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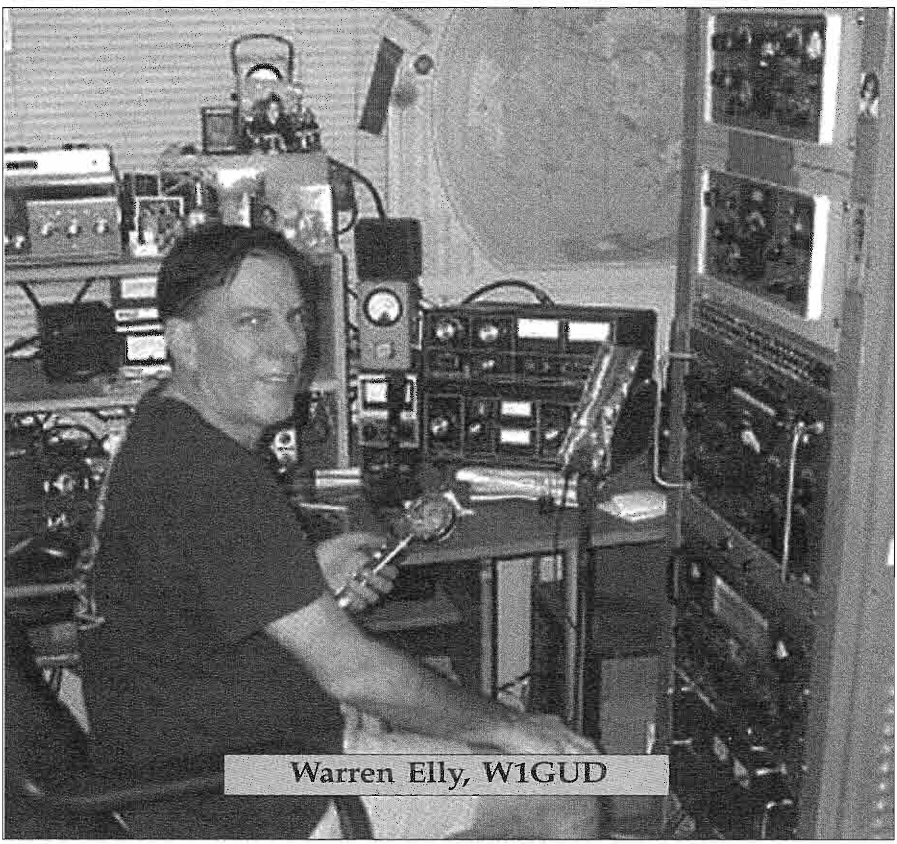
ELECTRIC RADIO

celebrating a bygone era

Number 192 May 2005



ELECTRIC RADIO

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Electric Radio is dedicated to the generations of radio amateurs, experimenters, and engineers who have preceeded us, without whom many features of life, now taken for granted, would not be possible. 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.

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:
Bob Dennison (W2HBE), Chuck Teeters (W4MEW), Jim Hanlon (W8KGI), Tom Marcellino (W3BYM), Bruce Vaughan (NR5Q), Bob Grinder (K7AK), Bill Feldman (N6PY), Dale Gagnon (KW1I), John Hruza (KBØOKU), Brian Harris (WA5UEK), Hal Guretzky (K6DPZ)

Editor's Comments

Vintage Field Day

Once again, it is almost time for the Electric Radio Vintage Field Day. It will be held the first weekend in June, as in the past. I would like to plan on starting at 8:00AM Pacific time (11:00 Eastern), and ending Sunday noon at 12:00PM, Pacific time, or 3:00 PM Eastern. Work as many stations as possible, send me your photos and stories and I will run them in a special photo section later this year. I am planning to operate the Mighty Elmac from a high mountain pass if the snowpack permits the roads to be open that early.

Electric Radio Photo Contest

As I mentioned last month, I am starting an annual Electric Radio vintage photo contest. The contest will run from May 31st to August 31st, so there will be plenty of time for everyone to enter their photos. I will announce the winner in the September 2005 issue.

There are three categories: 1) Best overall vintage station photograph, 2) Best commercially-made vintage equipment, and 3) Best homebrew equipment. The winner in each category gets a 1-year extention on an Electric Radio subscription, or a new subscription of the winner is not a subscriber. The winning photo in each category should be a sharp, attractive, creative photo, well composed with good color balance and adequate shadow detail. They can be made with a digital camera or from a conventional film camera. You may email or send your photos through the US mail. If you email photos, please limit the file size to 1 Meg per message to increase the chances that I will receive them. The email address inside the rear cover is the right one to use. If you mail the photographs, please mark the package "Photos, Do Not Bend" or they might be damaged in transit. Photos of operators using their equipment will probably add to the overall appeal of the photos, but this is not a requirement.

I won't be judging the photos on the rarity of the equipment in the photos, but on how nice of a picture it is. Hopefully, enough photos will be submitted so I can

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Restoring an NC-101X

By Jim Hanlon, W8KGI
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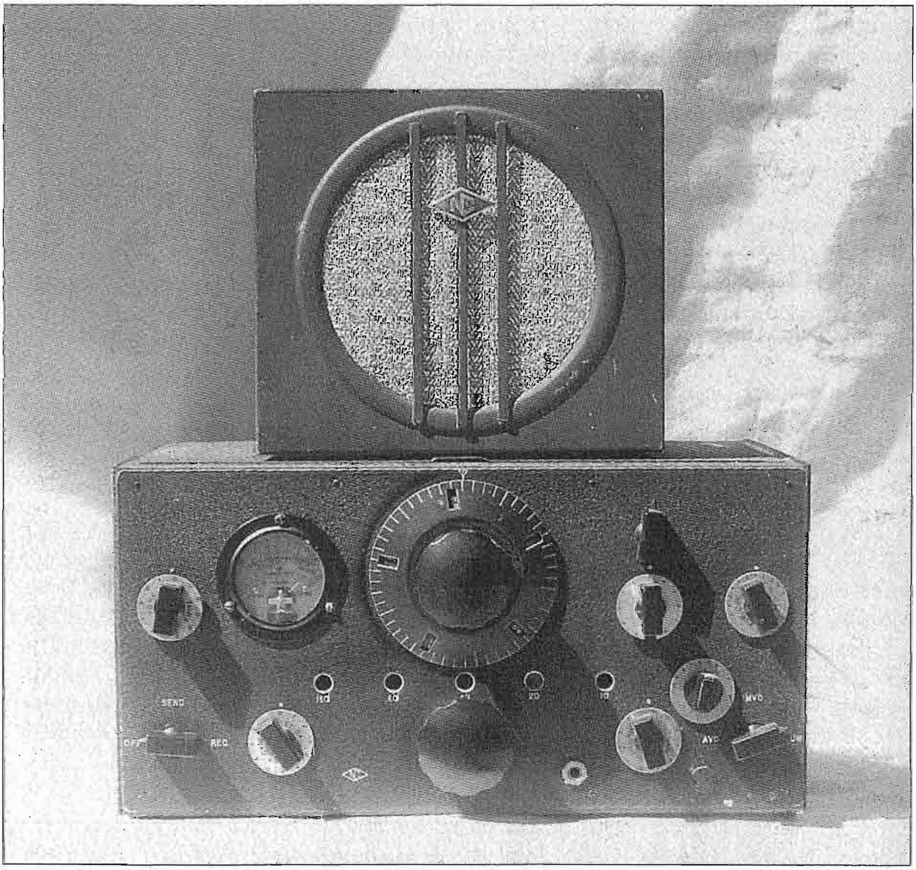
w8kgi@arrl.net

The NC-101X is the Ham-band only member of the NC-100 receiver family[1]. The NC-100 was developed by National in 1935. It is a sliding-coil-bandswitched receiver with one RF amplifier, two IF amplifiers, push-pull 6F6's delivering 10 watts of audio, a built-in power supply, and in the NC-100X version a crystal filter. The original NC-100 is a general coverage set covering from 540 kc to 30 mc in five ranges. It offers no bandspread other than the 20:1 mechanical gear reduction afforded by its National NPW dial. In 1936, the engineers at National made a "special" version of the NC-100X that covered just the five HF amateur bands from 160 to 10 meters for their boss, Jim Millen. While it started as a one-of-a-kind special for the boss, when word got around the amateur community about it, quite a few of the guys wanted one too. National announced



The restored NC-101X plus a vintage speaker found at last summer's Albuquerque, NM Hamfest.

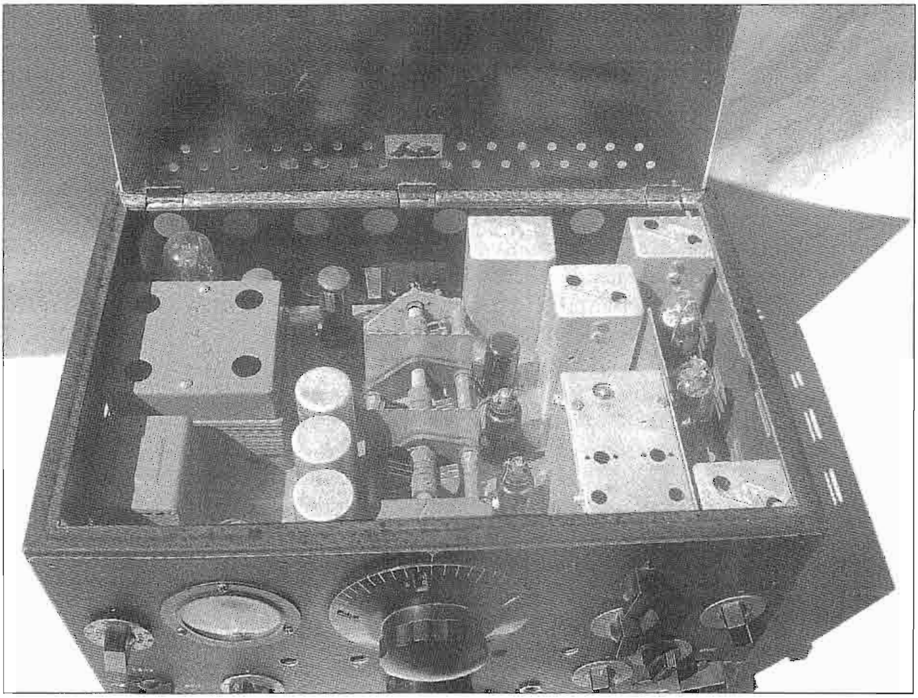
the availability of a limited quantity of this "special" in their one-page ad in the December, 1936 QST, and it was so well received that the NC-101X joined the NC-100 as a permanent member of the family.

The radio that is the subject of this article really needed me, and I'm glad that it found its way to my bench and my shack. It had originally started off as a 1936 vintage NC-101X, probably the earlier model with a tuning-eye signal strength indicator and an inductor-based tone control. But, sometime probably in the early 50's it got a considerable workover. It's RF stage was changed from the original, double-ended 6K7 to a single-ended 6SK7, the tuning-eye tube was removed and replaced with a Hallicrafters S-meter, the first IF transformer and crystal filter were removed and replaced with a crystal lattice filter made from four FT-171 crystals, and the detector and ANL stages were completely rewired to use what appeared to be a dual triode of unknown type. When it came to me all but one of the tubes were gone, leaving me to do some educated guessing, especially about the areas that had been modified, and to make it even worse, several wires had become snagged in the coil catacomb contacts beneath the tuning capacitor, bending and threatening to break the fixed spring clips that make contact with the fingers that protrude from the moving coils. Many people would probably have consigned this set to "parts radio" status and sold it piecemeal on eBay. But, I had wanted an NC-101X for a long time and this was a good chance to recover one, so I decided to give it my best shot.

My friend, Doc, from Espanola, NM, was the donor of this radio. Doc brought me another NC-101X that was in much better shape to finish restoration on for him, and my NC-101X was the very generous "payment" for that job plus a little more alignment work on some other receivers. Another restorer had already replaced all of the old paper capacitors on Doc's receiver with disc ceramics, but he was unable to figure out what was going on in the second detector, AVC, noise limiter portion of the circuit. What puzzled him was that the 6C8G Detector/Noise Limiter socket was not wired per his diagram[2], and the grid clip and lead for that tube were completely missing. Also, the 6F8G first audio amplifier/AVC socket was miswired, and the grid clip lead was present, but it was too short to attach to the tall, glass octal 6F8G tube!

Doc's receiver, it turned out, was an earlier, 1938 model – the reason why it did not match the normally found schematic for the NC-100/101 receivers that represent the later production runs. Bill Fizette (W2DGB), the world's premier sliding coil National mechanic, and John Hurst (KU6X) kindly provided the schematics for the two earlier models that I needed. Doc's version, an apparent second-generation model, includes an S-meter rather than the tuning-eye tube of the original radios, but uses a 6C5 second detector in that 6C8G socket. That's the reason why there was no grid clip and lead. It has no first audio amplifier or noise limiter, and it uses a shorter 6J7 AVC tube in that 6F8G socket, the reason why that grid clip lead was too short. Once I figured that out, I was able to supply the correct tubes to Doc's radio and to do a normal alignment job on it. The only persistent oddity about Doc's receiver was that the second IF stage insisted upon oscillating with the RF gain control full open. Try as I might, I could not find the source of the feedback loop that was causing the oscillation. So I finally just used a brute-force solution, inserting an additional couple hundred ohms of cathode resistance in that stage to "cool it down" so that it would not oscillate.

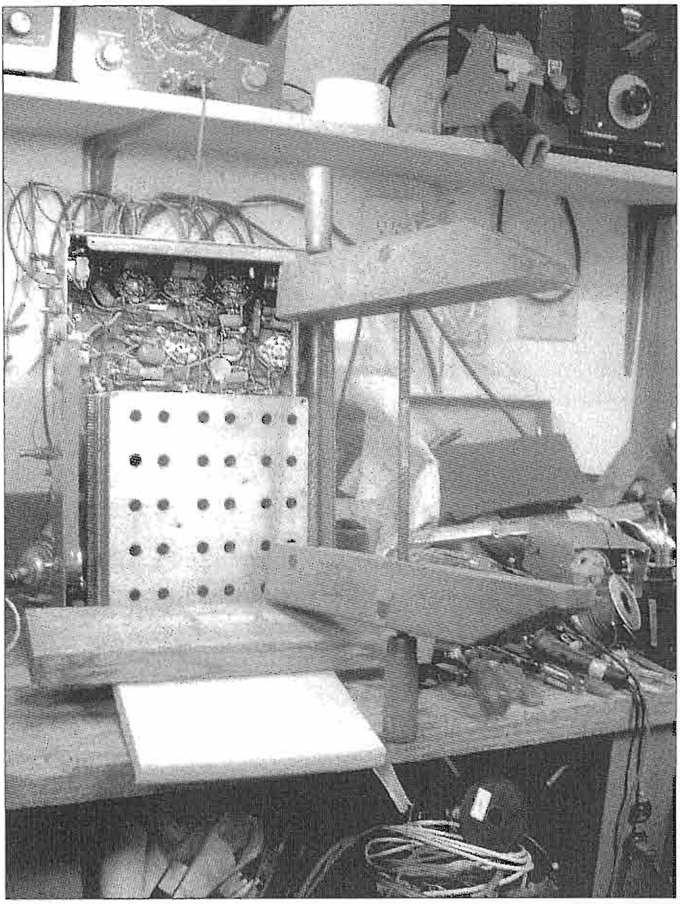
With Doc's radio working, it was time to go on to my own set. The first thing I decided to do was to see if I could un-



A top-side look inside the NC-101X. The HRO-50 crystal filter is on the right in front.

tangle the wires caught under the coil catacomb and save the spring clips. That necessitated a job that most NC-100 mechanics would prefer to avoid, the removal of the coil catacomb from the receiver. (Bill Orr, W6SAI, once said of putting the coil catacomb back into his NC-240 that he spent four or five hours doing it and that it was sort of like putting catsup back into the bottle.) I followed Bill Fizette's advice for the maneuver. First, I removed the front-panel knob that drives the coil catacomb position and then loosened the gear and shaft associated with that knob as much as possible. I also removed the white metal tab from the coil catacomb that serves as a band-marker. As Bill had warned, there was still not enough clearance between the gear-and-shaft and the catacomb to swing the catacomb up from the chassis, so I had to spread the chassis apart a little front-to-back to make clearance. Fortunately, I have several old Jorgensen wood-working clamps that can push two parallel surfaces apart when needed, so I used one of them to do the job. The coil catacomb was then free to swing up and away from the spring clips, rotating on the shiny metal rod that it usually rides on in the back of the chassis. To get it the rest of the way out, I used the Jorgensen clamp again to spread the receiver chassis sideways so that it would release the rod, usually captured and screwed in between two dimples in the sides of the chassis. That maneuver was also successful, and I then had the coil catacomb completely out of the chassis and the entire chassis wiring and the center, spring clip area exposed and available for work.

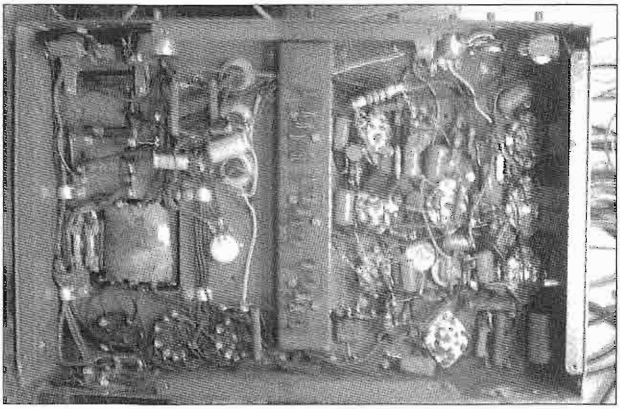
Several of the coil clips were indeed bent, but the metal was not fractured so I was luckily able to bend them back into their original positions. All would not be



Above: The NC-101X chassis on the bench with a Jorgensen clamp spreading it sideways.

lost even if they were broken, however. Many years ago, I acquired an NC-200, the 1940 successor to the NC-100 family, and it did have a broken spring finger. I soldered the broken finger back into place, backed it with a small piece of sheet brass where the fracture had occurred, and that NC-200 is still working well in my shack. So, if you have an NC-100 family receiver with a broken clip, do not give up and junk it. Try a soldered repair, it may well work.

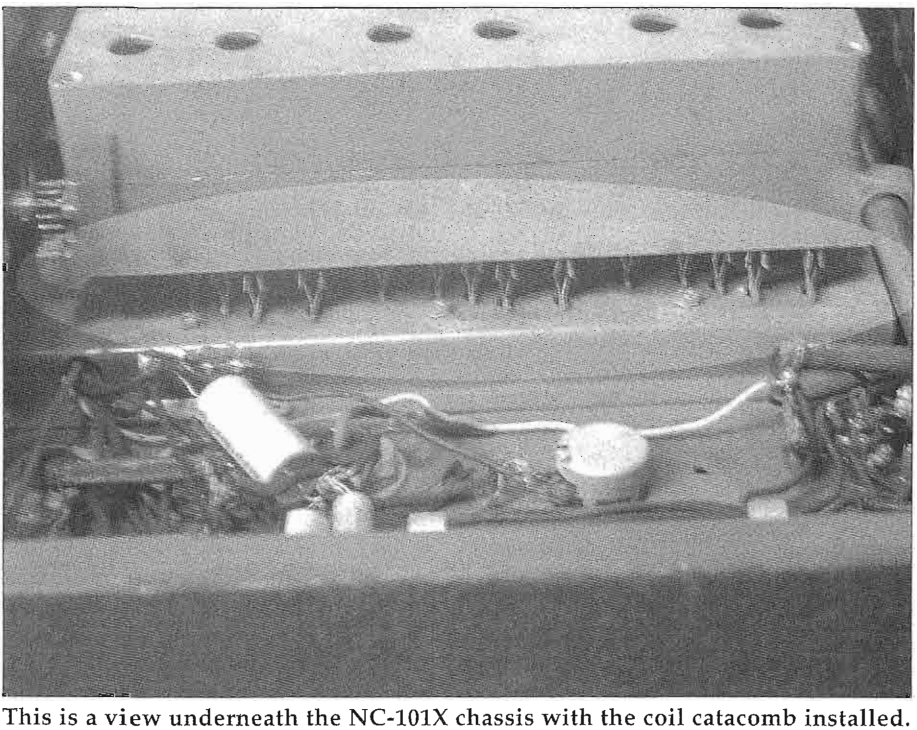
With the coil clips now functional, I knew I could return this receiver to working condition. So, I next set out to draw a schematic for what was there so that I could figure out what changes had been made. As I mentioned above, I soon found out that the RF amplifier had been changed from a 6K7 to a tube with an 8N socket pin out. That, plus the values of the screen and cathode resistors, pointed to a 6SK7 substitution. Since it was not a bad choice and it had probably been functional for a long time, I decided to keep that modification rather than to change back to the original tube. The mixer and local oscillator were wired pretty much per the late-vintage schematic for the original 6J7's, but there was an RFC isolating the local oscillator from the B+ line rather than the original 2k ohm resistor. The IF stages were again pretty close to the schematic, except for the screen voltage feed to the second IF and for that darned lattice filter. Instead of the original National crystal filter transformer between the mixer plate and the first IF grid, there were two smaller replacement IF transformers with the four-crystal lattice network. The crystals were wired together and shoved into a piece of Styrofoam, all held together with friction tape, hanging by its leads between them. That may have been great for SSB reception in the early 50s, but I wanted an original, AM phone/CW NC-101X from the 1930s, so that entire assembly was going to have to



Above: Under the NC-101X chassis with the coil catacomb removed.

go!

The circuit from the second detector out to the push-pull 6F6 audio amplifier input was something of a mess! The first thing I noticed was an extra tube, a miniature 6C4, that had been mounted on an L-bracket under the chassis and that was wired as a first-audio stage. An extra pot had also been installed in the front panel between and above the audio-gain control and the AVC/BFO switch, and there was an empty hole in the panel beneath that pot. Also, the tube socket that had originally held either the 6C5 first detector, if it was an early model receiver or a 6C8G detector/noise limiter if it was a later model, had been rewired to use some kind of dual triode whose filaments came out on pins 7 and 8. I made up my mind just to tear out the 6C4 and whatever else was there and to rewire that entire area of the receiver per the 1939 version schematic, using the extra pot as the noise limiter control.



