$2.50

ELECTRIC RADIO

celebrating a bygone era

Number 150 November 2001

Steve Moll, WAØBPU

ELECTRIC RADIO

published monthly by Electric Radio Press, Inc.
14643 County Road G, Cortez, CO 81321-9575
Periodicals postage paid at Cortez, CO

USPS no. 004-611
ISSN 1048-3020

Postmaster send address changes to: **Electric Radio**
14643 County Road G
Cortez, CO 81321-9575

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Office Manager - Shirley A. Wiseman

Electric Radio is published primarily for those who appreciate vintage gear and those who are interested in the 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/operating with an emphasis on AM, but articles on CW and SSB are also needed. Photos of hams in their hamshacks are always appreciated. We invite those interested in writing for ER to write or call.

Regular contributors include:

Bill Breshears, WC3K; Bob Dennison, W2HBE; Dale Gagnon, KW1I; Bob Grinder, K7AK; Jim Hanlon, W8KGI; Brian Harris, WA5UEK; Tom Marcellino, W3BYM; Ray Osterwald, NØDMS; Chuck Teeters, W4MEW; Bruce Vaughan, NR5Q.

Editor's Comments

Dick Houston, WØPK, Silent Key

Dick passed away in the last week of October after a short illness. He was 80 years old. For the past 11 years he has been our proofreader and also our good friend. Shirley and I will miss him very much.

Although I knew Dick for a long time (I met him around 1985) I didn't realize how little I knew about him until he was gone. As best I know it, he was born in one of the southern states, I think it was Alabama. He spent his entire youth there. After graduating from university with a Electrical Engineering degree he went to the Washington, DC area where he worked for the Navy developing submarine sonar and communications gear. In the 50's he went to work for Collins Radio in Cedar Rapids in the broadcast transmitter division. After a few years he transferred to the Richardson, Texas plant where he worked until he retired. He and his wife Barbie then moved to Durango where he spent a few years keeping all of the broadcast transmitters in the area on the air.

After Barbie passed away about 5 years ago Dick moved into an apartment. He occupied his time with the Kawanis Club and volunteer work at the Southwest Safehouse for Women. Dick liked to go there and read to the kids and be helpful in any way that he could. He was a very caring person.

Besides catching punctuation and grammatical errors Dick contributed a lot by keeping ER technically accurate. I respected his opinion over that of almost anyone. When Dick said that something wasn't right I believed him. I'm looking for someone else in the area like Dick. Wish me luck.

Collins 300G Restoration Update

So far I've been very, very lucky. After getting the transmitter back together after

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AMI Update—November, 2001

by Bill Kleronomos, KDØHG
Rocky Mountain Director, AMI
klerosb@earthlink.net

Because of job commitments Dale's usual words of wisdom will be AWOL this month so I'll do my best to fill in.

The first matter I want to cover is one that has probably had the most adverse impact on 75 meter band AM operations for over a year now. It is the often potent RTTY signal that's popped up on 3885, the nationwide AM calling frequency. Let me give all of you a bit of background on this issue and an update on where we stand.

Last fall, several of us within the AMI organization contacted the ARRL, including discussing the matter on the phone with Jim Haynie, League president, and asked that the matter be looked into so that we could work towards a constructive resolution. Our DF'ing efforts have all indicated that this station is most likely located in the area of the south Atlantic in the vicinity of or in South America. Using standard FSK, it appears to be sending code groups as opposed to plain text. Since this station appears to be operating within our ITU Region 2, it's important to note that in certain countries of South America, fixed commercial services have primary rights to the top of our 75 meter band, including 3885 kHz. These countries are Argentina, Bolivia, Chile, Ecuador, Paraguay, Peru and Uruguay. Our plan to deal with this is to first determine precisely who the intruder is and to contact them directly for the purpose of making them aware of the adverse impact they are having on amateur operations in North America. It would seem very unlikely that any of the countries on the permitted list would be intending their transmissions to be received in the United States, and that they could be persuaded to QSY, reduce power, or to use a directional antenna pattern protecting North America. In the event this station is not operating from where internationally permitted, then our position is all the stronger.

