 215, Craig, MO 64437. 913-634-3863.

WANTED: ARC-5 rcvrs, racks, dynamotors. Jim Hebert, 900 N. San Marcos Dr. Lot 77, Apache Junction, AZ 85220

WANTED: Front panel for Kenwood VFO-230. KH7TU, Ken Thomas, PO Box 4003, Lihue, HI, 96766, 808-647-0645, captdale2@hotmail.com

WANTED: Harvey-Wells Odds-'N-Ends: Speakers, phones, mikes, manuals, supplies, prototypes, military, aircraft. Kelley, W8GFG, 219-365-4730, 9010 Marquette St., St. John, IN 46373

WANTED: Collins R-389 LF receivers, parts, documentation, anecdotes, antidotes. W5OR Don Reaves, PO Box 241455, Little Rock AR, 72223 501-868-1287, w5or@militaryradio.com or www.r-389.com

WANTED: Incarcerated ham seeks correspondence. w/others on mil (R-390's &backpacks) & tube radios. Also copies of postwar-90's surplus catalogs, backpack specs & photos. W.K. Smith, 44684-083, FCI Cumberland Unit A-1, POB 1000, Cumberland, MD 21501.

WANTED: Receivers. Telefunken E1800, Rohde Schwarz, EK-56/4, NC-400, Racal 3712, Hallicrafters SX 88, Collins HF8054A, Collins 851S-1. Manual for Racal R2174B(P)URR 310-812-0188(w) alan.royce@ngc.com

I NEED INFO!: Radiomarine T-408/URT-12/USCG/1955. Sam, KF4TXQ, PO Box 161. Dadeville, AL 36853-0161 stimber@lakemartin.net 256-825-7305

WANTED: Scott Special Communications rcvr. EA4JL, please call Kurt Keller, CT, 203-431-6850, kkeller1@comcast.net

WANTED: SCR-602 components, BC-1083, BC-1084 displays, and APS-4 components. Carl Bloom, 714-639-1679

WANTED: Western Electric horns, speakers, amps, and mics. Barry Nadel, POB 29303, San Francisco, CA 94129 museumofsound@earthlink.net

WANTED: Tektronix memorabilia & promotional literature or catalogs from 1946-1980. James True, N5ARW, POB 820, Hot Springs, AR 71902. 501-318-1844, Fax 623-8783 www.boatanchor.com

WANTED: Collins promotional literature, catalogs and manuals for the period 1933-1993. Jim Stitzinger, WA3CEX, 23800 Via Irana, Valencia, CA 91355. 661-259-2011. FAX: 661-259-3830 jstitz@pacbell.net

WANTED: Will pay your price for National HRO M doghouse power supply type 697. Also HRO coil D w/bandspread. Carl Carter, Apt 405A Bahama Dr., Norwood MA 02062 781-762-9122

WANTED: Westinghouse SSB Transmitters MW-3 (Exciter, Amplifier, Power Supply). Also, MW-2 (AM). Will pickup anywhere. Gary, WA4ODY, Seabrook, TX 77586, 281-291-7701 myctpab@earthlink.net

DONATIONS WANTED: Southern Appalachian Radio Museum, Asheville, NC, where others can view your radio treasures. For general information or donations call Clinton Gorman, Curator, 828-299-1276

WANTED: Need test set I-135 "G" or "F" will trade WWII I-135 "E" or will purchase, also have BC-611 to trade. Steve Bartkowski, 1-708-430-5080, 7702 Austin Ave, Burkank, IL 60459

WANTED: Power transformer w/175VAC winding, and at least 50mA capacity. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

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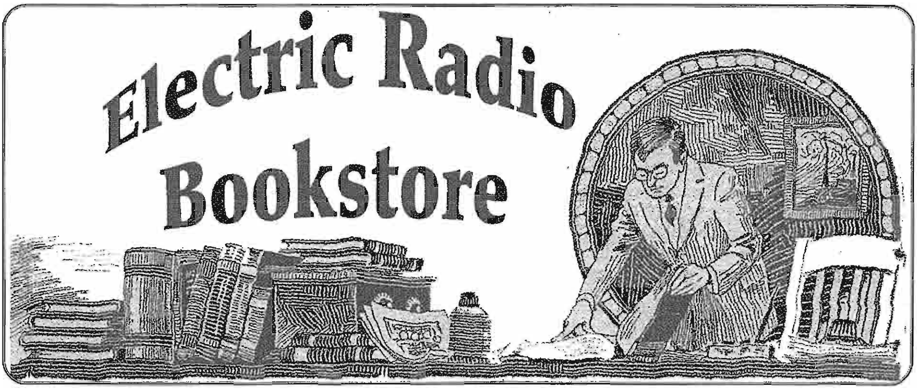

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