This is a view underneath the NC-101X chassis with the coil catacomb installed. The spring contacts for the sliding coils are shown in the highlighted area.

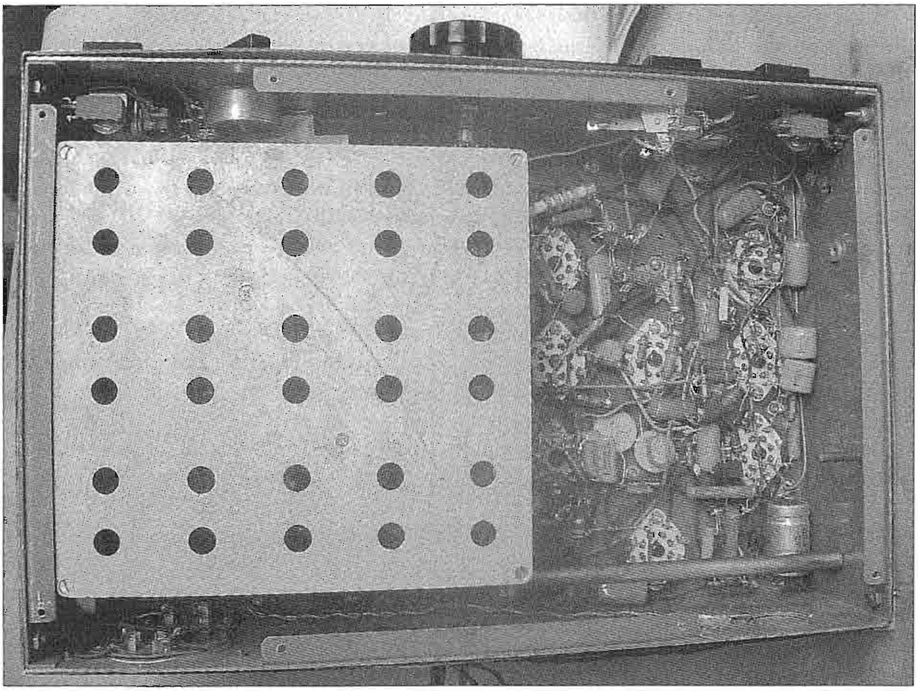
With that decision made, the rest of the restoration was a lot of hard but straightforward work. I checked a few of the original paper capacitors and found them all to be leaky, so I just replaced them all with mostly orange-drop capacitors because that's what I had on hand. I found plenty of room under the chassis on the power supply end for a couple of modern, electrolytic capacitors – so much smaller than the original 1930's cans. I had decided initially to leave out the input capacitor on the power supply filter, turning it into a choke-input filter and lowering the B+ a bit to make life easier on those 70-year-old parts, but I eventually realized that was a bad idea. While I was testing the B+ switch which is in the hot side of the B+ line between the rectifier filament and the filter input, I noticed a flash showing through the phenolic insulation side of the switch when I turned the B+ off! Then I realized that I was trying to change the current in the first filter choke from a finite value to zero, and as we all know, inductors will resist an instantaneous change in current through them by developing a voltage across themselves as high as necessary to break something down and keep the current flowing! In this case, it was arcing over the switch contacts. So, I compromised and installed a 2-microfarad filter capacitor from my junk box at the input to the filter. That didn't up the voltage very much and it also stopped the switch from arcing.

The original NC-100 family receivers used the field coil in their electrodynamic speakers as the second choke in their power supplies. The only speaker I had was a permanent magnet type, so I mounted an extra choke out in the speaker cabinet along with an output transformer appropriate for matching the pair of 6F6's in the receiver to the speaker voice coil. Bill Fizette recommends putting whatever resistance may be necessary in series with that choke to bring the total resistance up to the 500 ohms of the original speaker's field coil – something I did not do because I had already lowered the power supply voltage by going light on the filter input capacitor. But, keep Bill's suggestion in mind if you are working on an NC-100 in that area. I acquired my output transformer, a nice husky 10-watt job, from Play Things of the Past[3]. He keeps a very nice selection of old audio transformers on hand, and I was able to find just what I needed at a very reasonable price.

You are probably wondering what I did to replace the crystal filter. Well, back around 1960, I took a very deep breath and replaced the crystal filter in my trusty HRO-50 with a couple of mechanical filters, one 2.1 kc wide for SSB and the other 300 cycles wide for CW. I also threw in an extra IF amplifier stage to make up for their loss and a tee-notch rejection circuit that I borrowed from the 75A-4. They work so well that I've kept them all these years, and of course I hung on to the HRO's crystal filter assembly as well. Wouldn't you know, the crystal filter assembly from the HRO-50 fit perfectly into the NC-101X! The shafts came out in exactly the right places on the front panel, and there were holes in the right places in the NC-101X chassis to accommodate the wires that came out the bottom and even for the mounting screws! Good old National didn't change a good design when they didn't have to. So, I was able to drop the HRO-50 filter right in place, and it is now happily working for me again in a slightly older receiver.

I filled that extra hole in the front panel with a "snap button hole plug" as Antique Electronic Supply calls them. I sprayed it with a little black-crackle paint before I installed it so that it would blend in with the rest of the panel. As you can see from the picture, it certainly is not the first thing that catches your eye when you look at the receiver.

Getting the coil catacomb back into the chassis was pretty much a reverse of

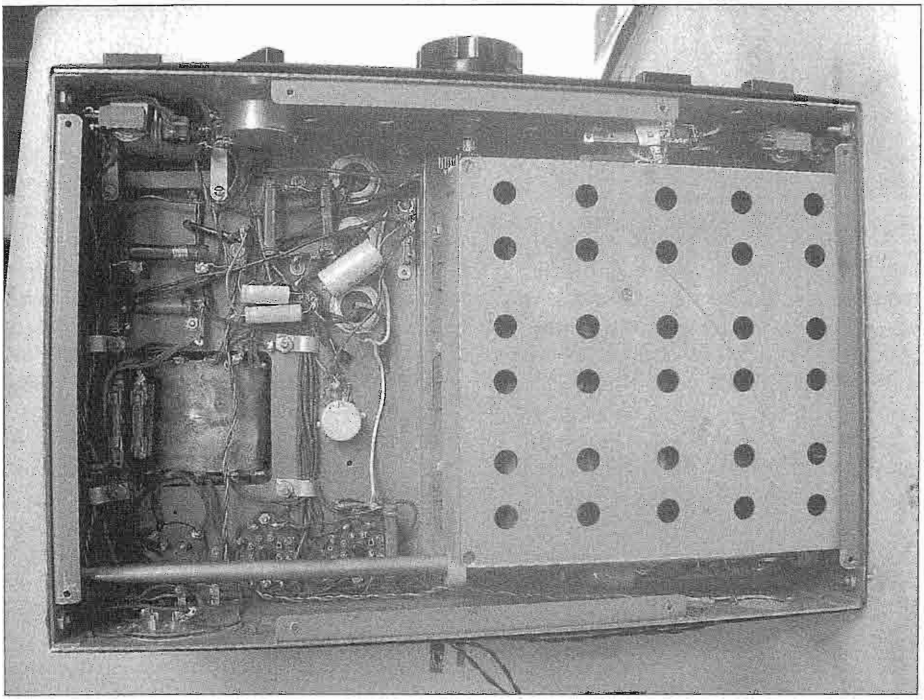


Under the chassis with the coil catacomb back in place. The RF/IF/detector section of the receiver wiring is exposed with the catacomb in this position. Moving it to the other side of the chassis exposes the power supply and audio output wiring, as is shown in the photo on page 9.

the way I took it out. As with many old sliding-coil Nationals, I found in this receiver that one of the grommets that go into the brackets on the coil catacomb and ride on the supporting metal rod had come out of its bracket hole and was clinging tightly to the rod. I made a lengthwise cut in the grommet and peeled it off the rod, then glued it back into the hole in the catacomb bracket using a very thin film of epoxy. I had a bit of trouble getting the rod to go through the grommet when I was putting things back together; so, brilliant engineer that I am, I put the rod in the XYL's freezer for a couple of hours thinking that it would shrink just a little and go through easier. Boy was I wrong! The grommet grabbed onto that cold rod and pulled right out of the hole again. So I cleaned it off, glued it in the hole again, and put just a little bit of fine machine oil on the now room-temperature rod. This time the rod easily slipped through the grommet and I was in business. I used the Jorgensen clamp to spread the chassis, first sideways to get the rod into place, and then front-to-back to swing the coil catacomb back into place.

It's easy to say that I just rewired the detector/AVC/noise limiter/first audio section per the schematic, but it was a little more difficult to accomplish it. Out of that experience, I would advise "Think twice, solder once," and also check your wiring the next day to make sure that you did it right. I made a couple of mistakes that I caught that way before I ruined something by applying the B+.

Once I got everything put together, the NC-101X submitted to alignment and worked just as well as Doc's receiver



The power supply parts are exposed when the coil assembly is moved to the other side of the chassis.

had, less the problem with the "hot" second IF stage. The HRO-50 crystal filter works as well as it ever did, and it reminds me of the days when I was using it to pull signals apart on the 80-meter novice band in 1952. Push-pull 6F6's are a bit of overkill for a Ham-band receiver that spends most of its time listening to 40 CW and driving a pair of headphones, but that's no worse than the push-pull 6V6's in the HRO-50 that I've lived with happily for the last 56 years. The NC-101X does have some significant warm-up drift, but if I turn it on a half-hour or so before I plan to use it, it's rock steady. I certainly enjoy having it in my shack, and I can see why Jim Millen and the other guys who owned one in the 1930s liked it too.

References:

[1] "The National NC-100 Receiver Family," Hanlon, ER #79, November 1995, p. 20.

[2] There are two manuals available at http://bama.sbc.edu/ and at http://bama.edebris.com/manuals/, the 1939 version with the noise limiter (both the "regular" model and the battery model with one 6F6 in the output), and the "early," 1936 version with the tuning eye. If there's anyone out there who needs a schematic for the 1938 version of the NC-100/101, the one with the S-meter but no noise limiter that is not currently available at BAMA, I would be happy to supply a copy of my copy via either e-mail or USPS mail.

[3] Play Things Of Past, Cleveland, Ohio; http://www.oldradioparts.com/, 216-251-3714.

ER

The Navy RBM and RBS Receivers

By Doran Platt, K3HVG
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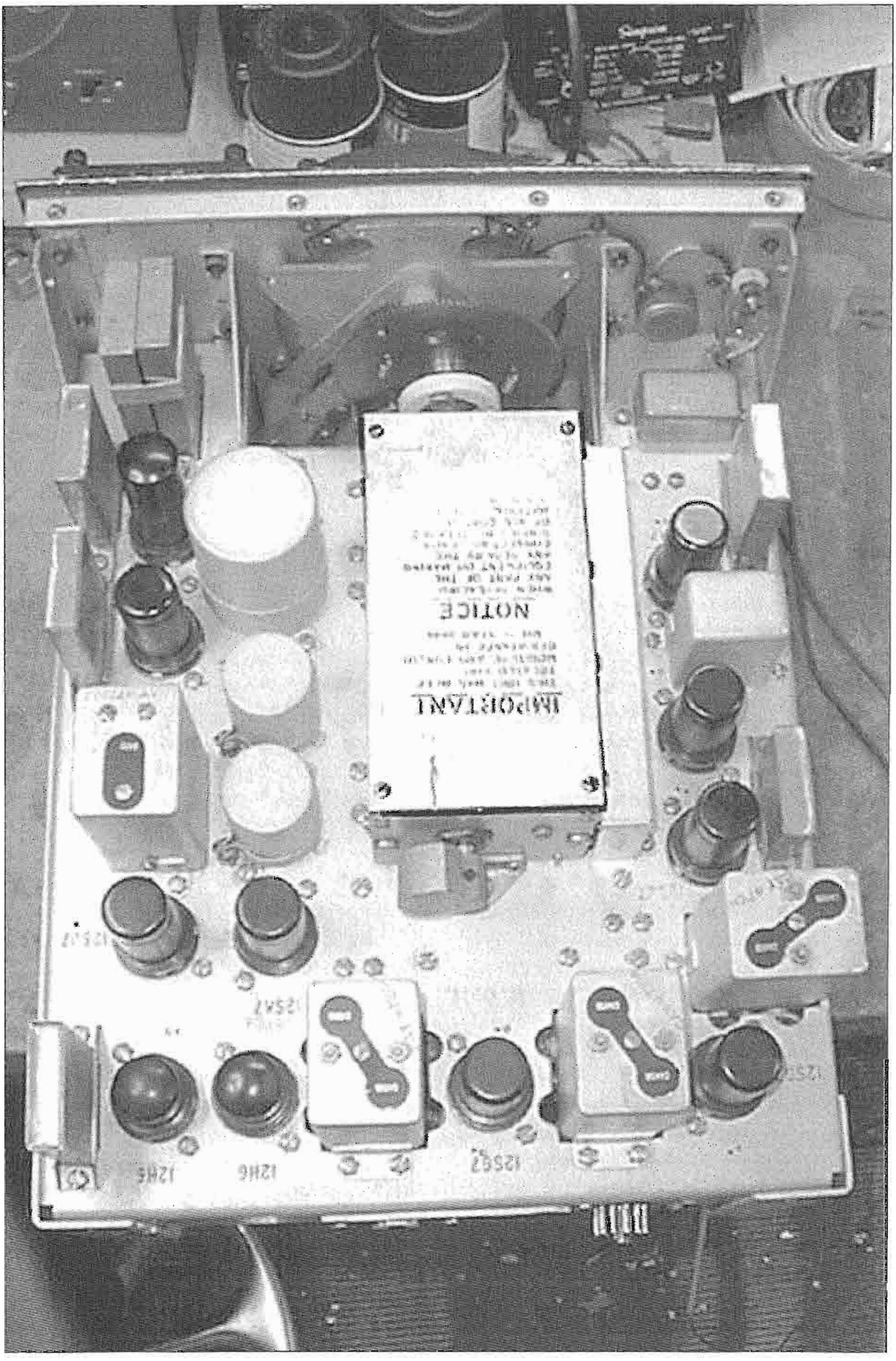
Monrovia, MD 21770

Although having been licensed in the late 50's, I didn't get into officially accumulating boatanchors until about 14 years ago. Back when I was first licensed, I don't recall that we referred to the equipment as boatanchors as most were front-line gear for us beginning hams. Collecting, for the most part, wasn't possible in that one had sell or trade in order to afford any new stuff. Thus exited my BC-610E, HT-20, TCS-12, and a myriad of other now-priceless gear for things new and shiny! Over the past few years, though, I had some success in locating lost treasures and discovering not a few new ones, too! Over the years I'd seen RBM and RBS receivers in pictures, once in a while at some ham's shack or aboard a museum ship, but never owned one until now. My first of these nice receivers was an RBS-1, bought locally, via eBay.

The U. S. Navy models RBM and RBS radio receivers are 4-band, single-conversion superhet receivers. RBS receivers were generally used aboard ship, with the RBMs used either as a portable receiver group or paired with a transmitter (typical a GO-9 or TBW) and, as appropriate, a gas generator, dynamotor, and/or batteries, all as part of a complete tactical communications system, ashore. The RBMs were generally fielded as a pair; one medium frequency receiver tuning 150 kHz to 2 MHz, and one high frequency receiver tuning 2 MHz to 20 MHz. RBS receivers appear to have been delivered only as a high-frequency receiver, a fact recently appreciated. The appropriate RBS-series manual supports this premise. Given that RBMs were/are

The RBM receiver with its mounting base attached and the new chart type.



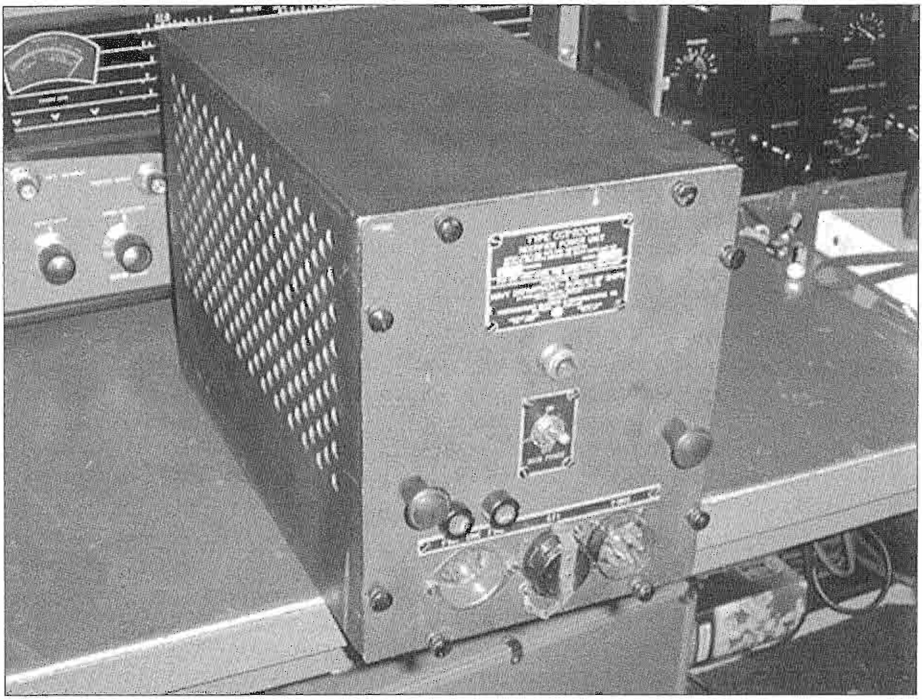
This is how a typical receiver top-chassis view looks.

all but identical to their ship-borne brethren, many receivers found their way into fixed, shipboard installations rather than as their original purpose would indicate. As mentioned elsewhere, the RBM was powered by an AC power supply, a dynamotor, and/or batteries. The RBS was supplied with a rather large, external, combination power supply and audio amplifier.

In perusing the manual on this equipment NAVSHIPS 900,385 (RBM), 900,324 (RBS) with supplements, and 91944 (RBS-3), one finds that these receivers were contracted for and delivered to the Navy, in part, from March 1939 to June 1945. RBS-3 equipment would have been delivered at the end of WW2 and during the immediate, post-war era. In the above manuals, field changes and modifications are inclusive up to 1948. Scuttlebutt has it that RBMs and RBSs were leaving the fleet by the mid to late 50's but, like the TCS, I'd suspect that more than a few were still around into the 60s![1]

The RBM,-1,-2, and -3 were designed by Westinghouse but subcontracted to, and built by, Stromberg-Carlson. The RBM-4 was built by both contractors, with the RBM-5 built by Westinghouse, alone. RBS, 1, and 2 series receivers were built by Stromberg-Carlson. The RBS-3 was manufactured by J&D Machine Products of Cleveland, Ohio. Although I have not been able to glean the actual cooperation between Stromberg-Carlson and Machine Products, there is a virtual sameness of receivers between all manufacturers. As with all Navy contract equipment, those carrying the Navy CAY designation are of Westinghouse manufacture, those with the CCT are from Stromberg-Carlson. I have not found the code for Machine Products...yet. Included at the end of this article are contract and reference number data that I've been able to glean from various sources. Although a joint venture by the above manufacturers, it is interesting to note the differences in manual styles. Manuals are complete and to Navy specifications, but reflect the accent of each. If your receiver is sans nomenclature tag, other than the tell-tale knobs, how do you know which receiver you have? Chassis component designations for the RBM receivers are designated 4xx, and RBS receivers are designated 5xx. Although the basic circuitry is virtually identical, there are minor differences in cosmetics and in ancillary circuitry between models. Some of these changes include suppression of radiation from the local oscillator, a change in capacitor type, changes to the output audio wiring, a dial lock in late receivers, and MFP applied to some receivers. Power connections to each receiver, and the operation thereof, are identical. Other differences are that early receivers had a flip-up, scrolling paper roll chart mounted to the front panel. The chart in later receivers was either a 2-screw flip-down or a 4-screw removable logging chart with multiple plastic cards. Another point of trivia is that RBMs with the older style roll chart do not have a Navy acceptance/in-service date tag affixed to the front panel, unlike later models. The most easily identifiably feature of RBS receivers are the telltale, engraved control knobs. The principal operating controls are engraved with an appropriate letter connoting their use; Tuning, Band, Gain, and Level. I've been told that some RBM/RBS receivers were shipyard modified in the early 50's with Type N antenna connectors to accommodate coaxial cable for further shielding. If you see one with an SO-239 on it, it's a Ham mod, for sure! If your receiver has a black control knob sub-panel and a factory-provided gray cabinet, you most likely have an RBS-3 receiver. Given these physical dissimilarities, it can become interesting when trying to assemble a "matched" pair of these receivers.

In acquiring documentation for your RBM or RBS receiver, you need to note that the RBM through RBM-4 receivers are virtually identical, schematically. If



This is the RBM-RBS AC power supply unit.

you have an RBM-5/RBS-1, 2, or 3 there are some additional filters, alluded to above, included in that latest of designs. The correct schematic, for each, is most helpful. And, yes... I have copies of all versions, if you need the information.

Unlike many other Navy receivers with their steel cabinets, the RBM and RBS receiver enclosures are fabricated of fairly light-weight aluminum, not unlike ARC-5 and other airborne equipment. Although conveniently removable, facilitating access to the tubes and a few alignment points, the top covers are, more often than not, found dented or deformed. All of the receivers in my collection, and in fact most all RBS/RBM receivers I've seen, have been (at least internally) in quite nice condition. One of my receivers indicates it was overhauled by the Boston Naval Shipyard in 1950. Alignment or other service requires removing the receiver chassis from the cabinet. The procedure for this removal is as follows: If your RBS receiver has come equipped with the table-top mounting plate and slides, you'll need to remove this prior to disassembly and removal of the chassis. After removing the plate (if so equipped), the top cover, and the 20-or-so 4/40 cabinet screws and washers, (but before attempting to slide out the chassis), it will be necessary reach inside the top of the cabinet and lift up the rear of the receiver (inside the cabinet) slightly, then slide out the chassis. This is required so that the rear shock-mounts clear of the bottom of the cabinet. The front edge of the cabinet is notched to accommodate the forward shock mounts and are, thus, not an issue in chassis removal.