Where do we stand today? Going into another winter season of 75 meter activity, there has regrettably been no apparent follow up on the matter and the RATT racket is still there. On the advice of my ARRL director, Walt Stinson, WØCP, I have directly contacted the Region 2 intruder specialist within the IARU, Martin Potter, VE3OAT. Martin advises me that the League contacted the FCC about the matter last year, but at that point the matter seemingly dropped through the cracks somewhere. At the current time, I'm working to positively identify who the station is as nothing can be seemingly done until then. Further action will be determined by our findings. I am soliciting letters urging the League to follow through and work towards a cooperative resolution of this matter. Notes of support with your name and call sign can be e-mailed to me at **klerosb@earthlink.net**. You don't need to be a League member to express your support. I will be forwarding received names in the form of a petition asking for League support of our efforts. Hopefully, by the time this goes to press the licensee of the RTTY station will have already been contacted.

Related to this loss of a piece of our customary AM operating spectrum, there has been a considerable amount of discussion on the Internet about operating outside the customary "AM Window" centered at 3885 kHz. I think this is good advice and to those with Advanced or Extra class licenses, be aware there is an increasing amount of AM activity around 3825-3840 kHz. Let's loosen the dial locks on those receivers and join in.

On another note, it appears our concerns may be lessened concerning a

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RAS-5, Lost and Found

by Robert Gravel, K1BUB
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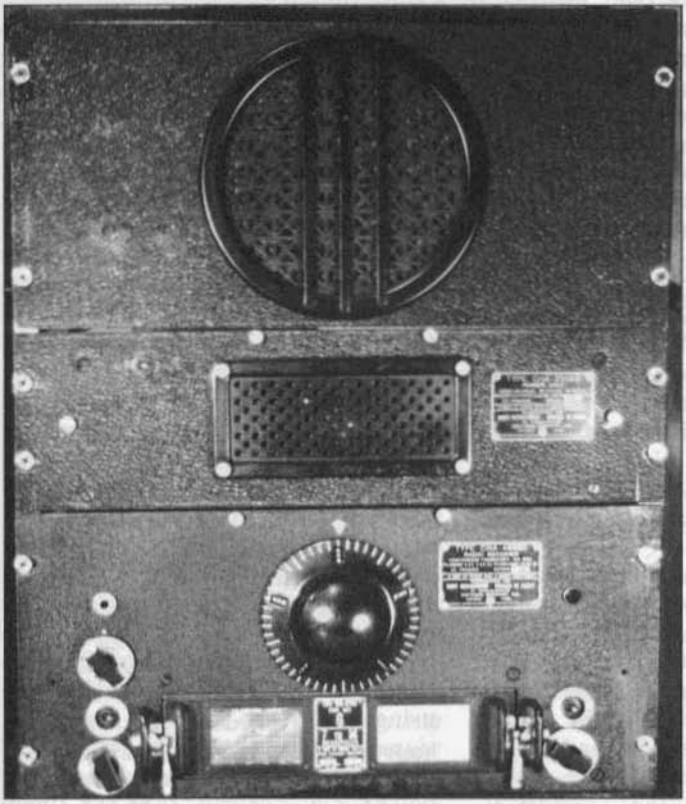
A picture of my shack circa 1959 appeared in ER #119 and in that picture the receiver I was using was a borrowed RAS-5. My good friend George Rancourt, K1ANX, knowing that I no longer had that receiver called to tell me that he knew where there was one for sale. I wound up buying it for $50. It was in pretty bad shape—it would have to be repainted and the power supply transformer was missing—but I did get the coil box with coils and the speaker.

As I was going through the receiver a lot of little things reminded me of that RAS I had so long ago. On a hunch I called the fellow I had borrowed it from back in '57. He was one of my mentors Art, W1KK. Even though he's 90 years old now, he confirmed that this indeed was his old receiver that he had loaned me when I first got my license. (The only receiver I owned back then was an S-38B. Art told me to use the RAS until I could get something better. As I recall he didn't think much of the S-38 as a communications receiver.)



Art told me that he had sold the receiver to a fellow in Rhode Island and then it had went to the Boston area before coming back to Springfield.