I have acquired 4 RBS and RBM receivers, a couple of power supplies, and an RBM control box. Finding connectors for the receivers and accessory equipment has been a problem. Even Bill Perry has thus far been unable to locate some of the needed parts. If one cannot locate the proper original mating power plug for the receiver, the original connector can be easily removed and replaced with an octal plug, with no mechanical modification or damage to the chassis. I've had to resort to replacing the rear connector on each of mine. Be sure and keep the original for when you do locate the correct mating connector! In rendering each receiver operational, I've also had to do some sort of maintenance to each prior to applying power. Fortunately, the RBM and RBS receiver mechanical design makes this maintenance a pleasure, especially compared to some other military equipment. In both model receivers, there are several oil-filled capacitors. If they're leaking, they'll need replacement. Other capacitors (typically bathtubs) have not, so far, been problematic and I've not had to wholesale change them out. One subtle item in firing up the receiver is to ensure that a jumper is in place that loops the audio output pin back into the receiver for routing to the front-panel phone plug (see miscellaneous data). As delivered, it was expected that the audio would leave the receiver and, via switching and muting, be returned for local, front panel output. I have found that, although quite usable for phones, the audio level for a speaker (such as an LS-3) requires a bit of amplification. On two of my receivers, I found that I had to replace a couple of the RF/IF/LO tuning/alignment capacitors, owing to the fact that the swaged collars that hold the capacitor plates in tension had cracked, allowing the rotor to spring back and short out. (I understand that this also can be problematic in BC-312/342 receiver) Fortunately, none resulted in burned resistors, but either the receiver would be dead (as in the case of the LO trimmer), have poor sensitivity, or could not be aligned. These capacitors are located in enclosed aluminum boxes (or modules) much like the BC-312/342 receivers. These adjustments are visible, however,

This is the older RBM receiver with a flip-up style chart

and close inspection can reveal if the capacitor collar is damaged. The movable portion of the capacitor should be level with the outside collar. Removal of the boxes, and the offending capacitors, is not too difficult. The mechanical design has provided a convenient rotating lock for the rear end of the bandswitch shaft. One has to loosen the setscrews on the front shaft coupling, swing the rear shaft lock out of the way, and then slide the shaft out the back of the receiver via a hole in the rear of the chassis. Electrical connections have to be un-soldered from the offending box and the attaching hardware on the top of the chassis removed. While you have the box open, take the time and use DeOxit® on the switch wafers, as they can't be accessed at any other time.

Power supply requirement for filaments is 12.6 volts at about 2 amps. B+ voltage is anywhere from 190 to about 220 volts at about 70 ma. There's not much room inside to esthetically mount a power supply and no dynamotor to remove. The external power supplies supplied with either the RBM or RBS are designed to operate a single receiver, although both will power two of them if you push the issue. I only have one power supply for each two receivers, so I built a changeover switch so that I can select one receiver or the other via the system control box. One curious item that initially led me to believe that the RBM power supplies would hack two receivers was that inside the power supply there's a switch that selects one or two receivers. I thought that it might be a tap on the transformer, or something, but all it really does is to jumper the front panel power switch so that it can't be turned off, locally. Has it something to do with remote operation? If you locate an original RBS power supply, the included audio amplifier makes things quite convenient. A final observation on power supply considerations is that, although easy to do, there's no good reason to substitute 6-volt tubes for the 12 volters. Radio shack has a nice 12-volt filament transformer available and there isn't a direct sub for the 12A6 beam-power audio tube, although a 6V6 appears to work OK. If a change to 6 volts is contemplated, the series-string pilot lamps can be left, as is, or re-wired in parallel for better illumination. If you do decide to re-string the panel lamps, bypass the dimmer control inasmuch as its dissipation can be exceeded, above a certain setting. Again though, I'd advise leaving well enough, alone.

I won't bore anyone with a mundane explanation of the workings of a simple, single-conversion superhet receiver. I will, however, offer up some of the finer points of this receiver with respect to circuitry and operation. The antenna input is set up for a wire type antenna. Using a 50-ohm coaxial input will work, passably, but using a tuner or amplifier appears to help. The sensitivity charts in the book show an acceptable sensitivity of about 3-8µv. Not great, but OK for routine listening. I find that an Ameco PCL-type preamp really brings things up, and not just noise! The mode switch offers a few interesting points. The AVC position is for listening to fully AVC-controlled signals; AM, MCW and the like. In the MOD position, there is partial AVC and is used for MCW reception. In the CW position, the BFO is operative, with still a bit of AVC. This makes reception of SSB signals somewhat of an issue, but not impossible. Arriving at the proper balance of RF and audio gain settings for SSB makes post-receiver audio amplification virtually a necessity, unless using 'phones. The OL position is for Output Limiter. This is a CW mode whereby the audio output is leveled such that a sudden, very strong CW signal won't blast the operator's ears. Once set to a comfortable level, the audio output need not be readjusted.

The IF frequencies of the receivers are: 140 kHz for the medium frequency RBM receiver and 1255 kHz for both high frequency receivers. Selectivity is stated to be 10 kHz in the broad mode and about 5 kHz in the narrow mode. I've been using some surplus Icom IF filters in my TCS receivers, etc., but no good here owing to the non-standard IFs. An S-meter, of sorts, can be connected to the receivers via J-404 or J-504 on the rear panel of the receiver chassis. Normally jumpered, a micro-ammeter can be connected between the terminals for bench alignment or as an operational tuning aid, although note that the back of the cabinet does not have a hole to bring out any wiring. Finally, yes... one can even set the dial-light brilliance!

One modification I tried was to fully bypass the audio low-pass filter circuit between the 1st and 2nd audio stages of these receivers. It is said these filters attenuate all frequencies above 3500 Hz. I found that bypassing the aforementioned did nothing to improve neither the audio quality nor output level. One thing I have not done is to characterize all the resistors in these receivers. Mine all now appear to work well, so if they ain't broke, I don't care to fix 'em. I did check numerous capacitors, though. Virtually all the receivers I have are from the mid to late production and, hence, use bathtub-type capacitors[2]. These, so far, have mostly checked out just fine. As mentioned earlier, however, a few of the chassis mounted oil-filled caps have had to be replaced. I tried to see if I could gut the metal can and re-stuff them but had little success. I was able to seal the bottoms of the cans, though, and install replacement equivalents, unseen, under the chassis.

My RBS and RBM projects are just about complete. I guess all I really need now (not counting finding still needed connectors) is to tune around and try and find NSS sending out their CW broadcasts to the fleet!

[1] In 1966, aboard the USS Hammerberg (DE-1015) during the UNITAS VII cruise, I was shown a TCS-13 system in an emergency radio storage case. This ship was commissioned in 1955.

Miscellaneous Data

Navy Contract numbers and dates for RBM, 1, 2, 3, 4, 5 receiver equipment:

NOs-65690	March 16, 1939
NOs-72056	Feb. 26, 1940
NOs-95095	Dec. 8, 1941
NXs-4744	June 2, 1942
NXs-19329	Dec. 21, 1942
NXsr-38081	Sep 28, 1943
NXsr-51520	March 13, 1944

Navy Contract numbers and dates for RBS, 1, 2 equipment:

NXsr-12481	Aug. 27, 1942
NXsr-33641	June 30, 1943
NXsr-51559	March 4, 1944
N5sr-5940	June 2, 1945

Manufacturer's Part Numbers:

RBM,-1,2,3 Medium Frequency Receiver CCT-46076
RBM-4 Medium Frequency Receiver CCT/CAY-46076
RBM-5 Medium Frequency Receiver CAY-46076-A
RBM, -1,2,3 High Frequency Receiver CCT-46077
RBM-4 High Frequency Receiver CCT/CAY-46077
RBM-5 High Frequency Receiver CAY-46077-A
RBS High Frequency Receiver CCT-46217
RBS-1 High Frequency Receiver CCT-46217
RBS-2 High Frequency Receiver CCT-46217
RBS thru RBS-2 High Frequency Receiver w/ rack CCT-46217-A

Rear Panel Power Connections RBM-()and RBS-( ) Receivers:

40 Audio input to phone plug (jumper to 42)
42 Receiver audio out. (jumper to 40)
49 B+ +200v DC (nom.) @ .07 amps
50 12.6v AC/DC @ 2.0 amps
52 Gnd

[2] Documentation indicates that production changes included the introduction of bathtub type capacitors. RBM-1 and subsequent RBM models, and the RBS-series, all employ bathtubs, so one can assume that only very early, unnumbered RBM units, probably prior to 1941 production contracts, would be found to have the less than desirable types.

ER

Restoring the AN/GRC-26A Communications System, Part 3

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Three years is a long time to restore an old radio, but when I acquired an AN/GRC-26A communications shelter in August of 2001, I could never have guessed the twists and turns the project would take, and the delays I would encounter. But it has been lots of fun, and there is still more to do. I would like to thank everyone who sent e-mails and letters with advice and encouragement after the first 2 articles that appeared in ER issues 150 and 152. Unfortunately, my former computer crashed and I lost all of my e-mails, so if you sent me a message, I apologize if I cannot acknowledge it or include it in this article. At the same time, I would be grateful if anyone who sent me such helpful information would be kind enough to send it again so that I may put it on the website or incorporate it in future articles. For the last year the e-mail address has been dormant because of a tremendous amount of spam that started coming in, so please direct e-mail to ken44@nyc.rr.com. In addition, I have had to pull down the website temporarily, but it will be back soon.

In mid-2001, after reading in ER that Dale Gagnon (KW1I) had discovered what he called a "time capsule" from 1952, I was intrigued. I called Phil at Fair Radio Sales in Lima, Ohio and agreed on the phone to buy the beast. During a business trip cunningly devised to take me through Lima (my boss never missed me!), I inspected the shelter, and got it ready for transport to New Jersey. My first act of ownership was to remove the nameplates for safekeeping. I had bought a trailer over the phone several weeks earlier and arranged to have it delivered to Fair Radio that morning. I had arranged with the dealer to haul the trailer back to northern New Jersey, a trip we made in a day and a half, and we parked it at an outdoor self-storage facility in New Jersey.

As much as I wanted to plunge into the electronic restoration and repair, I first turned my attention to documenting the condition of the shelter, and to disassembling it prior to doing some necessary carpentry work on it. Shortly after I began work on the shelter, I found the vehicle that the Army would have used to haul it around: the 2½-ton GMC M211 truck. The mechanical and electronic restoration I faced was daunting enough. Did I dare take on the task of restoring a 50-year-old truck as well? I took the plunge and acquired the truck, and never looked back! My specific M211 truck, serial number 629, was delivered to the Army in August 1952, so it makes a perfect match to the AN/GRC-26A. So, I split my time between rebuilding the shelter and getting the truck up and running safely. Military vehicle restoration is a hobby in itself, even without the radio component, and there is a very large support network out there. So, although I approached the challenge with very little vehicle experience, things went smoothly, and I was always able to find the help I needed, plus a whole new group of friends. But it was a real challenge to set my priorities: should I lubricate the R-388 tuning mechanism, or install a new wiring harness in the cab of the truck? I had to put first things first, which meant acquiring a lot of vehicle experience in a hurry. As it turned out, I found the truck fun and fascinating in its own way, because it has an important characteristic in common with our beloved boatanchors: it was built in an era when the universe of available parts was smaller and more standardized, thus making it very easy to work on, and very enjoyable. And yes, a manual came with it. I will say more on the truck later.

The shelter was indeed a time capsule. Just about everything was just as it had been left in the early 1950's. Inside I found a new-in-the-box spare 250TH, new 2A3's, and lots of other spares, all packed over 50 years ago. MFP stamps showed the dates of the moisture-fungus proof varnish applications between late 1951 and late 1952. The MFP stamp on the BC-610H says December 1951. Among the items missing: the clock (no surprise there), the exhaust blower, electric heater, typewriter, Dietzgen tape measure, T-50 dynamic microphone (has anyone ever seen a T-50 in the flesh?), a special wrench to reach just one of the BC-610H mounting bolts, and the date-time stamp. On the topic of the date-time stamp: thankfully I have a picture of what the actual date-time impression looked like...some bored grunt idly stamped the cover of the BC-221 manual and there it sits. The MP-47A transmitting antenna base and MT-657 mount had been removed, perhaps by the Army to convert the shelter to semi-fixed operation, or simply by a treasure hunter. But all of the electronic equipment was still there: a pair of R-388's; the combination VFO/Frequency Shift Exciter O-39; the CV-182 Frequency Shift Converter with its drift correction feature; every one of the TTY machines; and of course, the BC-610H with BC-939 tuning unit and BC-614 speech amp. The parts list specifies a BC-221 frequency meter, and there is a little shelf for it (but no way to tie the unit down) right in front of the BC-610H. However, a mimeographed update to the bill of materials states that the BC-221 is eliminated in

My 1952 GMC M211 2½-ton Army truck has been authentically restored to carry the AN/GRC-21A equipment shelter.

the AN/GRC-26A inasmuch as the R-388's do such a good a job at determining frequency.

All of the electronic gear, except for the 2 Collins receivers, has nameplates showing Barker and Williamson as the supplier, including even the TT-55's, (otherwise known as Model 15's, made only by the Teletype Corporation, but labeled "Modified by Barker and Williamson). B&W even claims credit for the BC-610H. So we can assume that this particular AN/GRC-26A began its life in Bristol, Pennsylvania. The "York-Hoover Corporation" made the shelter structure itself on a contract dated 1950. (Could these be the same folks who made vacuum cleaners? Maybe so, considering that Lionel made J-36 semi-automatic keys). Most of the BC-610H tuning units were made, or at least assembled, by a company named Heath.

There was ample evidence of rain having entered the interior of the shelter, but damage to the radio gear was minimal. In part this is due to the liberal use of MFP varnish, and post-war construction design that included hermetically sealed transformers in the BC-610H and in most of the other gear. Mud wasp nests were everywhere, especially inside the equipment. The TTY mechanisms were fairly frozen with some rust and lots of solidified grease, but all was treatable.

The shelter itself was in poor condition and must have been tossed around quite a bit before and after its time with the Army, the right rear quarter showing the most damage. It didn't help to have the 401-pound BC-610 at that location. The roof above the transmitter had caved in partially, due to the heavy weight of the VFO/Frequency Shift Exciter O-39, located on the upper equipment shelf. At 110 pounds, it is the last unit you'd want to put at that location because the front edge of the shelf at that point hangs pretty much in mid-air, supported only by 4 rods that are secured to the wooden ceiling. In the early photos you can see how that end of the shelf is noticeably lower than the other end. The opposite end and the rear of the upper equipment shelf rest on 1-inch angle iron fastened to the walls. Two oak stiffeners running the length of the roof outside proved useless at spreading the weight of more than 250 pounds of gear on the upper shelf. The door was deformed, the window broken, and the plywood floor was almost completely rotted away. These shelters were notorious leakers; the roof was a layer of canvas on top of 1/4'" plywood. Over the years a layer (or layers) of tar had been applied in a vain attempt to keep the water out. But, like the radios themselves, the shelter was never intended to last 50 years, so all in all, we can say that it survived pretty well.

The AN/GRC26A shelter dates from 1952. The publication date of the manual, TM11-264A, is January 1953. The dates on the MFP stamps pinpoint the assembly to late 1952. The unit may have been in service into the 1960's: there was new nomenclature stenciled on one of the sides: AN/MRC-32. Two new-style National Stock Numbers (NSNs) were stenciled on the rear wall: 5306-00-186-9250 and 5306-00-186-2486.

Although the radio system itself is capable of AM and CW, the real emphasis is on the radioteletype function. It can run full duplex by using separate receive and transmit frequencies. The IF outputs of both R-388 receivers feed the CV-182 Frequency Shift Converter, so good diversity reception can be obtained when two sufficiently separated receiving dipoles are used. Because the RTTY demodulation takes place at the receiver IF frequency, the BC-610 can be modulated for AM, thus providing a simultaneous voice channel. If the system at the other end of the circuit is similarly equipped with IF demodulation, the outbound carrier can contain a voice signal as well. Thus two full duplex channels, one voice and one RTTY, are available. With the two Model 15/TT-55's, plus a Perforator-Transmitter and Tape Transmitter-Distributor (TD), all controlled by the C-808 Control unit, the operator can switch the keyboards and printers around. A small jack box is mounted to the rear of the operating bench, and provides two independent local loops powered by Rectifier RA-87for the TTY red and black plugs (receive and keyboard, respectively).

As to the antennas, there are mast sections and bases supplied for 3 receiving whips and one transmitting whip, enabling truly portable or in-motion operation. However, semi-fixed operation was also possible: 6 masts plus guys, 1000 feet of W-1 wire, and 1,075 feet of coax is supplied to construct as many as 2 receive dipoles separated by up to 950 feet, plus a single transmit dipole. Thoughtfully, a tape measure and a compass, both made by Dietzgen, were included in the tool kit to customize the dipole lengths and orient them. In addition to the RF capabilities, a TTY line-matching unit mounted on the wall can be connected to a twisted pair for wire communication with remote TTY units and networks. Also, a pair of EE-8 field phones sits in little racks just inside the door. (For "mobile-in-motion" use, the manual instructs operators to connect the EE-8's with a twisted pair line from inside the shelter to the cab of the truck.) Unlike the earlier SCR-399/499, no JB-70A junction box or equivalent is supplied. All system functions that were previously managed by that junction box such as receiver muting, keying control and break-in control are now handled by the C-808 Control unit, which the manual calls the "heart of the system". Other JB-70A functions, most notably Remote Start and Stop for the PE-95 gasoline generator, have also been eliminated. After my initial ER articles, I received a few e-mails from some who used the AN/GRC-26A in Germany during the cold war. They indicated that encryption gear had been installed, but it is hard to see where it would have fit. There is some blank panel space available in the receiver rack under the CV-182 Frequency Shift Converter and its associated power supply. (In the -D model, this space was occupied by a double exhaust blower, which simply moved hot air from inside the rack to inside the shelter.)

The overall system manual TM11-264A, is very detailed in listing all the spare parts and accessories. No Department of Defense $2,000 toilet seat procurements here. Just basic stuff from basic suppliers: Oil, Lubricating, 3 in 1; Pencil M-139 (1 dozen), Pencil, M-140 (2 dozen), Mucilage, 4 oz. Bottle (that funny LePage glue bottle with the rubber top, from grade school?), and don't overlook "Broom, flat, floor, sweeping; corn bristle; Sears part number 11F06606. Function of part: sweeps shelter." I also found a mimeographed bill of materials with even greater detail than the manual. For instance, of the two types of chairs supplied, one is described with a part number from McElroy. Was this the famous maker of Morse code training equipment? And could it be that, although they failed to get any other products included in the system, they were satisfied with selling a few chairs that they themselves never manufactured? Such was the procurement game in the 1950s I guess.

Finally, the system included a trailer-towed PE-95 gasoline powered generator rated at 10 KW, more than enough to supply the gross primary power requirement, which never exceeded 5,500 watts, including the 1,000 watt electric space heater.

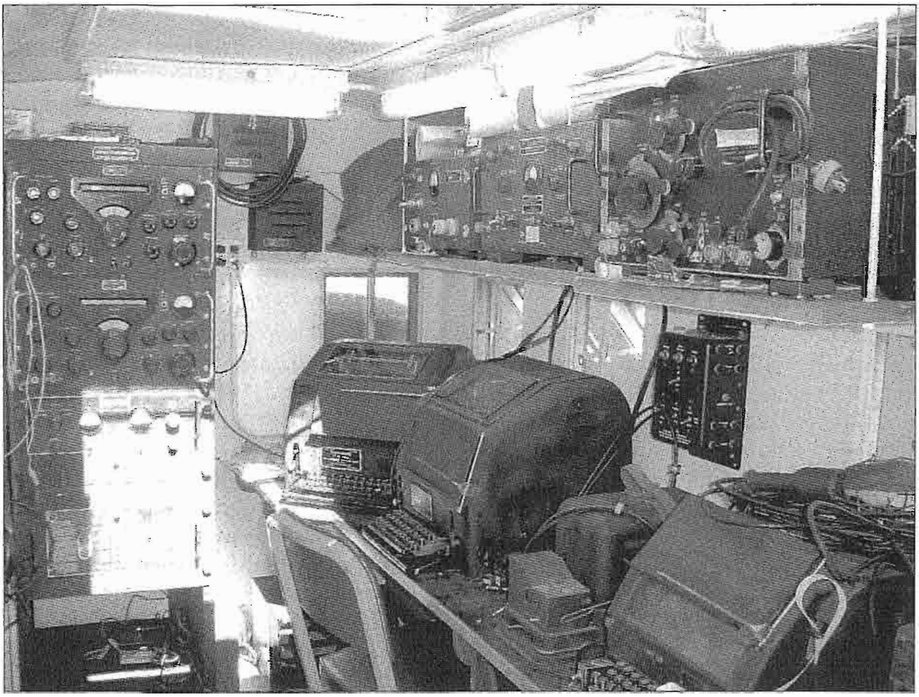
The immediate predecessor of the -A model, the AN/GRC-26, had a very different interior, and used R-366's, which were stabilized BC-312/342-type receivers. But the basic configuration of all the GRC-26 series as a transportable HF system in the 200-400 watt power range is directly descended from the World War II SCR-299 and the SRC-399/499, with performance established by the BC-610 and the two receivers. Those earlier units, however, did not include TTY. Later GRC-26 models, principally the -D version, were used through Vietnam. They were physically very similar to the -A, but were updated with R-390 receivers (generally not R-390A's), a T-368 transmitter, and newer accessories.