As you can see from the photo, the receiver looks OK after the new paint job. The nameplates were also missing but I managed to find replacements. Electrically all that was required was some new caps. The receiver works very good now, just as I recall that it did 40 plus years ago. ER

Restoring the AN/GRC-26A Communication System

by Ken Kinderman, WB9OZR
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I. Introduction and System Description

This summer, I was fortunate enough to acquire a GRC-26A in a condition best described as fair-to-good. More important than the condition was the completeness of the unit. Although many of the movable pieces were gone, all of the equipment and cabling was virtually untouched. Some important spare parts remained, including a yet-to-be tested spare 100TH and 250TH, BC-610 tuning units and coils, and all but one of the manuals. The contract date on the shelter is 1950, but MFP (Moisture Fungus Proof) dates on the equipment place it around 1953. Also included was a complete bill of materials drawn up by Hallicrafters, dated May 1953. This list is critical to the replacement of missing parts, and to the proper configuration of the finished unit. It also answers such questions as, how big was the fire extinguisher, and where are the two brooms stored? Although the GRC-26A shows its Hallicrafters lineage, by the early 1950's many other manufacturers were involved, including Barker and Williamson. The BC-610-H tuning units in my GRC-26A look exactly like those from earlier years, but they were assembled by an upstart company called Heath.

This article, and additional parts to follow, describe how I came to own it (we already know why!), and the process of restoring it cosmetically and electrically. As I write this, the job is not yet finished. Therefore, right at the beginning, I invite ER readers to contribute to the project with information, suggestions, historical insight, or anything else that adds to our common store of knowledge about this line of workhorse radio systems. My desire to share this restoration project in real time with ER readers puts diligent historical research temporarily into the back seat. If you can add to the record, please do. Some fine articles on the subject have appeared (Note 2). In particular we would all like to hear from anyone who has had actual field operating experience with the GRC-26. As I acquire more information, I will include it in later installments of this article. In addition I have set up a website with photos, a progress report, and expanded information, where I will also post new information as I receive it. The web address is **www.arc-5.com/grc26a**.

The AN/GRC-26A traces its pedigree back to the SCR-197 (Note 1), through the famous SCR-299 of World War II (and variants SCR-399 and SCR-499) (Note 2). Its job by the early 1950's was to provide the Army with "a transportable assembly of equipment" for transmission and reception of radio teletype (RTTY), wireline teletype, radiotelephone, and CW. The system is actually quite flexible, offering dual diversity, simplex or full duplex, and remote operation. A nice touch is the capability of running RTT and AM simultaneously. This is made possible by picking off the RTT signal at the receiver IF and demodulating it before it hits the audio system. This avoids using the BFO to create an audio FSK signal, and leaves the audio channel of both receivers free for AM detection. If you have ever listened to an FSK signal

The AN/GRC-26A stands approximately at the evolutionary mid-point of the U.S Army's mobile, mid-power, H.F. communications systems used between the 1940's through the 1970's.

with the BFO turned off, you'll know that there is still a residual clicking noise audible. The manual recommends turning on the receiver's noise limiter to improve intelligibility of the AM demodulation. The system on the other end of the circuit also needs to use IF demodulation for 2 way communication to take place. Because this method of dual modulation depends on the constant carrier provided by the RTT traffic, the AM capability was probably no more than an occasional "intercom" between the two RTT stations. We will find out just how effective it all is when the system is up and running.

The manual describes 3 operating conditions: mobile, mobile-at-halt, and semi-fixed. In the two mobile conditions, the on-board whip antennas are used. When operating semi-fixed, two receiving dipoles are erected, ideally 950 feet apart, for diversity reception, and one transmitting dipole is erected within 30 feet of the shelter.

The nomenclature AN/GRC-26A refers to the entire unit consisting of the communications equipment and accessories, and the S-69/GRC shelter that houses it. The core electronic gear of the -A version is a BC-610H, 2 Collins R-388 receivers, teletype converter and modulator, and the teleprinters. This differs from the original GRC-26 which had two modified BC-344 (BC-312) receivers, and a BC-221 for calibration. The GRC-26 series itself is very different from the SCR-299 of World War II. The family lineage is unmistakable: both use a BC-610(*) and two receivers. Both were in a hard sided shelter, mounted on a 2-1/2 ton 6x6 truck, and towed a PE-95(*) generator. However, the layout inside the two shelters differs substantially, and the SCR-299 was capable of AM and CW only, no RTT. It is the addition of RTT capability that makes the GRC-26(*) not so much a different system, as a more evolved one.

The interior walls of the shelter are wood, and all equipment is grounded to 2 inch copper strap running throughout. This strap connects to the outer steel sheeting, and to copper clad

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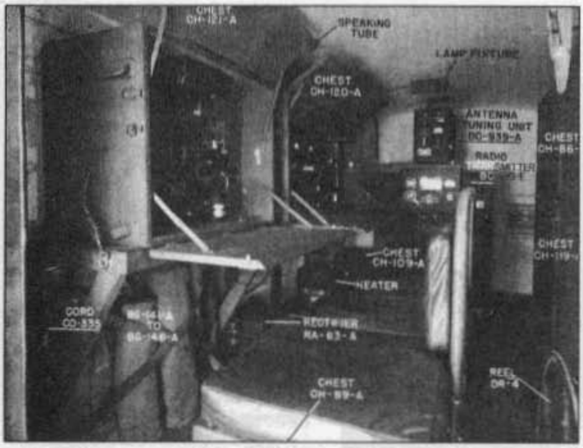

Interior view, left hand side, looking forward.

steel screening under the floor. I will attempt to restore the integrity of this "shielding", (if it ever had any integrity). But I may not succeed given the corrosion that must still exist at the junction of some of the outer steel sheets. Perhaps all that can be hoped for is not to turn the shelter into one big reradiating antenna. All equipment uses 2 bladed plugs, with braid straps for grounding. The entire system is powered off the 110 volts 60 cycle AC of the PE-95. Four fluorescent lamps with special "noise suppressed" starters run along the ceiling. The shelter is 12 feet 1 inch long, 6 feet 7-1/2 wide, (an important dimension as we shall see) and 6 feet 9 inches high.

By the way, for those of us who care, a word needs to be said about the look of the BC-610H. I know I will get some flak, but here goes. The -H is a "later" model BC-610. It differs noticeably from the BC-610E and earlier models. Yes, there are many electrical improvements, but the -H has about as much visual appeal as a welding machine compared with the art deco lines, translucent dials, stepped cabinet, and other details of the -E version. Nonetheless, it still is a classic, and still stands as an icon of its era.

II. Acquisition

After reading Dale Gagnon's brief but very accurate description of the unit, I contacted Fair Radio's Phil Sellati. See Dale's excellent article (Note 3), for additional photos, and a description of the unit's initial condition. Following a review of some digital photos Phil sent me, I owned the unit. The first challenge was getting it from Lima, Ohio to the east coast. A business trip to Houston a few weeks hence, with the possibility of diverting through Toledo, gave me some time to plan the pickup, transport, and eventual storage. Within a few days I found Dick Brock, a very knowledgeable trailer dealer right down the street from Fair Radio. Dick eyeballed the shelter and measured the width. A tandem axle flatbed, 16 feet long by 7 feet wide fit the requirement, and I asked Dick to deliver it just prior to my arrival. The plan was to pick up the shelter with two forklifts, and lower it straight down onto the trailer. The less desirable Plan B was to slide it on from the rear. A quick education on why Ryder and U-Haul refused to let me tow my own trailer left me up a tree until Dick volunteered to drive it east, with me as passenger. After arranging for an out-of-the-way (i.e. cheap) outdoor storage space in rural New Jersey, the plan was ready.

From Houston (and a very pleasant visit with Robert Downs, WA5CAB), I was off to Toledo. After a bus trip to Lima, Ron Sellati of Fair Radio was kind enough to pick me up at the local Greyhound stop. The next morning bright and early I showed up at Fair Radio and met Joe Sellati and the crew. Steve and the others at Fair Radio are truly professionals, and they are the ones who literally did the heavy lifting.

Interior view, right hand side.

A small glitch with the trailer worried me a bit: when I double-checked the order with Dick Brock the day before I got to Lima, he informed me that the trailer arrived OK, but with non-removable angle iron railings extending up 14" on three sides. That meant we couldn't drop the shelter down onto the trailer. It had to be slid on. Interestingly, it is the same method recommended in the GRC-26A manual:

"If no hoist is available, some other method must be devised for raising the shelter to truck level and sliding it on (!)..." then, using two wooden skids, "hook the skids to the rear of the truck platform. Attach ropes to the shelter, and feed them through the front gate of the truck; one on each side of the cab. Attach the other ends of the ropes to a second truck and pull the shelter up the skids".

Easy for them to say! Since we were now limited to sliding the shelter on from the rear, I was concerned about side clearance. Over the telephone from Houston, I spoke with Dick. He offered to cut the railings off. "Before you do", I asked, "how much clearance will the shelter have on either side?" "Oh, plenty" Dick replied, " a good three quarters of an inch." After much dragging and some brilliant thinking by Steve, it worked. By mid-afternoon, after lunch with the crew, we were on our way.