The restoration story to the present point is mostly one of mechanical challenges met and solved. The two earlier ER articles recount the first steps necessary to restore the basic integrity of the S-69 shelter, the "box" which, together with all the equipment and accessories, constitutes the nomenclatured AN/GRC-26A. In order to be repaired, the shelter had to be completely emptied out of all the electronic gear and the interior furniture. The floor had rotted out, the roof had some problems, some of the outer sheet metal panels were damaged, and the door needed major work. The operating bench, upper equipment shelf, receiver rack, and storage cabinet were all removed, along with over 1,000 pounds of electronic and TTY gear. The stuff removed from the interior had to be stored somewhere, so it went to an inside self-storage unit at the same location where the shelter was parked. All that remained in the shelter was the 401-pound BC-610H. I also left in place the lamps, electrical conduit, the 2 circuit breakers (one main, and one for lighting), and power outlets. The interior color is painted a semi-gloss straw yellow except for the door panels, which are semi-gloss olive. Unfortunately, because I was working "part-time" on the project, the months went by and I was often unable to do things in the sequence I wanted. You might think it would be a good idea to re-paint the interior walls while the shelter was completely empty. No such luck. Once the interior was basically done, it was the dead of winter and the shelter interior was cold as a witch's nose, so no paint. The water-based, computer-matched paint would of course freeze on contact. But the equipment and shelving in the rented storage bin were burning up money at the same time, so it had to go back inside the shelter as soon as possible, paint or no paint.

Many personal issues intervened to slow down my work during 2003, but some progress was made during that time. By early 2004, I was able to accelerate the work: all the structural and cosmetic work on the shelter is finished, including all interior paint. The truck needs a final coat of paint, but that will have to wait until this spring. Both will be ready for their "coming out" at the beginning of this year's hamfest season and vehicle rally season.

Because the electronic gear had to take a back seat for while, I plan a follow-up article to focus on it exclusively. While it was tempting to fire up some of the pieces for an initial smoke test, I disciplined myself to stick with repairing the shelter and the truck. At one point I did give in to the temptation to see some tubes glowing and turned on both of the R-388's after changing the only the power supply electrolytics. I did not recap either set. Both receivers work OK, but could use an alignment and some lubricating. I further rewarded myself for all the grunt work by taking a few hours to soak one of the Model 15's in kerosene just so I could see and hear the machine clunking along again on a local loop.

While the shelter itself is not strictly a boatanchor topic, allow me to go into some brief detail about how it is constructed. It is noteworthy because the communications gear depends on it for support and protection from the weather, and because I spent so very much time putting it all back in shape! Interestingly, the structure is an off-the-shelf item, not one designed expressly for its use as a radio station. It carries its own nomenclature as an "S-69". The earlier AN/GRC-26 was housed in a similarly sized S-55, and the WWII antecedent



This interior view of the AN/GRC-26A equipment shelter shows the operating bench and the teletype equipment. Space in here is very restricted.

SCR-399 came in the somewhat smaller HO-17-A shelter. All fit on the cargo bed of a 2½ ton truck (which measures 12 feet 3 inches long by 7 feet 4 inches wide). Notwithstanding its "off-the-shelf" status, the box fills the bill adequately, with only some minor shortcomings. For example, there are two "air vents", with filters, in the front wall. But neither filter is accessible for cleaning or replacement: the one at the right front doesn't actually vent, because it is almost completely covered by one end of the operating bench, and the other is in a blind corner in the left front, blocked by the receiver rack and storage cabinet.

Structurally, the S-69 is constructed so plainly that, except for a few welds, you could build it in your garage with simple hand tools. Pieces of 20-gauge sheet steel cover a wood frame. The interior walls are ¼" plywood. Sandwiched in between is fiberglass insulation and copper screening (which has long since corroded away). Two front-to-back 3x3 oak beams along the outer edges of the floor support the left and right walls, and cross stringers of hardwood rest in thin U-shaped sheet metal cross-pieces to support the floor. Those two front-to back oak beams are important because they rest on heavy, 12 foot long steel strips, which are the "skids" of the entire shelter. These heavy steel strips are then welded to 4 upright corners of heavy 3 inch angle stock, and together they constitute a virtual "cage" that provides overall integrity for the box. Heavy rings are attached to the 3 inch angle corners to allow the entire shelter to be pulled along the truck bed if necessary. To this "cage" are welded four sling hooks plus supports for four tie-downs that attach to the side of the truck bed. These tie-downs are made of ½" rod, with hooks and turnbuckles. The photos show this clearly. I had 2 new tie-downs made to replace two that were bent beyond repair. The same sheet metal shop fabricated some other important structural parts, and the MT-657 antenna mount.

At some point in its life, the shelter had been hoisted by the sling hooks without spreaders at the hoist points, causing the side walls to buckle inward. While not serious, it was enough to break through the interior walls and to displace the upper equipment shelf; one more thing to repair.

The shelter gets important additional rigidity from the interior furnishings: the storage cabinet at the left is attached at 3 points: floor, left wall, and ceiling; the operating bench is also attached at 3 points: floor, right wall, and forward wall; the receiver rack up front is attached at 2 points: it is bolted to the floor, and connected to the front wall with two shock mounts. Everything is bolted down quite securely with two exceptions: the BC-221 (in the earliest model GRC-26A's) sits unsecured on a shelf in front of the BC-610; and the RA-87 TTY loop supply is on a shelf below the operating bench. Although this 40-pound brick is not bolted down, it sits behind a lower shelf lip and a lip hanging from the bench-top above. So not only can it not go anywhere, it is virtually impossible to remove with ease.

Making this non-boatanchor part of the story as short as possible, let's just say the structure needed some rebuilding. The canvas over the plywood roof was replaced with new "water resistant" 1950's canvas material from Beachwood Canvas, an outfit the specializes in original spec tops and such for restorers of military jeeps and trucks. Under the canvas is overlapping tar paper. The new roof is "Mil Spec" and looks great. (It even smells right.) My initial fears about being able to sufficiently tighten the canvas were unfounded: the stuff shrinks and is now tight as a drum. The original floor over the cross stringers was a double layer of plywood covered with a seamless piece of something called (believe it or not) "battleship linoleum". It is a kind of burlap-backed linoleum, olive in color (on the surface only... the linoleum is not tinted through like present day floor tiling). In finally covering the floor, I was not looking forward to wrestling with a single sheet of any kind of stiff material, particularly because the BC-610 had to stay inside all the while. In the end, the problem solved itself because I couldn't find "battleship linoleum" of any color, much less 1950s olive green. So I used 1/4 inch Masonite painted with semi-gloss olive deck paint, which was computer matched to the original (non-Mil-Spec) floor color.

Because the interior of the shelter is all wood, the makers ran 2-inch copper strap along the wall behind the equipment shelf and under the bench, with convenient studs and wing nuts at intervals. All equipment cases and the AC power breakers are strapped to this ground bus with flat 1-inch braid. The ground then goes through a stud in the wall to the outside sheet metal and terminates at a wing nut. A 10-foot piece of braid with lugs on each end completes the trip down to the GP-26 ground rod. The 2-pin female Crouse Hinds AC connector on the outer rear wall of the shelf (visible above the nameplates) connects to a power cable, which leads to the generator, towed behind the truck. Thus the 110-volt AC power arrives from the generator in a hazardous male-terminated plug. No one yet thought of procuring a special $500 adaptation of an off-the-shelf piece. Crouse Hinds no longer makes the connectors, but they were kind enough to send me their 1949 catalog page showing them. The cable is out there somewhere, but not even Fair Radio has found it yet. I replaced the connector temporarily with a weatherproof box and a three prong male plug. Two power cables were specified (both missing): a 12-foot and a 50-foot. The earlier

SCR-399 specifies a 100-foot power cable, which may be why the JB-70A junction box was configured with Remote Start-Stop for the PE-95 generator.

Some initial observations about operating the system. The GRC-26 must have been subject to some improvisation by the troops in the field. Some problems the designers never thought of, or missed, or just plain ignored:

1. No wastebasket is specified in the parts list. Even if it there were, there is no place to put it out of the way. A small detail, until the TTY paper and tape begin to pile up.

2. No place to hang punched tape. A few tiny spring clips I found screwed to the upper shelf may have served the purpose.

3. No place to put the typewriter except on the operator's lap. Every inch of space on the operating bench is spoken for.

4. No place to work on a piece of equipment. Although a TS-352 Multimeter and a tool kit were supplied, there is absolutely no place to put a piece of electronic gear while working on it, except on the floor. The later AN/GRC-26D solved the problem by providing a work shelf that slipped onto studs on the receiver rack at about the 30-inch level. This shelf was "stored" by tossing it in the blind left front corner along with the 2 folding chairs.

5. There is a flimsy wooden box under the operating bench about 20 inches wide, 30 inches high, and about 24 inches deep. It is used to store rolls of teleprinter paper and tape. This box is made of 1/4 inch plywood and held together at the corners with 6d finishing nails, glue, and cloth tape. It is meant to slide out. But it has no wheels, and no sliders. So you pull it by a little hand hole cut in the plywood, and try to slide 80 pounds of paper along the linoleum floor, which, by the way, has a non-skid surface.

6. CW operation was obviously an afterthought: the only key provided is a J-45 with leg strap. There is literally not a spare square inch of horizontal space to put a straight key or a bug.

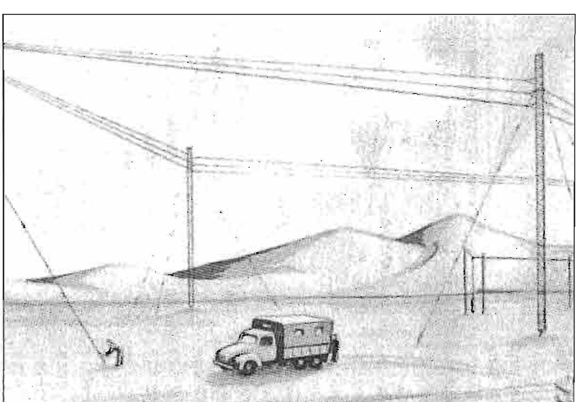
7. Worst of all, the BC-610H is bolted to the floor with four fine thread, ½" stainless steel bolts. There is even a special 4-foot long socket wrench specified, for the sole purpose of reaching the one bolt of the four located in the cramped corner at the right rear. Thus, to gain any access to the back of transmitter you need to slide it along the non-skid floor surface so that its rear panel is in the doorway of the shelter. But if it is in the doorway, you can't get in and out of the shelter to gain access to the front of the transmitter. And the only way to work on it from the rear is to stand on the tailgate of the truck. Naturally, when such repairs are made not only will it be raining, but the eager tech doing the repair must remember not to step backward to admire his or her work. This BC-610 location problem was shared by the earlier GRC-26 and was even worse in the SCR-399, where the transmitter was up against the front wall of the shelter. Apparently the problem was never solved: the -D version has the T-368 in the same spot, but it may have been on wheels, I am not sure.

The M211 Truck

The M211was produced by GMC for the Army from 1950 to 1955 as one of several models designed to succeed the famous CCKW of World War II. It was one of the vehicles that served the Army's 2 ½ ton post-war utility transport needs (REO produced a competing model). A few saw service in Korea, but most stayed in the continental US. They remained in use with the Army and National Guard into the 1960's, and some are still in civilian service today. By the way, for us truck novices, the 2 ½ ton rating on the truck (hence the term "deuce-and-a-half") refers to the rated cross-country payload. The rated highway payload is 10,000 pounds, thus the truck is able to carry the fully loaded AN/GRC-26A, which weighs in at about 6,590 pounds.

Unlike the CCKW, the M211 has an automatic transmission, thus improving overland performance by not losing momentum while manually shifting. It has air-assisted hydraulic brakes, ten wheels, and all-wheel drive, including separate drive shafts to the two rear axles. It drives like a truck: noisy, hot, and slow. With two ranges on the automatic transmission, maximum rated speed in the "Normal" range is 55 MPH, and in the "Low" range it is 14 MPH. The passenger seat folds down into a diamond patterned steel platform for use when a gun ring is mounted above the cab. The driver's seat has some back and forth adjustment, but it is clear that young soldiers in 1952 were smaller, with no middle-age paunch. In the only concession to the modern age, I installed 1970's style military taillights with Mil-Spec turn-signal/ blinkers. Some of the repair work that the truck needed: 2 new 12-volt batteries, a new starter motor, a new exhaust manifold, new battery trays to replace the ones that corroded, a new master cylinder for the brake system, and four new military tires. Cosmetically, the truck is in beautiful original condition, with no metal corrosion and no "modifications" (Nope, no one installed an S-Meter on the front panel!) Although I acquired the M211truck only a few months after the shelter, I kept the shelter propped up on the flatbed trailer so I could work on it from above and below. It was not until early 2004 that the shelter was towed to the garage where I was working on the truck to be hoisted onto the cargo bed. Just as loading the shelter onto the flatbed at Fair Radio took two forklifts, the same process was used to get the shelter onto the bed of the truck. The most beneficial effect of finally getting the shelter onto the truck bed was the reduction in storage costs: I now had only one footprint to rent.

The shelter now sits ready for the electronic part of the restoration job. The truck just needs a final coat of paint, and the application of the proper markings. That will happen when the weather warms up. In order to get the electronic gear running again, the interconnecting cables that were removed over two years ago from inside the shelter have been checked and, in some cases, re-constructed. Some were dry as a bone, and some surprisingly like new. They are now ready to go back in. Once they are in, switch contacts in the various units will be inspected, other components checked visually, and the equipment will be fired up cautiously. As noted, the R-388 receivers work acceptably well, but the other units will be brought up slowly. I don't expect much capacitor trouble because most are sealed. In the next article I will describe the overall system as well as some of the individual pieces of gear in greater detail, particularly the less common pieces such as the VFO/Frequency Shift Exciter O-39 which feeds the BC-610H, and the CV-182 Frequency Shift Converter with its discriminator-type frequency drift compensator.



ER

The KDØZS Equipment Notebook

The Essential National NC-183D, Part 2

By Chuck Felton, KDØZS
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Wheatland, WY 82201
Photography by Greg DePrez

The IF Amplifier Treatment

I developed this IF amplifier treatment from working on several of these radios. Most NC-183D's have a harsh sound because of regeneration in the IF strip. I've had excellent results by introducing unbypassed cathode resistance to improve audio linearity in many receivers and transmitters. Here, I expanded on what National did at V-5, the first IF amp (R-18). The .1µf, 630V yellow Mylars are an excellent bypass capacitor at IF frequencies. Since we're not under pressure by management to minimize parts count (maybe to stop working and come to bed), we can make sure every thing is bypassed and isolated. It helps that the yellow Mylars are half the size, ten times as good, and 40 cents apiece. See the schematic in **Figure 1**.

The AGC and detector drivers re-

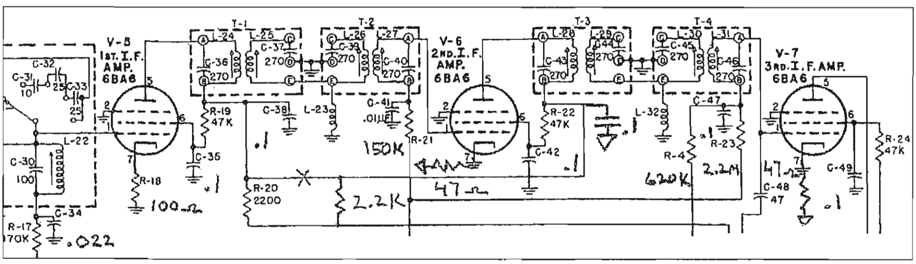


Figure 1: IF amplifier schematic showing locations of the component changes.

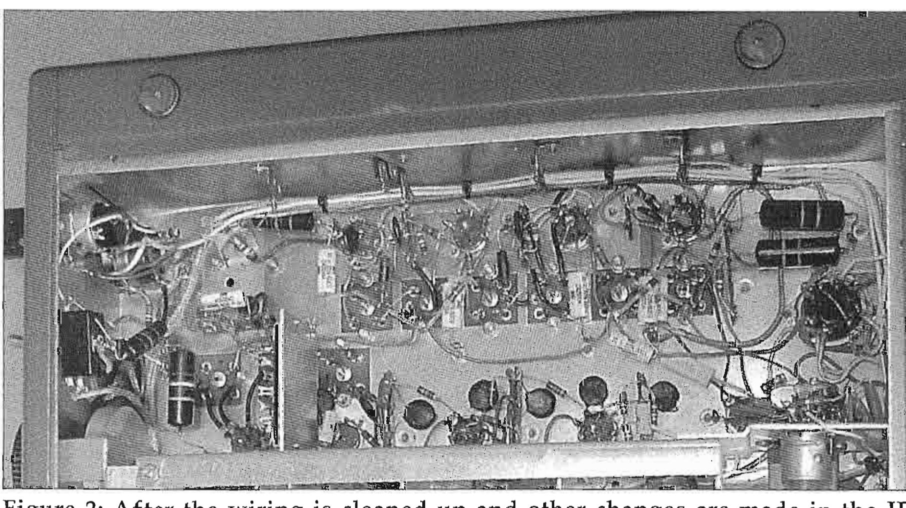


Figure 2: After the wiring is cleaned up and other changes are made in the IF amplifiers, the wiring layout is much neater. This contributes to overall stability.

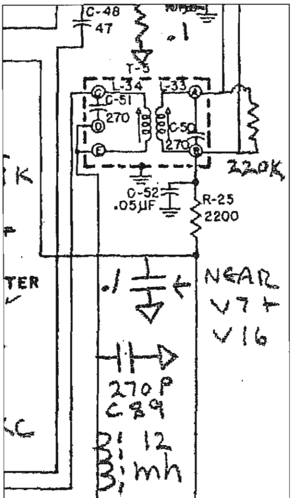


Figure 3

sponded well to some resistive plate loading (220k) and no longer contribute to shaping the passband. The detector output runs right back to the input of the crystal filter. No doubt that arrangement contributed to the regeneration problem. Relocate C-89, the 270-pF RF bypass, next to L-5 and insert a choke, roughly 12mH, between that point and the coax going to the front-panel limiter control. To avoid feedback, make sure the blue IF amplifier plate leads don't stray over the previous IF transformer. See **Figure 2**.

Industry distortion specs were referenced to 30% modulation for some reason, while all transmitter engineers and operators shoot for 100%. Diode detectors require forward bias and an optimum load resistance for low distortion. Feed a 100% tone-modulated carrier into your receiver, look at the detector output on a DC coupled scope ($5 at a swap fest), and play with it[1]. In this case, forward biasing by an 8-Meg, metal-film resistor from the regulated +108V supply did the job. See **Figure 3**. These changes resulted in low-distortion, open-sounding audio with no ringing. Note the added 2.2k resistor and the wiring change in the B+ lead around R-20 that isolates the plate supplies of V5 and V6.

Improving the AGC

After some months of use, the stock AGC came up wanting. With good AGC and CW/SSB detection, the MGC feature is no longer needed. This frees up the MVC-AGC switch so the receiver can have selectable AGC hang time. I went to what has become a standard approach for me, impedance scaled to this radio: Fast attack at V-6, the last controlled IF stage (150k / .01µF), graduating towards a slow AGC action at the 1st RF amplifier, V-1 (470k / .1µF). I decreased the attack time by reducing R-41 to 100k (100k / .1µF). A series-storage network, 2.2µf, 100V Mylar plus 47k ohms, is switched in at the MVC position of S-12 for CW/SSB listening or when there is fast flutter on the band.

The 3rd IF-detector driver, which is after the AGC pick-off point, gets only part of the AGC to keep the audio output level. Its response is very slow (2.2M / .1µF). This voltage divider also sets the default AGC decay time. Note changes at R-21, R-23, and R-4 shown in **Figure 4**.

The V-16 AGC amplifier stage, in particular, was changed to a single-point ground, and the bypass capacitor values were increased as I did with the IF amplifiers. The 8-Meg forward-bias from the screen, and the R-32 change, both increase AGC delay. V-16's cathode is the AGC detector reference. **See Figure 4**.

S-Meter

Originally, the "S" meter is sourced from the detector. This goes against the natural order here in Wyoming, plus it doesn't work on CW/SSB. Changes at R-69 source the "S" meter from the AGC line, as well as now allowing the unused S-1A to calibrate the meter at one spot on each band. On older radios (this is a model change time reference), change V-12 to the 6SN7 to pick up the meter amplifier as shown in **Figure 7**.

Noise Limiter

I usually soften the characteristics of these limiters so that initially they clip at about 90% modulation. This takes the tops off of moderate noise spikes, but still allows good fidelity. Then, as you rotate the control, it clips deeper as nec-

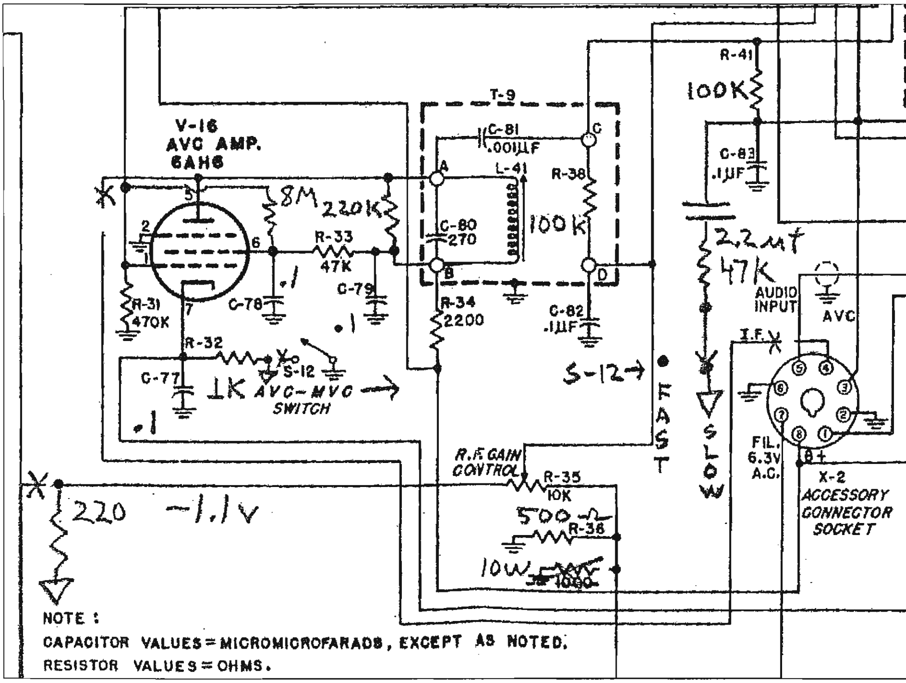


Figure 4: Schematic showing the AGC changes that are described in the text.

essary.

BFO Changes

A diode is a low-distortion heterodyne product detector if given enough BFO injection. "Enough" is about 5 times the signal level. Replace R-45 with a 1.6-mH shielded choke which approximately resonates the V-9 plate circuit for enough injection. "Shielded" is a way to preclude possible interaction. On the other hand, "shielded" is a lot harder to come by. So, try what you have got. See the added .1uf bypass in the BFO plate circuit, which is also the regulated +108V line (installed at V-15's plate).

Tone Control

There are a lot of excellent forgotten ideas in older engineering books. As it

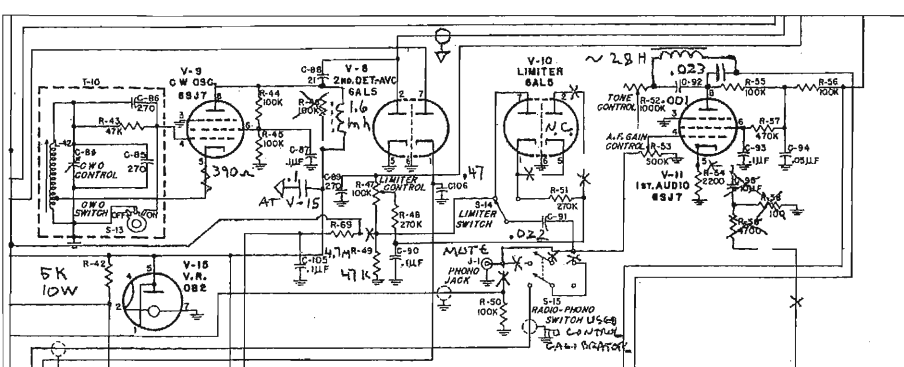


Figure 5: Modifications to the BFO, detector-AGC, limiter, and first audio stages.

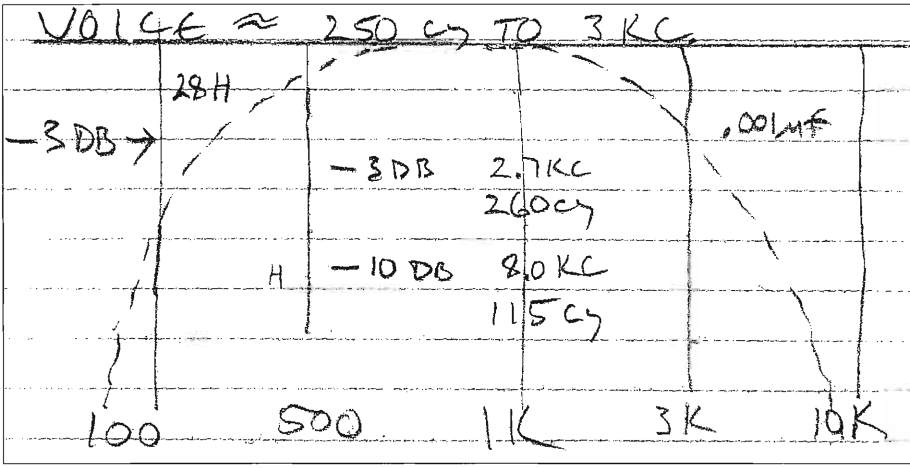


Figure 6: Response curve of the motified tone control when it is adjusted for the voice range.

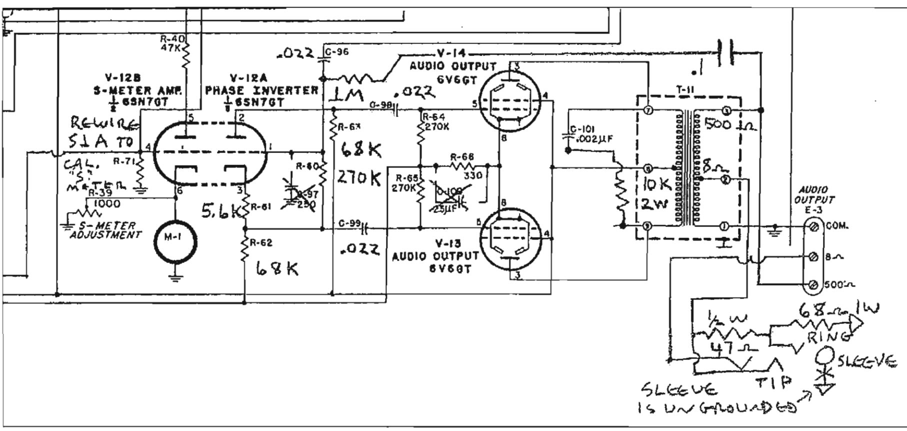
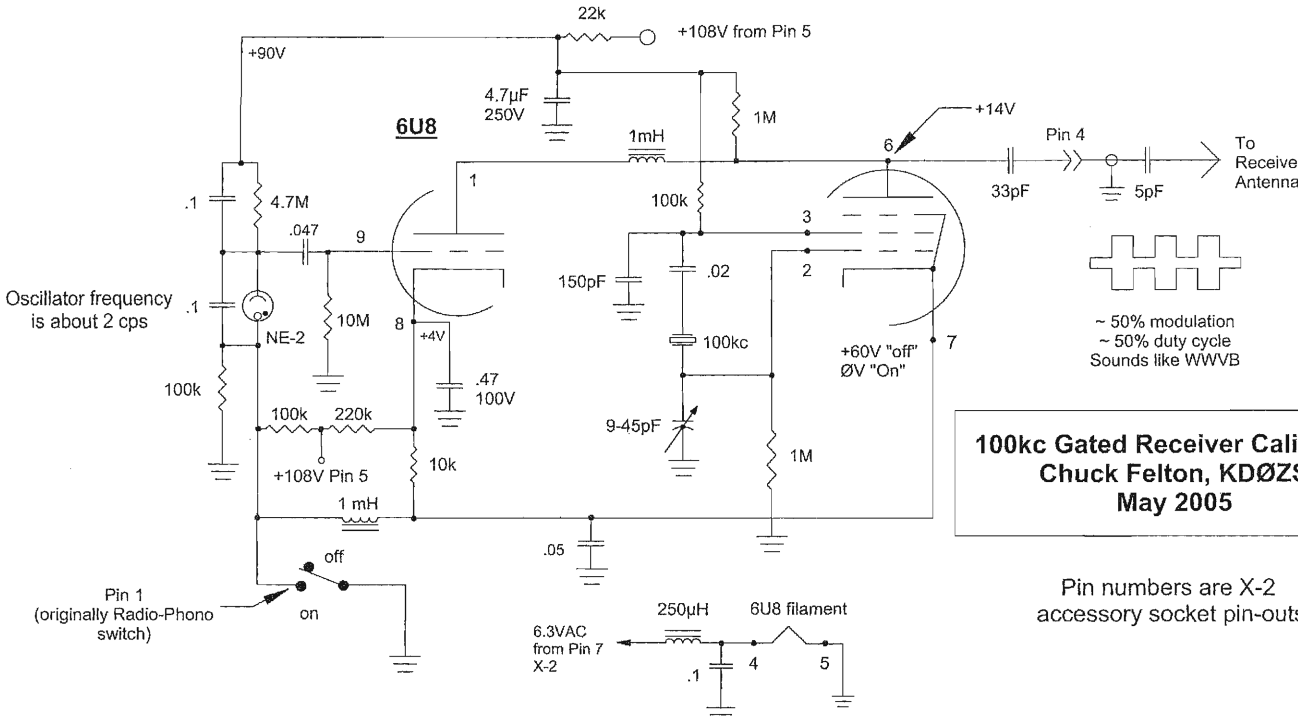


Figure 7: S-meter stage and the audio output stage modifications are shown here. The new phone jack is Mouser P/N 502-N-114B.

came from National (and everyone else), the tone control is kind of useless. By replacing C-92 with a roughly 28 Henry audio choke (high pass) that is paralleled with a .001µf cap (low pass), you get a continuously variable audio bandpass filter that goes from a flat music resonse to a voice bandpass. Now it's useful. These changes are shown in **Figure 5**, around V-11, the 1st audio stage. R-52 is referenced to the 8-ohm audio output (negative feedback) which gives a 10 dB increase in tone control range. A sketch of the voice response is shown in **Figure 6**. The fly in this ointment is the 28-Henry audio inductor. UTC made lots of those parts in the 50's and 60's, but so far I haven't discovered a modern source. Power transformer windings have too much shunt "C". Maybe a driver transformer secondary would work.

Audio Output

Negative feedback from the speaker to just before the power amp is necessary for speaker damping. A clean, tight sound with minimal phase shift provides best



100kc Gated Receiver Calibrator
Chuck Felton, KDØZS
May 2005

Pin numbers are X-2 accessory socket pin-outs

Figure 8

intelligibility. This was covered well in 40's and 50's Hi-Fi design. Where I go further is optimizing each stage for large signal handling. This gives lower distortion at all signal levels, with minimal negative feedback. The changes are shown in **Figure 7**. Negative feedback is applied here at the unbypassed cathode resistor (R-66), from the 500-ohm output tap to the phase inverter grid (V-12A), and from the 8-ohm speaker tap to BPF ground (R-52). Modern stereo headphones are much better than those vibrating diaphragm hair pullers. The switched stereo jack (Mouser P/N 502-N-114b) and resistor network allow matching stereo headphones and switching of the speaker. Note that the sleeve floats. If you like to get hammered when feeling around behind the radio, you can mute at the B+ terminals on the back. Or, install a single-hole mounted RCA jack (I used J-1) in the back panel and run a shielded cable to the input lug of R-53, the volume control.

Receiver Calibrator

A 100-kc calibrator tops this radio off. The band-spread calibration, zeroed at 100-kc points, will get you within a kc or so, plenty close for this mode. (One morning I was tuning around on 10M, heard someone calling, turned on the DX-100 cold, zeroed and called him. About 20 minutes into the QSO, he said he had followed me quite a ways across the band through other QSO's and everything. Oops!) Most calibrators tend to get lost in a crowded band. This is an attempt to fix that by keying the signal for identification. A neon relaxation oscillator drives the 6U8 triode section to modulate the crystal oscillator plate current. This makes a calibrator signal that gates on and off at about a 2 CPS rate. It sounds and looks like the WWVB signal. The full schematic is shown in **Figure 8**, page 30.

My calibrator is designed to plug into the X-2 accessory socket, but the socket wiring has to be changed. If you have, or intend to have, the National Select-O-Ject or the NBFM adapter you will have to find another way to install the calibrator. Probably a better location for the calibrator is on the bracket between the rear of the RF inductor shield and the back panel of the receiver cabinet. This is a good location, and frees up the accessory socket for National accessories. (If you're looking for these at a swap fest, you better be fast!) The photos are of a radio done this way.

To use the accessory socket for the calibrator, rewire socket pins 1, 4, and 5 inside the radio chassis as follows:

<u>1</u>: Originally audio going to the phono/radio switch. Use this switch and coax to ground 6U8 cathodes to turn on the calibrator.

2: Ground

3: AGC, not used

<u>4</u>: Originally the IF, and is now the calibrator output. Run a piece of small coax to the 5-pF coupling capacitor at the antenna jack.

<u>5</u>: Originally pin 5 was audio to the Radio/Phono switch. Rewire it for +108 volts coming from the regulator tube.

6: Ground

7: 6.3 VAC filament supply

8: B+ 265 VDC

The calibrator is turned on by grounding Pin 1 of the original Radio/Phono switch. This places a DC ground on the 6U8 cathodes that, in turn, causes plate current to flow.

There is a good reason to control the oscillator, or any oscillator, in the cathode. A running oscillator draws grid current over part of its operating cycle. A conducting grid collects cathode material and develops grid emission. Grid emission makes an oscillator noisy. Turning off the B+ line on an energized tube causes a constant flow of grid current. This, over time, destroys the tube as an oscillator. The safest way to cut off an oscillator is to lift the cathodes from DC ground, or bias the tube past cut-off. The NC-183D has a negative 41 volt bias source, but it isn't enough to completely cut the calibrator off. So, a voltage divider from the +108 volt B+ supply was devised to lift the cathodes to +60 volts when not shorted to ground by the rewired Radio/Phono switch. The worst case of grid emission I've ever seen was in the BFO in this same radio. The fix will involve making S-13 disconnect the cathode instead of shorting the grid.

IF Alignment

The simple crystal filter isn't so simple. The confused and contradictory attempts to explain alignment sans sweep set up in the various radio manuals should be a clue. Put them all together and they average to zero. Basically, you're tuning for a null, or minimum in over-all response at phase zero. It's not, I suspect, possible to hear that. When that lowest, broadest peak is attained, that is the IF center frequency. It's really obvious with a sweep set up. This is something that should be kludged together out of junk and passed around. Almost any sweeper designed for TV servicing will work. Jim Hanlon (W8KGI) described an easily-built sweep generator in ER #177, February 2004.

Following the manual alignment instructions will result in a very narrow 2-kc passband. Instead, peak up the T-1 through T-4 IF transformer top-side adjustments 2 kc high, and the below-chassis adjustments 3-kc low. Peak the rest at the center frequency, then gently adjust T-5, L-21, and C-29 for a flat-top response with a sweep generator. With the phase control at zero, slightly adjust L-22 and C-104 for the best shape at position 1. Instructions are good for high IF at 1720 kcs.

Re-Soldering Tips

You'll need good solder wick to clean old solder from tube socket pins and tie points. Some types of solder wick are useless and should be sent directly to the trash can. I use Solder-Wik® Rosin 80 SD, type 80-5-10 with good results. To clean a connection, heat it first and then flow a little SN-62 rosin-core solder into the connection. Then, reheat with Solder-Wik® brand desoldering braid doubled between the tip and the connection to be cleaned. By massaging the tip and the wick against the connection, most of the old solder will flow into the wick. Then, the old connection can be taken apart wire-by-wire using flush-cutting diagonal cutters and an angled hemostat. Muli-strand wire requires more care and more solder wick.

For switch and contact cleaning, try Q-Tip® brand Q-Tips and 99% isopropyl alcohol (from Safeway stores) and 50-100 psi compressed air. The compressor isn't critical, since short squirts is all you will use.

For a soldering iron, I choose my Weller® series W-60 with 1/16, 1/8, and 1/4 inch, 700-degree tips. In the W-60 series the soldering temperature is controlled by the type of tip. I keep 2 irons running when I'm working.

References:

[1] Improving Modulation Acceptance, ER #171, August 2003.

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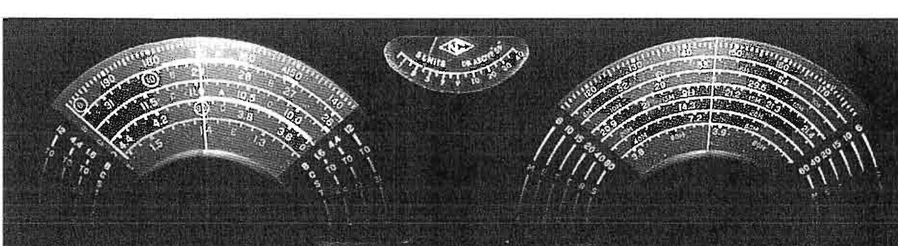

Using Modern Crystals in Pierce Oscillators

By Dave Gordon-Smith, G3UUR
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Introduction

The older style quartz crystals specified for some of the vintage transmitters we use are becoming increasingly hard to find, and many readers are probably wondering whether it is safe to use the modern quartz resonators that are available in their old transmitters. As a rule, if your transmitter has the crystal between grid and ground, as in the Colpitts oscillator, then you'll almost certainly get away with using modern crystals in it. The level at which the crystals work in such circuits is relatively low, and crystal dissipation shouldn't be a problem. There are exceptions to this rule, though, and the 'Tritet' form of oscillator and tuned power crystal oscillators are two notable cases. The 'Tritet' has a tuned circuit in the cathode circuit, which could cause some problems for modern crystals. I haven't tested any modern crystals in one of these circuits, so I don't know how vigorous it really is. I'm just going by its reputation. I haven't done a survey of oscillator types to ascertain how bad a time they give crystals, so I can only give very general advice on other types of crystal oscillator. The purpose of this investigation was to establish what level of excitation modern crystals could withstand, and I happened to use a Pierce oscillator to do that. As a result, I devised a means of reducing the level of excitation in the Pierce oscillator, which is reported here. Certainly, the Pierce circuit, which uses the crystal between plate and grid, can produce some extremely high levels of crystal current. I've heard of very fierce Pierce circuits that even destroy 10X and FT-171 crystals, so it's hard to imagine anything that could be worse, but there may be!

The Problems

Modern plated crystals have a much smaller active region of quartz than the old air-gap types with clamped stainless steel electrodes, and as a consequence many people think they can stand only a fraction of the crystal current that the FT-171, 10X, and FT-243 types can tolerate. The lack of an air gap, the difference in physical size, and their improved activity give modern plated crystals a slightly different electrical equivalent circuit compared to the old types, with very different component values – see **Figure 1.** Notice that the FT-171 equivalent circuit has an extra 30 pF series capacitor representing the air-gap capacitance, and that the motional and static capacitances of the FT-171 crystal are much larger than those

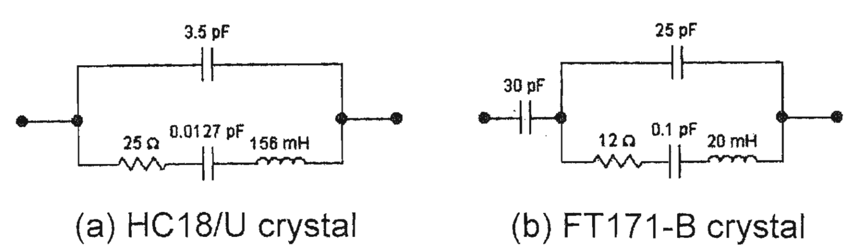


Figure 1. Electrical equivalent circuits of 80m crystals.

of the HC18/U. This is because the area of the older style crystal is much greater than that of the modern crystal. The effective series resistance (ESR) of the FT-171 crystal is actually lower than that of the HC-18/U, despite the HC-18/U crystal having a much higher Q, because the reactance of the motional inductance and capacitance of the older crystal is so much lower at the resonant frequency. The large size of the older crystal does have some advantages!

Now, what level of crystal current d'ya think a modern crystal can really withstand? Perhaps it's a milliamp, or two, maybe? No, a modern miniature HC-18/U 3.579MHz crystal with 6mm diameter silver electrodes and a Q of 140,000 can actually stand 60 mA without fracturing, though its frequency stability is pretty punk with this amount of current going through it! I tried several in a 6V6 Pierce oscillator running at 400 volts, and they all performed pretty much the same. It took 100 mA of crystal current for several minutes to partially fracture one of them, but it still worked when it had been allowed to cool back down to room temperature again, despite the fact it had lost part of the resonator plate! Amazingly, the frequency had only altered very slightly. Long before crystals fracture, the power loss in them causes a continual drift in frequency of up to several hundred Hz/MHz, which persists long after any start-up 'whoop' in the oscillator has died away. This drift can be up in frequency or down a small amount and then up, depending on the manufacturing tolerance of the angle at which the quartz plate has been cut from the crystal. With 60 mA of crystal current, the internal heating power was about 100 mW for the HC-18/U quartz crystals I tested, and this was enough to make their cases feel very hot to the touch after 10 minutes of operation.

It's the internal loss and the volume of material in which this happens that really matters, and not the actual amount of current going through them. Really good crystals with exceptionally high values of Q can stand more than poor ones, but it's not just the Q that matters, surprisingly enough. A high Q crystal will have a lower value of ESR than a poor one of the same design. Since the heating effect is caused mainly by acoustic and scattering loss in the crystal and electrode material, and this is represented by I^2R loss electrically, a poor crystal with a higher value of ESR will have a higher internal dissipation than a high-Q crystal for the same crystal current. The plated area also affects the ESR, and crystals with smaller electrode areas will also have a higher value of ESR for the same Q. They have a smaller active volume of material between the electrodes, too. Manufacturers of modern plated HC-18/U quartz crystals suggest that their products are operated at no more than 1 mW, but I've found that for our non-critical applications in oscillators you can get away with 10 mW in a crystal with 6-mm diameter electrodes on 80m. At this sort of operational level the frequency stability is good enough for long contacts on CW or AM without any problems. This internal dissipation corresponds to 20 to 30 mA of crystal current for typical HC-18/U or HC-25/U 80-m crystals. However, in vigorous Pierce oscillators, the current through modern crystals could be as high as 300 mA! This is because these circuits have been designed to work with old style crystals, and in using them the crystal current would be something less than 60 mA. Apart from the excessive crystal current, modern crystals also expect to see a particular load to work on their marked frequency, and the Pierce oscillator doesn't normally present them with the right capacitive load for this. Consequently, modern crystals usually operate several kHz high of their marked frequency in these circuits. This could be a problem if you're a net operator, and like to be within a few hundred Hz of the nominal net frequency. If you've a transmitter with a Pierce oscillator, and would like to use modern crystals in it, then read on!

The Solution

A typical Pierce oscillator circuit using a triode is shown in **Figure 2**. The crystal current in this oscillator is almost directly proportional to the value of the capacitance between the grid and ground (including about 10 pF grid to cathode in the tube). Older designs sometimes make this capacitance as high as 100 pF, and this is a real killer for modern crystals. Designs using Pierce oscillators from the '50s and '60s, generally, just relied on the tube input capacitance to give the required phase shift at the grid. This is much kinder to modern plated crystals, but the circuit still oscillates several kHz higher than the frequency on which the crystal was designed to operate. Higher plate voltages also increase the crystal current, so 250 volts is kinder to the crystal than 400 volts. Sometimes, though, you just have to use a high plate voltage to get enough drive for subsequent stages.

The Pierce oscillator requires the crystal to provide roughly 180° phase shift with the capacitance at the grid. This means that with a modern crystal the frequency of oscillation is up near the parallel resonant frequency. Normally, the frequency of operation with the standard 20 pF, 30 pF, or 50 pF load capacitance is just above the series resonant frequency. This is what causes the difference between the marked and operating frequencies of modern crystals in the Pierce circuit. To get the crystal to work on its marked frequency it requires some additional phase shift in the feedback circuit of the oscillator. This can be done with a simple RC circuit, and at the same time the level of feedback is reduced. This, in turn, reduces the crystal current. The circuit of the modified Pierce oscillator is shown in **Figure 3**. Don't worry about the RC circuit degrading the frequency stability. It does, but any phase change with temperature in the RC circuit will be compensated by the crystal with a miniscule change of frequency because it has such a rapid change of phase around its resonant point. Believe me, the frequency stability lost because of this circuit will be far less than that due to internal heating of the crystal, and that will be barely perceptible if you set the feedback right.

You can alter the values of RF and CF to get the frequency or crystal current right for your crystal. The RC network is frequency conscious, of course, and has to be altered for each band. The dissipation in the feedback resistor (RF) can be high with the lower values of resistance, and I used a 4-watt carbon resistor in this position. The power rating will be dependent on whether you're running the oscillator continuously, or keying it. It'll also vary with frequency and the value of CF that you're using, so some experimentation will be needed to establish the best rating for your circuit. I used 10k with 47 pF for 80m, and only altered the value of RF for 40m (3k9) and 160m (22k). This gave me close to the 30 pF loading frequency for most of my modern plated crystals with 10 pF at the grid of the oscillator for CG. If your crystals are made for 20 pF loading, you'll need to reduce CF to 33 pF, or so. The crystal current with my arrangement varied with the activity and electrode area of each crystal, but was in the range 10 to 30 mA for most crystals with a plate voltage of 400 volts. You'll probably require smaller values of RF if you're running your Pierce oscillator at plate voltages lower than 400 volts, but you can always start with the values I used to be on the safe side. The general procedure is to increase the value of RF if the oscillator is too fierce, and to reduce it if the oscillation is too weak, or the crystal is having trouble starting. To adjust the frequency of the oscillation, you can alter the value of CF, and compensate for its affect on the level of feedback by changing the value of RF in the opposite sense.

Variations in Modern Crystals

The variations in electrode area used by different manufacturers for the same type of holder, and the variations in activity from one crystal to another, make it very difficult to give hard and fast rules for using modern crystals in Pierce oscillators. HC-18/U crystals are usually 8mm in diameter, but the electrodes vary from 3 to 6mm according to the manufacturer's preferences or problems with spurious responses. The older HC-6/U crystals are normally 14mm in diameter, but can be as low as 12mm, and have electrode diameters from 6 to 10mm. Modern HC-6/U crystals are sometimes repackaged HC-18/U or HC-49/U crystals, and could have correspondingly smaller electrodes. The current handling capacity of a crystal is related to its Q, electrode area, and resonant frequency. It's the density of the power lost within the volume between the electrodes of the resonator that produces the temperature rise, and creates the instability that limits the performance. It doesn't matter how good the Q of the resonator is, if the motional parameters are such that a higher value of ESR is presented to the oscillator feedback circuit the heat generated will be higher. Low frequency crystals are at a disadvantage here, because as the frequency is lowered the capacitance of the crystal decreases and its reactance goes up as well. So, for a given electrode area, the ESR quadruples at half the original frequency even if the Q at both frequencies is the same. In addition, it's very much harder to mount and connect to the crystal without adversely affecting the losses at lower frequencies, so values of Q at 160m are, generally, lower than at 80m. Consequently, values of ESR for 160m crystals are higher than those for 80m crystals with the same electrode area. The values of Q in plated 80m and 40m crystals are similar because the scattering losses in the metal electrode are becoming significant at 7 MHz, and these losses cause the Q to drop with increasing frequency. So, the ESR figures for 40m crystals are usually significantly lower than their equivalent 80m crystals, and the 40m crystals will be able to stand more crystal current than the 80m ones despite being half as thin. A rough guide for fundamental crystals of the same cut and equal electrode area is that the maximum crystal current goes up as the root of the frequency ratio from 1 to 10 MHz. Doubling the frequency gives roughly 40% more crystal current handling capability (1.4142 times). Above 10 MHz, the scattering loss in the metal electrodes will tend to drop the Q fast enough as the frequency increases that the ESR levels out, or even increases with frequency, so this rule will probably no longer apply.

AF4K's Crystals

When I told Ray (NØDMS) about my experiments with modern crystals, he suggested that Brian Carling, AF4K, might like to have some of his crystals tested on my set-up. Ray contacted Brian, and Brian kindly provided a comprehensive range of his modern crystals for punishment. Brian was pretty confident they'd perform well since there are already a large body of amateurs using his crystals successfully in a variety of commercial and homebrew tube transmitters. I selected a sample of these crystals and fully characterised them, so that I had some knowledge of their motional parameters, values of Q, and likely electrode areas. What I call 'HC-18/U' crystals appear to be called 'HC-49/U' now! The HC-49/U crystals on 160m and 80m have electrode diameters of 6 to 6.3mm, and the tiny HC-49/US crystals on 80m, 40m, and 30m have electrode areas equivalent to diameters of 3.1 to 3.7mm. The quality of these crystals is pretty high, in the main, with values of Q in the 100,000 to 200,000 range on 80m and 100,000 to 150,000 on 40m.

All of the HC-49/U and HC-49/US crystals from AF4K ran happily at 20 mA crystal current in the modified Pierce oscillator. Pushing the current up to 40 mA showed some self-heating problems in the HC-49/U 160m and HC-49/US 80-m crystals. This is pretty much what you

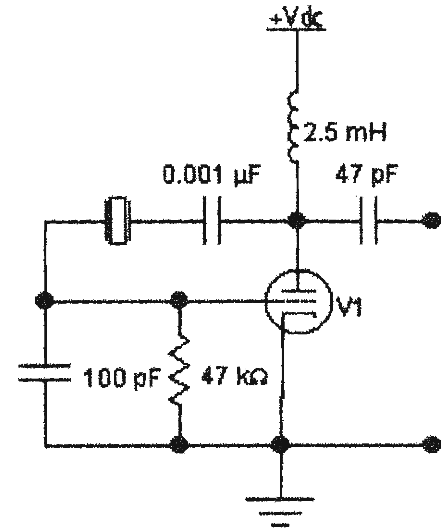


Figure 2. Original Pierce oscillator circuit.

used in electron microscopy, had gone open-circuit just before it joined the electrode panhandles. In one case it had pulled part of the silver panhandle away from the quartz. It looks as if the crystals had failed because of differential thermal expansion and stress concentrations, or weakness in the bonding agent. Normally, the bonding agent wouldn't be expected to be subject to much mechanical stress.

The most startling results were at obtained at 10 MHz. I tried three different crystals on frequencies just above 10.1 MHz, and at 100 mA of crystal current these little critters were drifting down in frequency by 100 to 300 Hz, and then up by 6 to 7 kHz on a long key-down, or extended periods of on-off keying. I estimated from the downward drift what the likely angle of cut was for each crystal. Then, from the subsequent upward shift I was able to estimate the temperature of the quartz inside the crystals. These little devils were getting well above 200°C (probably nearer 300°C) on continuous keying, or long periods of key-down. If I got the internal temperature too high the crystal current went unstable and dropped back, so I couldn't kill them! After a period of cooling down, they appeared to work normally again! I think I'd be able to kill them with a crystal current in excess of 120 mA, but I didn't have the heart to do it! Surviving 100 mA of crystal current is pretty impressive for such tiny crystals.

would expect from their size, motional parameters, and operating frequency. The AF4K HC-49/U 3.579MHz crystal performed exactly the same as my HC-18/U 3.579MHz crystal, and couldn't be destroyed with 100 mA of crystal current. The tiny HC-49/US 80m crystals could be killed with 70 mA of crystal current. The tiny HC-49/US 40m crystals could stand 70 mA, but were very drifty (several kHz) on prolonged key-down. A crystal current of 100 mA could kill them. Post-mortem examination of the dead crystals revealed that none of them had failed because the crystal plates had fractured. The HC-49/US crystals are 2mm x 8mm bars of quartz mounted horizontally in cradles that connect to the leads. The thickness depends on the frequency, of course, but the bar is thinned down towards the ends. Silver electrodes on either side of the quartz bar are approximately 5mm x 2mm with panhandles going in opposite directions to connect to the cradles through a blob of bonding agent at each end. The conductive bonding agent, which is similar to silver dag

Operating Conditions

I would suggest that you don't operate modern HC-18/U or HC-49/U crystals at much more than 30 mA crystal current on 80m and 40 mA on 40m, even the higher-Q ones with 6mm diameter electrodes, if you want reasonable stability. 160m HC-49/U crystals should be operated at 22 mA, or less. HC-6/U crystals

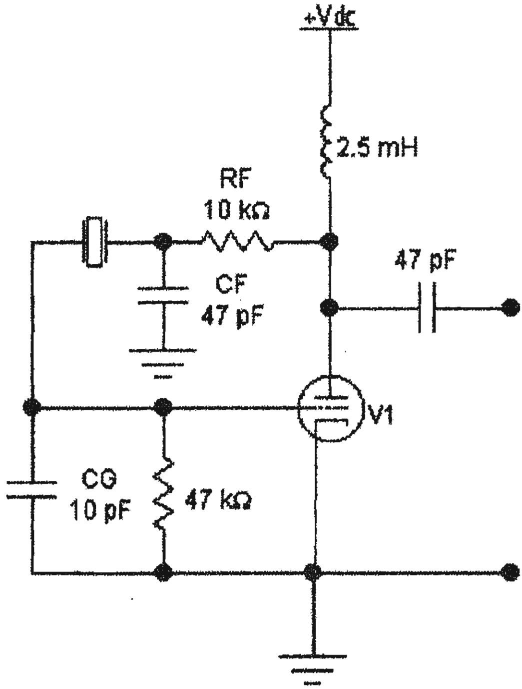
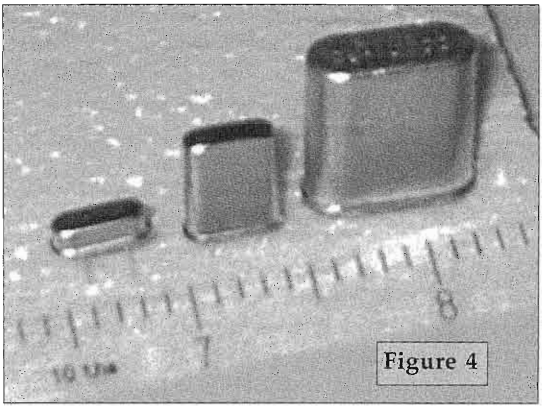


Figure 3. Modified Pierce oscillator circuit for modern crystals.

crystal. However, you can tell when you've got the operating conditions about right for your crystal if the beat note on a monitor receiver doesn't change noticeably when you hold the key down for prolonged periods of time. This is the ultimate test for the crystal and circuit. If it seems to be working satisfactorily, then it most likely is! When the internal heating is too great for the crystal, the effect on its frequency stability is very evident long before the current gets to a level at which the resonator will be destroyed.

Ultimately, given a set of crystal parameters determined by the manufacturer and serendipity, it's the performance that matters to most amateurs, and the only alternative to 'sucking it to see' is an extensive series of measurements. I wouldn't advocate that route to anyone unless they get a great deal of pleasure from investigating and understanding things. It can use up a lot of time! The 'suck it and see' approach is quicker and easier, and you can soon determine a stable operating level for your modern crystals without ever knowing the crystal current, power loss density, or Q. All you need to know is that modern crystals are more robust than their size would suggest, and if you take a few precautions to limit the crystal current initially, you should be able to determine how best to use them without any mishaps. I've included a photograph of the three types of modern crystal discussed here in **Figure**

with large electrodes (8 – 10mm diameter) can be operated at up to 30 mA on 160m, 40mA on 80m, and 55mA on 40m. However, if you don't know what's inside it's better to err on the conservative side. Also, you need to bear in mind that the value of crystal Q can vary in production, so you may need to readjust my figures a bit to allow for this. HC-49/US 80m crystals are best operated at less than 20mA crystal current, 40m ones at 30mA, or less, and 10 MHz ones at less than 40mA. The general rules are that lower frequency crystals should be run at lower crystal currents than higher frequency ones for a given electrode size, and small crystals should be run at lower currents than large crystals on the same frequency. Between these two constraints there are a multitude of variations that could make you very confused about what current to use with a particular unknown



Modern crystals: HC-49/US (left), HC-49/U (middle) and HC-6/U (right).

4, so that you can recognise them. You can appreciate how tiny the HC-49/US crystal is when you compare its dimensions with the one-tenth inch scale on the ruler in the photograph.

Tuned Plate Crystal Oscillators

Some words of caution for those who use crystals in tuned power oscillators might not go astray here. The crystal current can vary widely in tuned crystal oscillators depending on the state of the tuned circuit used in the plate of the oscillator tube, and whether it's loaded or not. For Tritet and straight tuned Colpitts oscillators, the crystal current can be low when the plate circuit is resonated. The worst conditions are when the plate tuning capacitor is tuned off resonance so that the load looks inductive. There can also be sizeable differences in crystal current between the loaded and unloaded states. Unloaded and off tune is the worst condition for any tuned crystal oscillator, and can cause increases of up to 6 times the working crystal current. It's wise to use the old ARRL trick of switching the HT voltage to a lower level for tune-up to reduce the stress on the crystal. The additional precaution of putting a bulb in series with the crystal is well worth taking. A 6V, 60 mA one is a bit more suited to limiting the dissipation in a modern crystal than the 2V, 60mA version used in the old days, because its hot and cold resistances bracket the usual values of ESR found in modern crystals quite nicely. If you can't get a 6V, 60mA bulb, a 12V 0.1A one has a similar resistance range but would need a miniature 50 mA fuse in series with it to fully protect the crystal. If you don't have anything else, and want to make a start, you can always sacrifice a bit of Q and put a resistor of 100 ohms to 1k-ohm in series with the crystal to limit the current while experimenting. Make sure you have the antenna or a dummy load connected to the power oscillator before you key up. Also, start with your plate tuning capacitor at maximum capacitance, and try not to tune too far passed resonance as you dip the plate current. The worst inductive load for the crystal is just on the low-capacity side of resonance, so operate slightly on the high-capacity side if you can. If you're using a Tritet harmonic oscillator, make sure that you have the cathode variable capacitor at minimum before applying power, and only advance the capacitor enough to get good stable oscillation. In addition, don't use a tuned circuit in the cathode when the plate circuit is operating on the crystal frequency.

Some crystal power oscillator circuits use the grid-cathode capacitance to provide feedback, and don't bother with any additional external capacitance connected there. I have seen suggestions that extra grid-plate capacitance should be added if problems are experienced with sluggish crystals. This is a dangerous route to go, particularly if modern crystals are being used. Use feedback from the cathode in preference to the plate. Use external capacitors from grid to cathode and cathode to ground to define the feedback. Try 27 to 47 pF from grid to cathode and 100 to 220 pF from cathode to ground as a starting point.

You can make the grid to cathode capacitor a trimmer for convenience. You can also play with the value of the grid resistor and add a cathode bias resistor to reduce the crystal current without affecting the output power too greatly with medium power oscillators. It can be well worthwhile sacrificing a little bit of output power to reduce the crystal current and improve the keying characteristics.

Modifying the Frequency of a Modern Crystal

If you have any surplus plated crystals on frequencies slightly higher than the channels on which you want to operate, you can always lower the frequency of a crystal by a bit of mass loading on the plated area. This can be done with pencil lead or solder, once the case has been removed. If you have cold-welded or glass-sealed crystals don't try this, you'll probably destroy the crystals in the process of trying to remove the case. Nickel-plated brass cases that are soldered to the base of the quartz crystal holder are easy to remove with a large soldering iron. It may sound crude, and some readers may worry about the frequency stability and ageing of 'doctored' crystals. But, you'd be amazed at how effective this can be. The frequency change with age of some of my modified crystals has amounted to less than 100 Hz at 3.6 MHz over many years, and more solder or pencil lead can always be added to the crystals after a few years to bring them back down to frequency if they do age up.

Pencil lead is not really lead, of course, and consequently it doesn't have the mass loading capability of solder, but it can give a 1 to 2 kHz decrease in frequency at 3.6 MHz if the whole area of the electrodes on both sides of the crystal are covered in a layer of pencil lead. This effect will be double the stated amount if done on a 7 MHz crystal, and half that of 3.6 MHz on a 1.8 MHz resonator. Rubbing solder into the silver electrode on both sides of the crystal will produce about 4-kHz shift at 3.6 MHz, and proportionately greater amounts at higher frequencies. It's best to cover a small test area in the centre of each electrode first, to see how far the crystal moves, and then work more solder onto the electrode surface as required to produce the shift you need. Modifying the frequency of modern plated crystals in this way reduces the Q, but it'll still be higher than the Q of any old-style crystals on the same frequency. It's important to add similar amounts of loading to both electrodes; otherwise less active unwanted spurious responses may be stimulated and cause mode hopping, or oscillation in other modes.

I have also used mercurochrome antiseptic to lower the frequency of crystals in the past. This has to be painted on a layer at a time, and allowed to dry before any more layers are applied. You need to check the frequency after each application, and waiting for it to dry, or drying it artificially is a bit of a pain. I can't give you any figures on the frequency shift per application of mercurochrome, because I didn't make any notes on it when I last used the stuff many years ago, and it's hard to get in the UK nowadays. You can always try experimenting with whatever you've got to hand, providing you've got a bunch of crystals you can afford to waste.

Final Note

The circuit modification I've presented in this article is quite simple to add to existing Pierce oscillators, and opens up the possibility of using modern plated crystals to get the new net frequencies you might require in the future. It could also allow you to use a lot of crystals you already possess with a transmitter you'd given up using long ago because it seemed to eat crystals! If your interest is power crystal oscillators, maybe you've now got a bit more confidence to try modern crystals in one of your circuits after reading this article. Whatever the case, experiment and have fun. That's what it's all about!

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Milestones in the History of Amateur Radio: The White Bill

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Radio activity in the United States was regulated by the Radio Act of 1912 until 1926. The Act was administered by the Department of Commerce, Bureau of Navigation. Herbert Hoover, the Secretary of Commerce, and a large cohort of bureaucrats in Washington D.C., controlled its destiny with advice from a host of constituencies which had a vested interest in how the regulations should be interpreted. Secretary Hoover called into session four radio conferences in 1922, 1923, 1924, and 1925, as he and the nation struggled to reduce chaos among competing powers and to enhance cooperation among them. Whatever Hoover accomplished was rendered meaningless when Federal Courts ruled in 1926 that the Secretary of Commerce lacked authority to regulate radio broadcasting. Anarchy on the wavelengths ensued until Congress passed the Dill-White Radio Act of 1927, from which a new regulatory agency emerged—the Federal Radio Commission.

The first of Hoover's radio conferences, February 28, 1922, amended the 1912 Act to require that all broadcast stations acquire a new form of commercial license. The conference also allocated two wavelengths for all broadcast stations, and it denied amateur radiotelephone stations access to the broadcast wavelengths. The inadequacies inherent in the regulations led to a second conference, May 1923, in which a broadcast band was established, but the proliferation of broadcast stations and splatter from radio telegraph stations—military, commercial, ship, and amateur—led problems to persist.

The May, 1923, and subsequent Hoover conferences would have been unnecessary had Congress acted on the "White Bill." Secretary Hoover appointed, following the 1922 conference, an "Interdepartmental Radio Board" to study existing radio regulations. The Act of 1912 did not "fix the details" or provide the Secretary of Commerce with authority to enforce such adjustments as conditions warrant and progress requires (Stratton, 1923). The Interdepartmental Board issued, March 1922, its report, which dealt mostly with non-governmental radio transmitting stations. Representative Wallace H. White, Jr., of Maine, then prepared a Bill based on the deliberations of the Board, and on June 8, 1922, he introduced it in the House of Representatives. Given the prominent role of the Bureau of Navigation in the governance of the radio spectrum, the bill was referred to the "Merchant Marine and Fisheries Committee," where it languished while the Committee disposed of shipping legislation.

"The new year of 1923 dawned auspiciously for radio," declared John Hogan, a leading inventor and radio engineer (Hogan, 1923, p. 422). The Merchant Marine and Fisheries Committee opened public hearings on the White Bill, January 2, the day before Congress re-convened after the holidays. Although the meeting had been announced only a few days before, representatives of major agencies concerned about radio-spectrum allocations were on hand, e.g., AT&T, RCA, ARRL, American Railway Association, Wireless Association of Pennsylvania, National Radio Chamber of Commerce, and the U.S. Government Departments of War, Navy, Commerce, Agriculture, and Post Office.

Secretary Hoover addressed the Congressional Committee on the afternoon of January 2nd. He pointed out that the radio art was being stifled by traffic congestion on the comparatively few wavelengths available. He stated that as of December 27, 1922, there were 21,065 licensed transmitting stations in the United States, of which 16,898 were amateur, 2,762 were ships, and 1,405 were commercial, government, and private broadcast stations. He suggested also that as many as two and one-half million radio receiving sets might be in use, and "necessarily, public interest in radio is profound" (Hogan, 1923, p.422). Significantly, he said, "the matter of interference (particularly in radio telephone broadcasting) threatens to undermine the useful purpose of the whole art."

The hearings continued until late Wednesday morning, January 3rd. A Navy Department spokesperson expressed reservations about the aim of the Department of Commerce to possess the power to regulate all commercial radio traffic. Since most Naval stations send occasionally "commercial" messages, he was concerned that Naval stations would be required to obtain licenses from the Secretary of Commerce. Another provision would have allowed the Secretary to refuse licenses to any party "monopolizing or seeking to monopolize radio communication through control of the manufacture or sale of radio apparatus." To mollify manufacturing executives, like those from RCA, the wording was changed to "unlawfully monopolize," which presumably did not include RCA and its affiliates.

Proponents of the Bill proposed that an advisory committee of twelve be constituted, which would be comprised of a representative from each of the six government departments of War, Navy, State, Agriculture, Commerce and Post Office, and six members not employed in government service. Hiram Percy Maxim, ARRL President, offered an amendment to make ineligible for one of the non-governmental seats anyone "affiliated directly or indirectly in the manufacture, sale, transmission or operation of radio telegraphy or radio telephony for financial profit." Maxim's amendment represented a transparent attempt to exclude all but amateurs from the non-governmental half of the committee. Hoover, however, spoke against the amendment on the grounds that technical professionals and engineers would be ineligible for participation on the committee if exclusions were too broad. He argued that the Bill should not embody restrictions that would "preclude recognized men of public spirit from appointment on the advisory committee (Hogan, 1923, p. 424).

The White Bill delegated responsibility for the issuance of licenses for non-governmental stations to the Department of Commerce. It also forbade aliens from owning radio stations in the United States, limited the duration of licenses, and provided a rationale for their revocation. In general, those present at the hearing believed that Bill was in good shape and that upon its passage, new powers in the hands of Secretary Hoover would resolve many current problems associated with radio broadcasting.

The ARRL staff endorsed the White Bill for two reasons ("The White Bill," 1923, p. 41). First, "there probably never will be a bill proposed more fair to the amateur." It recognized the status accorded amateurs by the Radio Act of 1912 and it provided that wavelengths for amateurs shall neither be less than 150 meters nor more than 275 meters [which in early 1923 seemed a highly desirable outcome]. Second, it was in the interest of amateurs to have the "broadcast mess unscrambled." If broadcast stations were on "diversified wavelengths," less jamming and blaming of amateurs for interference would occur. The White Bill following the hearings was thus reported unanimously out of the House Committee on Merchant Marine & Fisheries.

The bill seemingly dropped from the face of the earth when it was presented to the full House. Morecroft (1923, p. 270), a highly distinguished editor of Radio Broadcast and Professor of Electrical Engineering at Columbia University, eventually asked in exasperation, "Where is the radio bill?" He said that we have been waiting for months. The bill "represents the best thought of those executive and technical experts who have had most to do with radio development in America." Members of Congress, however, felt that they were being asked to delegate explicitly too much control over the radio spectrum to the Department of Commerce and rejected it by refusing to act on it.

Given the deplorable state of both broadcasting and wavelength allocations among the major constituencies, Secretary Hoover, acting with the support of radio engineers and entrepreneurs, decided that he possessed sufficient authority to reassign wavelengths particularly for broadcast stations and for amateurs. A Federal Court in 1926 determined otherwise, however, and it stripped from the Department of Commerce all administrative control over the domestic use of the radio spectrum. Activity in the broadcast band descended into chaos for a time. Finally, order emerged after Congress established in 1927 the Federal Radio Commission.

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Morecroft, J. M. (1923, February). The March of Radio. Radio Broadcast, 2, 267-274.

Stratton, S. W. (1923, February). Proper Radio Legislation is Urgently Needed. Radio Broadcast, 2, 210.

The White Bill. (1923, January). QST, 6, 40-41.

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[...Comments, from Page 1]

have some Electric Radio calendars printed, which many readers have asked for.

2005 Heavy Metal Rally

The BPL updates I've been running recently have taken space that might have been used to report the Heavy Metal Rally results from this year. I felt that the BPL information was important.

Here are the results that have been compiled from the logs I received over the last few months:

W7CE, 1st-place with 92 points
W9AD, 51 points
K2ORC, 42 points
WJ6W, 33 points
W8BAC, 31 points
K9KEU and K4XR, 21 points each
W7GMK, 16 points
W9FM, 14 points
W3LW, 5 points

Comments without logs were received from AA5T, WA1HKK, WA9MZU, and Mark Heller. Thanks to all who sent me this information. I'll try to reserve space in the next issue for some of the comments because they make interesting reading. The rally is a very popular event, and next year I am hoping to bring back the first-place winner's trophy. All of the certificates for this year's event have been sent out as of press time.

Dayton Hamvention AM Forum

Dale Gagnon (KW1I) would like to remind everyone attending the Dayton Hamvention this year that Dennis DuVall (W7QHO) will be speaking at the AM Forum. The forum is at 4:00 PM on Friday, May 20. Dennis will be giving a talk about the activities of the Military Radio Collectors Group, which is a large and growing organization devoted to the history, restoration, and operation of historic military radio equipment.

Dale will have an article in an upcoming issue about recent MRCG activities.

73, Keep Those Filaments Lit!
Ray, NØDMS

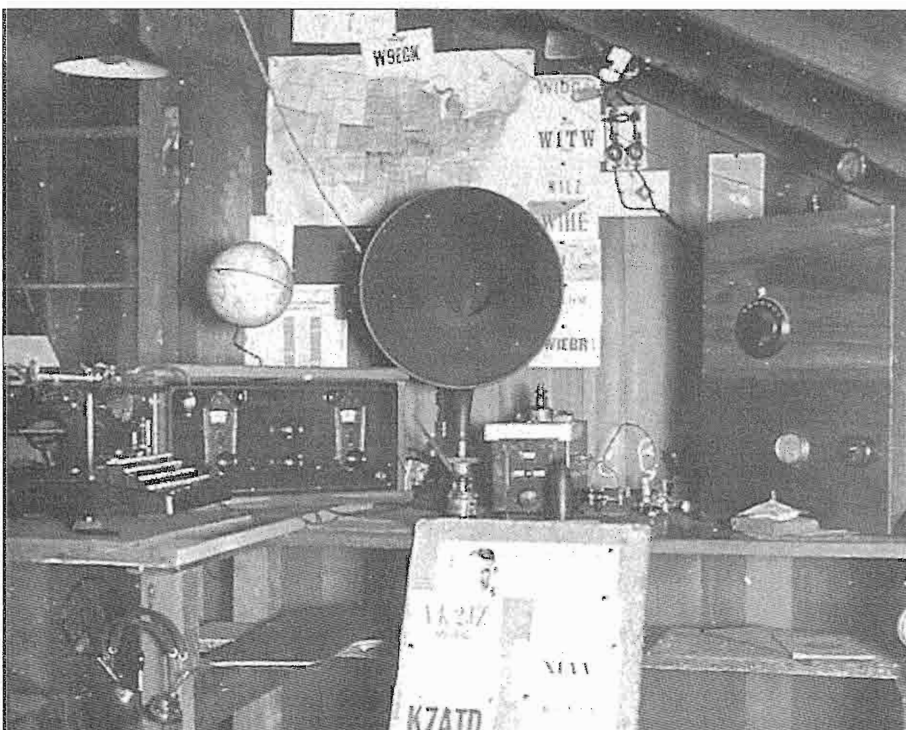
PHOTOS

Above: A group of Colorado AM'ers gathered April 2nd, 2005, at the Longmont, CO, Hamfest. Pictured above, left to right, are O.J. Jenkins (KØOJ), Jack Quinn (KØHEH), Mike Sell (KØCOM), Bill McCaa (KØRZ), Ray Osterwald (NØDMS), Paul Thompson (WØOD), Chuck Felton (KDØZS), and Carl Braun (KAØSHU). The Hamfest was not well attended, and not many boatanchors showed up for sale, but everyone had good times and good fellowship.

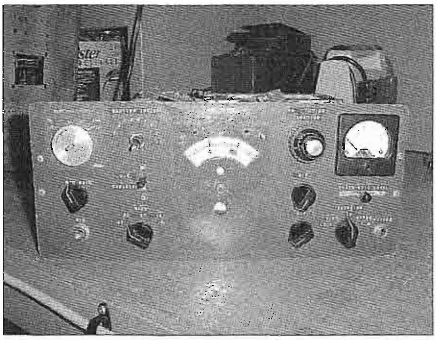
Top Right: Vernon Fitzpatrick (WA8OIK) was first licensed in October 1964. His present shack is located on the farm near Clare, MI, where he was born in 1929. The transmitter to the left of the Hallicrafters S-40B is a restored homebrew rig from the 1953 ARRL handbook that was built by NV8P, Dale, now SK. It presently operates on 40 meters. The AM line up is completed with two Gonset G-76 transceivers shown on the top shelf behind Vernon.

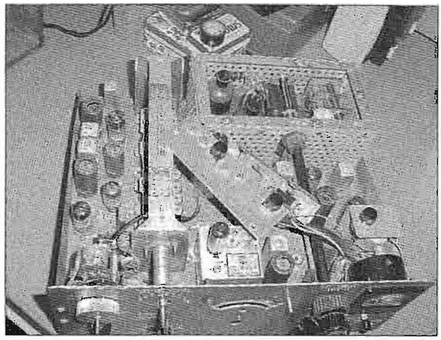
Bottom Right: Ed Marriner (W6XM) operated from his well-equipped shack in Laguna Beach, CA, as it looked in 1933, when he was licensed as W6BLZ .

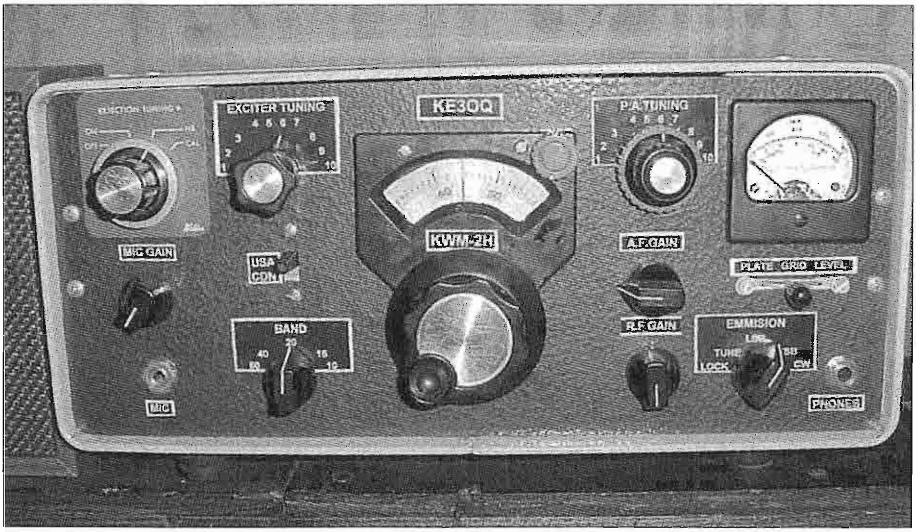
Vernon Fitzpatrick, WA8OIK.



W6BLZ, 1933







Is This A Collins KWM-2 Prototype?

Mike Janis (KE2OQ) has owned this transceiver for about 20 years. It is a replica of a Collins KWM-2, and appears to be either home built or a factory prototype. All the major components are factory-made Collins including the slug rack tuning system, the 70K-2 PTO, the SSB filter, and the final amplifier parts. The chassis is made from galvanized steel about the thickness of heavy furnace ducting and the front panel is made from 16-gage aluminum. The chassis layout is exact to the KWM-2, but there are 5 crystals mounted in individual sockets on the top of the chassis and 2 crystals soldered in place underneath. The radio covers 3.6/3.8/7.2/14.0/14.2 and 28.5 Mc. The dial is black plastic made to the dimension of the original and appears to be a factory "second." Mike recently tuned this radio up and it works very well. The PTO was realigned and the dial calibration is well within the 1-kc specification. The receive sensitivity and selectivity are excellent. He repainted and relabeled the front panel and is calling it a KWM-2H, for homebrew. Mike needs help documenting the history of this radio. The only clue that he has is the name on the military manual that came with it when purchased, "WILKY," and the call is KH6ACA. Mike got it from a Ham in Moose Jaw, SK, who in turn got it from someone in Alaska. If any ER readers can help find the original builder please write to Mike at his callbook address.

ER

VINTAGE NETS

Arizona AM Nets: Sat & Sun: 160M 1885 kc @ sunrise. 75M 3855 kc @ 6 AM MST. 40M 7293 kc 10 AM MST. 6M 50.4 Mc Sat 8PM MST. Tuesday: 2M 144.45 7:30 PM MST.

Boatanchors CW Group: QNI "CQ BA or CQ GB" 3546.5, 7050, 7147, 10120, 14050 kc. Check 80M winter nights, 40 summer nights, 20 and 30 meters day. Informal nightly net about 0200-0400Z.

California Early Bird Net: Sat. mornings @ 8 AM PST on 3870 kc.

California Vintage SSB Net: Sun. mornings @ 8AM PST on 3860 +/-

Colorado Morning Net: Informal AM'ers on 3875 kc Mon, Wed, Fri, Sat, and Sun@ 7 AM MT. QSX KØOJ

Canadian Boatanchor Net: Daily 3725 kc (+/-) @ 8:00 PM ET. Hosts are AL (VE3AJM) and Ken (VE3MAW)

Collins Collectors Association (CCA) Nets: Tech./swap sessions every Sun. on 14.263 Mc @ 2000Z. Informal ragchew nets meet Tue. evening on 3805 kc @ 2100 Eastern time, and Thu. on 3875 kc. West Coast 75M net is on 3895 kc 2000 Pacific time. **10M AM net starts 1800Z on 29.05 Mc Sundays, QSX op 1700Z. CCA Monthly AM Night:** First Wed. of each month, 3880 kc starting @ 2000 CST, or 0200 UTC. All AM stations are welcome.

Collins Radio Association nets: Mon. & Wed. 0100Z on 3805 kc., also Sat 1700Z, 14.250 Mc.

Drake Technical Net: Meets Sun. on 7238 kc, 2000Z. Hosted by John (KB9AT), Jeff (WA8SAJ), and Mark (WBØIQK).

Drake Users Net: Check 3865 kc, Tue. nights @ 8 PM ET. QSX Gary (KG4D), Don (W8NS), and Dan (WA4SDE)

DX-60 Net: Meets on 3880 Kc @ 0800 AM, ET on Sun. QSX op is Mike (N8ECR), with alternates. The net is all about classic entry-level AM rigs like the Heath DX-60.

Eastern AM Swap Net: Thu. evenings on 3885 kc @ 7:30 PM ET. Net is for exchange of AM related equipment only.

Eastcoast Military Net: Sat. mornings, 3885 kc +/- QRM. QSX op W3PWW, Ted. It isn't necessary to check in with military gear, but that is what this net is all about.

Fort Wayne Area 6-Meter AM net: Meets nightly @ 7 PM ET on 50.58 Mc. Another long-time net, meeting since the late '50s. Most members use vintage or homebrew gear.

Gulf Coast Mullet Society: Thu. @ 9PM CT, 3885 kc, QSX control op W4GCN in Pensacola.

Gray Hair Net: One of the oldest nets, @44+ years ,160 meter AM Tue. evening 1945 kc @8:00 PM EST and 8:30 EDT. Also check www.hamelectronics.com/ghn

Hallicrafters Collectors Association Net: *Sun.*, 14.293 Mc, 1:15 PM EST/EDT. *Sat.*, 7280 kc, 1:00 PM EST/EDT. *Wed.*, 14.315 Mc, 6-8:00PM EST/EDT. QSX op W8DBF.

Heathkit Net: Sun. on 14.293 Mc 2030Z right after the Vintage SSB net. QSX op W6LRG, Don.

K1JCL 6-meter AM repeater: Operates 50.4 Mc in, 50.4 Mc out. Repeater QTH is Connecticut.

K6HQI Memorial Twenty Meter Net: This flagship 20-meter net 14.286 Mc running daily for 25+ years. Check 5:00 PM Pacific Time, runs for about 2 hours.

Midwest Classic Radio Net: Sat. morning 3885 kc @ 7:30 AM, CT. <u>Only AM</u> checkins. Swap/sale, hamfest info, tech. help are frequent topics. QSX op is Rob (WA9ZTY).

Mighty Elmac Net: Wed. nights @8PM ET (<u>not</u> the first Wed., reserved for CCA AM Net), 3880 +5 kc. Closes for a few summer months QSX op is N8ECR

MOKAM AM'ers: 1500Z Mon. thru Fri. on 3885 kc. A ragchew net open to all interested in old equipment.

Northwest AM Net: AM daily 3870 kc 3PM-5PM winter, 5-7 PM summer, local. 6M @50.4 Mc. Sun., Wed. @8:00 PM. 2M Tues. and Thurs. @ 8:00 PM on 144.4 Mc.

Nostalgia/Hi-Fi Net: Started in 1978, this net meets Fri. @7 PM PT, 1930 kc.

Old Buzzards Net: Daily @10 AM ET, 3945 kc in the New England area. QSX op George (W1GAC) and Paul (W1ECO).

Southeast AM Radio Club: Tue. evening swap, 3885 @7:30 ET/6:30 CT. QSX op Andy (WA4KCY), Sam (KF4TXQ), Wayne (WB4WB). SAMRC also for Sun. Morning Coffee Club Net, 3885 @ 7:30 ET, 6:30 CT.

Southern Calif. Sun. Morning 6 Meter AM Net: 10 AM on 50.4 Mc. QSX op is Will (AA6DD).

Swan Nets: User's Group Sun. @4PM CT, 14.250 Mc. QSX op Dean (WA9AZK). Technical Net is Sat, 7235 kc, 1900Z. QSX op is Stu (K4BOV)

Vintage SSB Net: Sun. 1900Z-2000Z 14.293 & 0300Z Wed. QSX op Lynn (K5LYN) and Andy (WBØSNF)

West Coast AMI Net: 3870 kc, Wed. 8PM Pacific Time (winter). Net control rotates between Brian (NI6Q), Skip (K6LGL), Don (W6BCN), Bill (N6PY) & Vic (KF6RIP)

Westcoast Military Radio Collectors Net: Meets Sat. @ 2130 Pacific Time on 3980 kc +/- QRM. QSX op Dennis (W7QHO).

Wireless Set No. 19 Net: Meets second Sun. every month on 7270 kc (+/- 25 Kc) @ 1800Z. Alternate frequency 3760 kc, +/- 25 kc. QSX op is Dave (VA3ORP).

CLASSIFIEDS

Advertising Information

Subscribers receive 1 free 20-word ad per month. **Extra words are 20 cents.** Here is how to count the words in your ad: "For Sale" or "Wanted" and your contact information counts as 7 words. Hyphenated words count as 2 words. **Please count the words in your ad as described above, and if you are over 20 words, send payment for the extra words at .20 each.** Note: Not all readers use e-mail, so it is a good idea to include phone numbers. Non-subscribers: $3.00 minimum for each ad up to 20 words. Each additional word is 25 cents. E-mail ads are fine.

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⧗ Deadline for the June 2005 issue: ☞ Saturday, May 28

SERVICE FOR SALE: Repair and restoration on all vintage equipment; over 50 year's of experience. Barney Wooters, W5KSO, 8303 E. Mansfield Ave., Denver, CO 80237. 303-770-5314

MANUALS FOR SALE: Military Radio manuals, orig. & reprints. List for address label & $1. For specific requests, feel free to write or (best) email. Robert Downs, 2027 Mapleton Dr., Houston, TX 77043, wa5cab@cs.com

FOR SALE: Central Electronics 100V Good Condition $650. Heathkit Warrior Amp $400. BOB, W1RMB. 508-222-5553.

FOR SALE: Globe King 400 for restoration. Some rust and lots of dirt. Missing HV power transformer. All original knobs and meters. RF deck needs coils and V 70D's or conversion to 811A's. Modulator is complete and un-tampered with. This rig is not turn-key, it needs a resourceful person knowledgeable in Boat anchor clean up, operation and repair. Will ship or free delivery along I-15 from Salt Lake City to San Diego or to Denver or to Phoenix area, BO over $400 ends 5/31. Email for pictures. Brian, AI7Z, 435-865-9339, after 8AM MT. sparkee@infowest.com

FOR SALE: Radio Transmitter AN/FRT-15A . Frequency range 2-26 Mc, working condx., 3 racks, 4-1000s modulated by 4-1000s. $3000, PU only. George Rancourt, K1ANX, 413-527-4304, k1anx@mindspring.com

FOR SALE: Drake TR-7/TR-7A/R-7A service Kit. Includes 13 extender boards and digital jumper card. $63.85 including postage. www.atnet.net/~rsrolfne Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net, 509-766-7277

FOR SALE: Explor-Air 3 tube AC/DC regen rcvr. 4 bands, working, $75. Stuart T. Carter II, W4NHC, 680 Fernwood Dr., Melbourne FL 32904. 321-727-3015

FOR SALE: Lafayette model HA-500, 1966 QC inspection. $150. Art, 808-748-3883

FOR SALE: Collins 32RA transmitter, 1939, no mods, complete, needs cleaning, buyer PU or arrange shipping, no manual. Collins ART-13 Instruction Book AN 08-30ART13-5 (17H-2 ATC or AN/ART-13 equipment), printed by Collins, very nice original condx, cover stamped "Radio Service Engineering File Copy." Full factory pictorials and diagrams. Best reasonable offer both items. Barney, W5KSO, 303-770-5314

FOR SALE: Hammarlund HQ-225 solid state shortwave bands only receiver; researched & believe only prototype to exist; sister to HQ-215 solid state ham bands only receiver. Very good working and external condition. Can email photos. $500. BOB, KD9GI, 815-332-9520 KD9GI@msn.com

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FOR SALE: Viking Invader 2000, Good Condition, $1,500. Parts unit $400. You ship. Ken Sands, K8TFD, 734-453-7658, ken.sands@juno.com

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FOR SALE: Hallicrafters "00-100" back plate for main tuning knob. Perfect match, $13 shipped. Charlie Talbott, 13192 Pinnacle Lane, Leesburg, VA 20176-6146, 540-822-5643, k3ich@arrl.net

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FOR SALE: Cleaning house after 70 years a ham. Many old and antique items. LSASE for my long list. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002, 316-733-1856

FOR SALE: Hammarlund Telechron clock plastic face covers, crystal clear, new reproductions, $15 plus shipping. Rick Cutter, WA3MKT, 814-725-9490, richard_cutter@lord.com

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FOR SALE/TRADE: Original manuals: Drake, Hallicrafters, Hammarlund, Swan, National, Johnson, B&W, Ten-Tec, EICO, Ameco, Harvey-Wells. A.J. Bernard, POB 690098, Orlando, FL 32869. 407-351-5536

FOR SALE: Gonset G-33 receiver $80. Gonset GPP-1 phone patch $28. Heath HO-1234 coaxial switch, unbuilt in box $45. Johnson Challenger $130. All plus shipping. Bill, 989-848-5002.

FOR SALE: Original manual for Collins 75S-1 with updates thru 1958. $20 + shipping. Front very slightly soiled. Ken, Waco TX, 254-772-7307

FOR SALE: Hustler 5BTV vertical antenna, 10-80M, new in box, never assembled $95 plus shipping. Retails $169. William Mandale, 371 Prussian Lane, Wayne, PA 19087 610-687-0917 w2whw@msn.com

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CRYSTALS FOR SALE: AM and CW FT243 CRYSTALS - NEW LIST: 1885, 1900, 1930, 1945, 1970, 1985, 3721, 3837, 3855, 3870, 3875, 3880, 3885, 3890, 7018, 7050, 7123, 7143, 7250, 7255, 7260, 7280, 7285, 7290, 7293, 7295, 8400, 10106, 14286 kc. Many others available - See list at http://www.af4k.com/crystals.htm or call Brian, AF4K on 407-323-4178 af4k@hotmail@com

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FOR SALE: Cushman Service Manuals for CE-4/CE4B Comm. Monitor $25, CE-15 spectrum monitor, $20 shipped. 864-855-9570, k4deejim@aol.com

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

FOR SALE: National NC-33 parts radio, $25. MFJ-1040B deluxe RF preselector II, $25. TenTec digital readout model 244, manual, $75. Jerry Whitmore, K9HAW, 1706 Hillcrest Ct., Mendota, IL 61342. 815-539-7519

FOR SALE: Crosley model 51 tube rcvr $100. Swan 250C 6 meter rig w/PS, spkr, ext. VFO, orig. manual $175. 2 Allied FM rcvrs #2589: 30 to 50 Mc and 152 to 175 Mc $25 each. Heath Two'er $25. 3 Astatic mics $25 ea. Heath sig gen SG8 $25. Heath VTVM V9A $25. 2 Allied FM rcvrs $25 ea. 2 telegraph sounders $25 ea. Hallicrafters Super Skyrider $35. AK horn spkr Type M good, $125. 1927 Radio Operator's guide $25. 12 bound volumes of Popular Mechanics articles $60. ARRL handbooks 40s to 70s $25 ea. Many issues of Radio and The Horn Speaker. All + shipping. Vern Snyder, 5 Parkview Dr., Winder, GA 30680 1-720-307-1459

FOR SALE: Simpson 370 AC Ammeter, $60. Simpson 373 DC Milliammeter, $60. Ross Wollrab, 229 N. Oakcrest Avenue, Decatur, IL 62522-1810. 217-428-7385. REWollrab@aol.com

FOR SALE: Rack cabinet 22" wide, 18" deep, 70" panel ht. 110V inside w/12 AC sockets. Green wrinkle finish, on steel casters w/2 latch back door. Jerry, K5ULB, 918-724-8272

FOR SALE: Palomar Skipper 300 linear amp, $250 exc. Heathkit HW-100 $75. MFJ-981 3-kw tuner $195. National NC-188 $175. Ron, MI, 517-374-1107.

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

FOR SALE/TRADE: MT-1/Cheyenne/MR-1/Comanche/ps $275. RT-66/GRC $100. SX-99 $150. Want rcvr spkrs. **Wanted Info:** Radiomarine T-408/URT-12/USCG/1955. Sam, KF4TXQ, PO Box 161. Dadeville, AL 36853-0161 stimber@lakemartin.net 256-825-7305

HALLICRAFTERS PARTS: Hallicrafters SX101/101A reproduction main tuning knob. Includes silver inlay and set screws. $35.00 Mike Langston KL7CD, 1933 Diamond Ridge Drive, Carrollton, Texas 75010, mlangston@hcpriceco.com 972-392-5336

JOHNSON PARTS: EFJ replacement parts: Valiant tie bolts-4 for $18.50. Ranger tie bolts-3 for $17. 80-2CM mic connector (also for Heath/Collins/others) 10 All ppd. **WANTED:** EICO 722 VFO. Contact Cal Eustaquio, N6KYR/8, 823 W. Shiawasee St, Lansing, MI 48915. E-mail: catman351@yahoo.com

FOR SALE/TRADE: Transmitting/Receiving tubes, new and used. LSASE or e-mail 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, E-mail: jwalker83@kc.rr.com

FOR SALE: National vernier dials, new, ICN, $45; SCN, $45; N, $32. Heath HW-8 & HWA-7-1 P/S, $135. Richard Prester, 131 Ridge Road, West Milford, NJ 07480. 973-728-2454. rprester@warwick.net

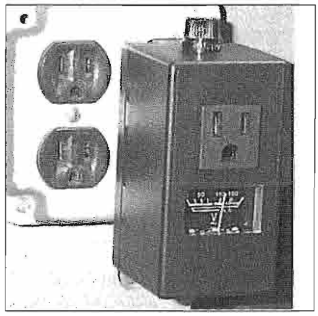
DRAKE SERVICE FOR SALE: R.L. Drake repair and reconditioning, most models including TR-7's, 35 years experience. Jeff Covelli, WA8SAJ, **440-951-6406** AFTER 4 PM, wa8saj@ncweb.com

FOR SALE: Army manual for BC-375E, make offer. Fred Clinger, 417 Beechwood Dr., Galion, OH 44833 419-468-6117 after 6 PM.

Inrush Current Limiters are now available from the Electric Radio store! These inrush limiters were reviewed in the September, 2004 issue of Electric Radio and are available in two versions:

ModelAB-1M (With Voltmeter) $34.95
Model AB-1 (With Pilot Light) $29.95
Shipping $4.95
(4 or more limiters are shipped for free for U.S. orders.)

The Inrush Limiter provides a gentle, slow startup for your vintage equipment in the 150-watt range. They also reduce the line voltage to original design values. Both models come with a full money-back guarantee.



Model AB1-M

FOR SALE: QUALITY LETTERPRESS QSLs LIKE IN THE OLD DAYS! Send $1 for samples. Smokey, W9STB, 8679 Pinkhurst Drive, Minocqua, WI 54548.

FOR SALE: R-390A's, R1051's, Harris RF-550's, URM-25D signal generators, military 28VDC gas generators, AS-2851 antenna kits. Call, Lots more stuff! S. Daniels, 636-343-5263

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, Box 187, Wheatland, WY 82201. 307-322-5858 feltondesign@yahoo.com

REPAIR! Radio repair reasonable charges. Manuals for sale. I buy Radios. J. Dan Rupe 998 Whipple Ave, Grayland, WA 98547 360-267-4011 W7ddf@yahoo.com

FOR SALE: Free list TT for obsolete Triplett transformers, chokes and manual copies. USA only. Bigelow Electronics, POB 125, Bluffton, OH 45817-0125

FOR SALE: Naval Receivers RAK, RAL, RAO, RBA, RBB, RBC, RBL, RBM. Some checked, pwr splys available. $75-$450 depending on condx. Many other types. Carl Bloom, 714-639-1679. carl.bloom@prodigy.net

TUBES FOR SALE: Tested good globe 201A and 226 $14, 227 $10 and others. Slightly weak 226, 227, 245, 280 guaranteed to work in early radios ½ regular price. Write or e-mail: tubes@qwest.net for a new price list or see www.fathauer.com. George H. Fathauer & Assoc., 123 N. Centennial Way, Ste. 105, Mesa, AZ 85201. 480-968-7686 or toll free 877-307-1414

PARTS FOR SALE: Strong steatite antenna insulators. Lengths from two to fifteen inches. SASE for list. John Etter, W2ER, 16 Fairline Dr., East Quogue, NY 11942. 631-653-5350

SERVICE FOR SALE: Vintage Radio Service. We repair radios, record changers, radios home, auto, tube & transistors. 1930-1980. Ken Hubbard, KA9WRN, POB 792, Beloit, WI 53512. 608-362-1896

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

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

SERVICE FOR SALE: Repair, Restore, Sales of antique, vintage tube radios. John Hartman, NM1H, www.radioattic.com/nm1h

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. bak@provisiontools.com

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

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

BOOKS FOR SALE: Used technical books: radio, electronics, math, military, magazines, etc. List: $1 (stamps OK). Softwave, 2 Dept. ER, 1515 Sashabaw, Ortonville, MI 48462

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

BOOK FOR SALE: Heath Nostalgia, 124 page book contains history, pictures, many stories by longtime Heath employees. (See ER Bookstore.) Terry Perdue, 18617 65th Ct., NE, Kenmore, WA 98028

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

MISC FOR SALE: Vintage equipment at the K8CX Ham Gallery Classified Ads section. Visit the largest Antique QSL Card Gallery http://hamgallery.com

PLEASE VISIT: RadioWorld-Online. Come to see our ham gear, parts, and more. Carl Blomstran PO Box 890473 Houston Tx. 281-660-4571.

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

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

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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 bugs@mnic.net

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PARTS FOR SALE: Parts, tubes, books, ECT. Send two stamp SASE or email for list. Wayne LeTourneau, POB 62, Wannaska, MN 56761 letourneau@wiktel.com

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SERVICE FOR SALE: Collins restoration. Everything inside & out to make it as Art Collins built it. 50 yrs experience. W9OJI / N4FZ, IL, 815-734-4255 or N4PZ@aol.com

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PARTS FOR SALE: Complete hardware set to connect Collins PM2 to KWM2 - $19.95 ppd. Warren Hall, KØZQD, POB 282, Ash Grove, MO 65604-0282.

PARTS FOR SALE: New Release. For details send 2-stamp LSASE to: Olde Tyme Radio Co, 2445 Lyttonsville Rd. Ste 317, Silver Spring, MD 20910

EQUIPMENT FOR SALE: Military and commercial communications items. Murphy's Surplus, 401 N. Johnson Ave., El Cajon, CA 92020. 619-444-7717 www.Murphyjunk.com

TUBES FOR SALE: Tube list, new & used, wide variety audio, and ham. Recently expanded. SASE 52c. Bill McCombs, WBØWNQ, 10532 Bartlett Ct., Wichita, KS 67212-1212

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 bigspndr@yk.mv.com

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, 1545 S CR 1150 W, Parker City, IN 47368

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, 307-322-5858, feltondesign@yahoo.com

SERVICE FOR SALE: COMPLETE SERVICE JOHNSON "TURBO" RANGER, Valiant, Viking 500, Vik-II, include panel / cab refinish. Also Hammarlund 180(A), National 300, 303, R390(A), others. http://w4pnt.8k.com Patty & Dee's Marina: 534 W. Main St. Waynesboro, Va. 22980. 540-249-3161 Cell: 540-480-7179, E-mail:

w4pnt@highspeedlink.net

WANTED: Eico 722 VFO in working condx. Tom Stanley, KA1T, 2625 Brownsville Hartland Rd, West Windsor VT, 05089 802-484-3304

WANTED: Schematic and/or service information for Eldico SSB-1000 amplifier. Robert, W4RL, W4RC@bellsouth.net

WANTED: Indoor FM antenna by B.I.C. made in 1960s. Condx unimportant. Also FM whip antenna. Charles Graham, 4 Fieldwood Dr., Bedford Hills, NY 10507 914-666-4523

WANTED: Drake TR-4 parts: tuning knob w/skirt, 40m band crystal and plastic cabinet feet. Steve Davis, KD2NX, 181 Center Avenue, Keansburg, N.J. 07734, 732- 495-8275, kd2nx_66@yahoo.com

WANTED: Harvey Radio Labs Tri-Tet Exciter or FT-30 Transmitter. $1000 reward! Robert Enemark, W1EC, PO Box 1607, Duxbury, MA 02331, 781-585-6233

WANTED: Pearce-Simpson VHF marine service manuals/schematics/radios, all models. JR Linden, K7PUR, PO Box 4927, Cave Creek, AZ 85327, jrlinden@usa.net

WANTED: Spilsbury and Northern Radio tube type communication equipment, portable or base station type. Ken Lakin, P.O. Box 310, Redmond, OR 97756. 541-923-1013, kd6b@bendbroadband.com

WANTED: Older model Heathkit C-3 condenser checker. Basket case is fine. State price plus shipping. John Snow, 1910 Remington Ct., Andover, KS 67002. 316-733-1856

WANTED: Any TMC Equipment or Manuals, what have you? Will buy or trade. Brent Bailey, 109 Belcourt Dr.,Greenwood, S.C. 29649, 864- 227-6292 brentw@emeraldis.com

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: Old military radar displays, scopes, antennae, receivers, manuals, etc. Even half ton items! William Donzelli, 15 MacArthur Dr., Carmel, NY 10512. 847-225-2547, aw288@osfn.org

WANTED: Seeking unbuilt Heathkits, Knight kits. Gene Peroni, POB 7164, St. Davids, PA 19087. 610-293-2421

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

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

WANTED: Info on xmtrs made by Clough-Brengle Co. Used by the CCC, in the mid to late 30's. Any help would be greatly appreciated. Ron Lawrence, KC4YOY, POB 3015, Matthews, NC 28106. 704-289-1166, kc4yoy@trellis.net

WANTED: WW II Japanese xmtrs & rcvrs (parts, plug-in coils) for restoration & ER articles. Ken Lakin, KD6B, 63140 Britta St., Ste. C106, Bend, OR 97701. 541-923-1013. klakin@aol.com

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: Looking for information on radio and radar equipment aboard the Navy PB4Y-1. Warren, K1BOX, NC, 828-688-1922, k1box@arrl.net

WANTED: WW II German, Japanese, Italian, French equipment, tubes, manuals and parts. Bob Graham, 2105 NW 30th, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

WANTED: Heath Gear, unassembled kits, catalogs and manuals. Bill Robbins, 5339 Chickadee Dr., Kalamazoo, MI 49009. 616-375-7978, billrobb@net-link.net

WANTED: TCS & TBY Navy radios. Ken Kolthoff, K8AXH, PO Box 215, Craig, MO 64437. Work #913-577-8422.

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: Looking for a National NTX or NTE transmitter/exciter for use in my vintage hamshack. Any condition, even basket cases or parts, considered. Will pick up in New England, or arrange shipping if outside of area. Paying any reasonable price, and most unreasonable ones! Please email with details or photos, all considered and most likely bought! Thanks! Bruce W1UJR 207-882-9969 or w1ujr@arrl.net

WANTED: Schematic and related info on Halowatt TR5 broadcast rcvr made mid-1920s in Portland, OR. Fern Rivard, VE7GZ , PO Box 457, Cranbrook, BC V1C4H9 CANADA crc@cyberlink.bc.ca

WANTED: Manual for Hickok VTVM model 209B. Also manual for Knight (Allied Radio) transistor 10-circuit lab kit #83Y299. WJ Klewchuk, POB 927, Wadena Sask. Canada SØA 4JØ 306-338-2264

WANTED: Stancor audio amplifiers and/or transmitters of the late 30's and early 40's.in any condition. Jim Schliestett, W4IMQ, 420 Lakeview Dr, Cedartown, Ga 30125, 770-748-5968, imq@bellsouth.net

WANTED: Collins 312A1 speaker, National SW5, Eldico R104 and T102, QSL cards from 1920's, 9CXX or W9CXX. Scott Freeberg, WA9WFA, 327 Wildwood

Avenue, Saint Paul MN 55110. 651-653-2054 Email: wa9wfa@qsl.net

WANTED: Hallicrafters HT-33 linear amplifier, dead or alive! John, W8JKS, 740-998-4518

WANTED: Plate circuit breaker as used in a **Collins 20V-2**. Dewey Angerhofer WØZUS, PO Box 540, Edgemont, SD 57735, 605-662-7692, dra@gwtc.net

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

WANTED: Commercial or kit-built 1930s and 40s transmitters.Doc, K7SO, 505-920-5528 or doc@cybermesa.com

WANTED: Hallicrafters SX115, SX88, Collins 75A-1, AM broadcast transmitter in New England area, Heath DX100B. Will pay good price for good equipment. w1txjohn@aol.com, 802-775-7632 Eves.

WANTED: Meters for following tube testers: Western Electric KS-15750, Weston 774-5 Analyzer. Walter L. Hughes, WB4FPD, 6 Academy Ct., Berryville, VA 22611 540-955-2635

WANTED: DAVID GRIMES: radio model 3XP, and advertising, ephemera, literature, references, parts; please contact: Mike Grimes, K5MLG; 5306 Creekside Ct.; Plano, Texas, 75094, 972-384-1133. Email: grimesm@flash.net

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: Sonar CB transceiver model J23 mobile set. 23-channel, tube-type CB radios, also 23-channel mobile sets. Ed, WA7DAX, 1649 E. Stratford Ave., Salt Lake City, UT 84106. 801-484-5853

WANTED: National NTE CW xmtr in working Condx. I love National. Sylvia Thompson, 33 Lawton Foster Rd., Hopkinton, RI 02833. 401-377-4912. n1vj@arrl.net

WANTED: PYE, Fairchild, Syncron, Langevin. Richard P. Robinson, PO Box 291666, LA CA 90029 323-839-7293 richmix@erols.com

WANTED: ARC-5 rcvrs, racks, dynamotors. Jim Hebert, 900 N. San Marcos Dr. Lot 15, Apache Junction, AZ 85220

WANTED: Scott Special Communications rcvr. EA4JL, please call Kurt Keller, CT, 203-431-9740, k2112@earthlink.net

WANTED: ANY Harvey-Wells speaker, aircraft unit, or military surplus component. Will answer all. Kelley, W8GFG, 9010 Marquette St., St. John IN, 46373, 219-365-4730

WANTED: Collins 310B-3, basket case OK, 70E-8A PTO per 1948. Chicago CMS-2, pair of Taylor T-21. Jerry, W8GED, CO, 303-979-2323.

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: 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

WANTED: Books about flight simulators, aircraft instruments, panel meters, or tube computers. Chris Cross, POB 94, McConnell, IL 61050.

WANTED: Westinghouse MW-2 Transmitter (RF Unit, Modulator, Power Supply, Coils, Transformers, Parts). Will pickup anywhere. Gary, WA4ODY, Seabrook, TX. 281-291-7701, myctpab@earthlink.net

WANTED: WWII Navy GP-7 transmitter in any condition, with or without tuning units or tubes, etc. Ted Bracco, WØNZW, braccot@hotmail.com A.C. 717-857-6404 X306

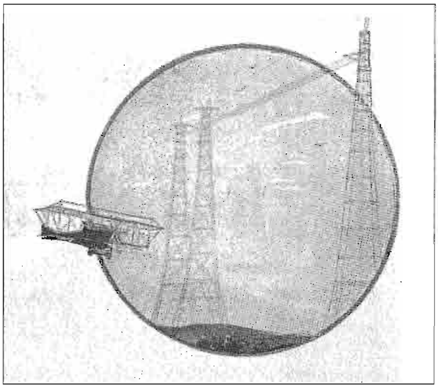
WANTED: Receivers. Telefunken E1800, Rohde Schwarz, EK-56/4, NC-400, Racal 3712, Hallicrafters SX 88, Collins HF8054A, Collins 851S-1. Manual for Racal R2174B(P)URR 310-812-0188(w) alan.royce@ngc.com

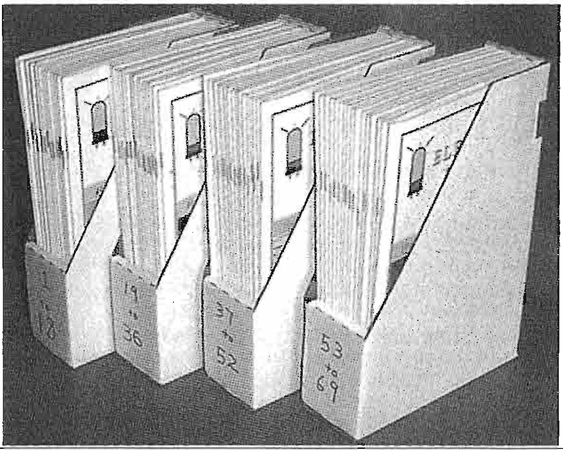
WANTED: WW I era and 20' s hi-end sets, amps, detectors: SE 143/IP 500; SE 1420/IP 501; CN 112; RCA 106; SE 1000; SE 1071; Kennedy 110,220; Grebe CR 18; early supers: Norden Hauck Navy 10; Golden Leutz; others; WW I, WW II RDF gear; need DU 1 Loop set-up; others; WW II spy radios. Always buying vintage broadcast gear, tube pre's, compressors, mics, stands, mic flags, by Altec, RCA, Sony, WE. I've got lots of cool radios and stuff to trade or pay cash. Ward Kremer, KI4JHA, 1179 Petunia Rd., Newport, TN 37821, Ph/fax: 423/625-1994. Please note: new e-mail: **witzend99@bellsouth.net**

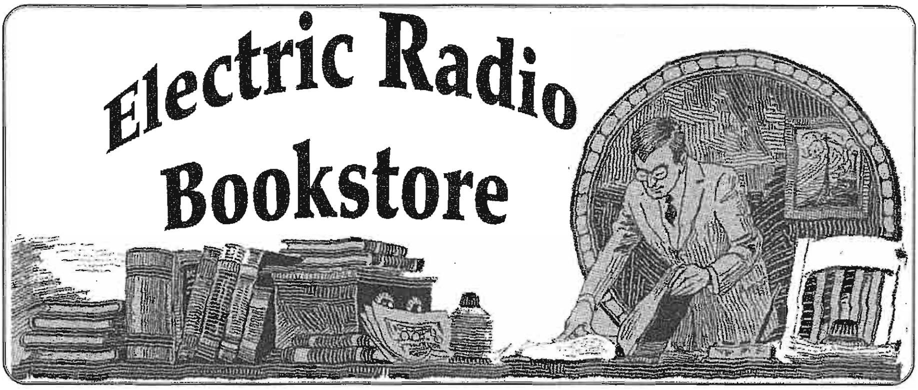
WANTED: References to articles in electronics magazines (or utility trade magazines) on the Rural Electrification Act (REA) in the 1930s. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

WANTED: Circuit for the "Mitey-Mite" transmitter-receiver. Harold Schaffner, W2GMX, 519 Perine St., Elmira, NY 14904.

WANTED: A dozen or more old empty FIVE (5) pin 1-3/8" O.D. new or used empty tube bases, so I can roll some SW coils. Quote your price. Thanks! Bob Ryan, 1000 S. Gilbert St., Apt. 132, Hemet, CA 92543-7065







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(Note: Shortwave Receivers, Past and Present is out of print and will not be available until at least late 2007 according to the publisher.)

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