III. Arrival and Assessment

After a pleasant overnight trip we parked the shelter at its new storage lot, and my assessment began. The S-69 shelter itself requires some repair. The structure is not "battle hardened" in any way. It is constructed of plywood with an outer layer of thin sheet steel. After evidently sitting outdoors directly on the ground for many years, maybe even decades, the wood and steel panels near the bottom are now corroded, as is the floor. The roof is varnished canvas over plywood, and is relatively OK, but more on that later. Very little corrosion is evident on the electronic gear: lots of shiny metal on the insides, and very little damage to the black wrinkle paint on the outside. At this point let's all give a resounding cheer for the guy or gal who laid the MFP varnish on so liberally 50 years ago! For purposes of clarity in describing the shelter I will refer to the front of the shelter as it would be seen when mounted on a truck bed, namely the end with the CY-1050 equipment cabinet. The rear is the end with the door.

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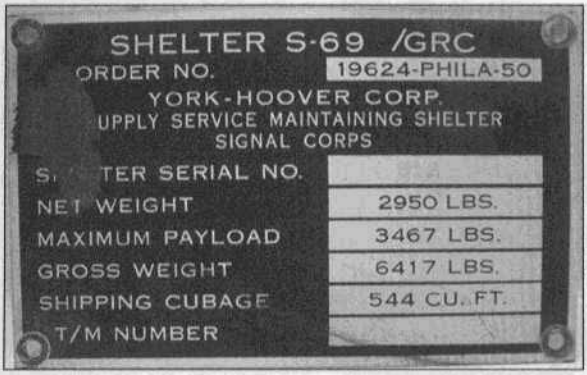


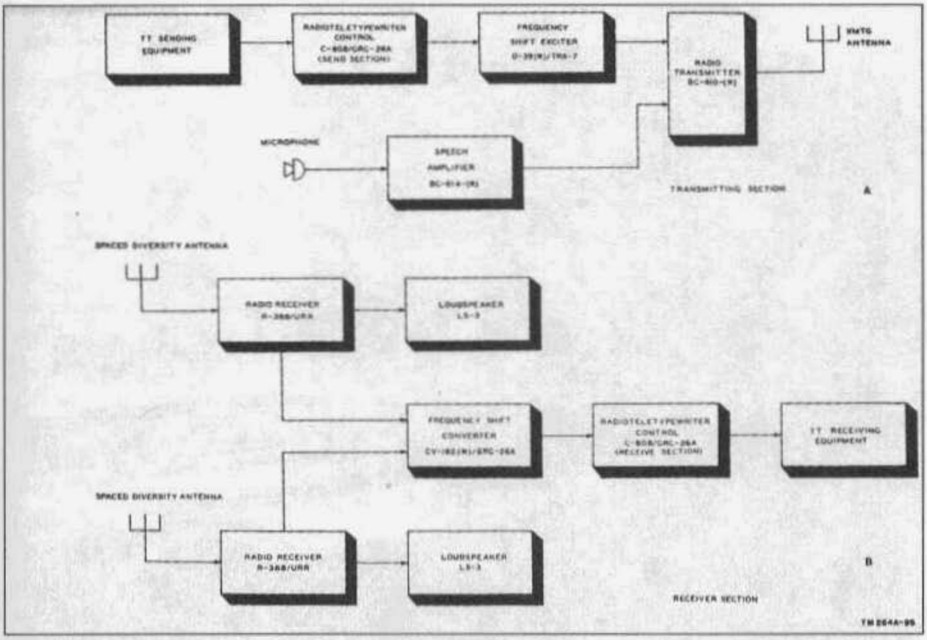
It is clear that the project presents itself in two parts: 1) the repair/rebuilding of the S-69 shelter, and 2) the refurbishing of the electronic gear. Equally clear is the need to separate these two parts of the job from each other. This means stripping the structure of everything.

IV. Disassembly

Along the inside left wall of the shelter is the wooden storage cabinet about 8 feet long and rising 6 feet to the ceiling. It is painted the same color as the rest of the interior, an eggshell finish in pale yellow. It has felt-lined compartments for the BC-610 tuning units and coils, as well as removable box drawers for spares and accessories. Sliding doors keep things in place. At the front end is the CY-1050 equipment cabinet with the receivers and RTT converter/power supply. On the right hand side of the shelter is the wooden operating bench, painted an eggshell olive green, and drilled to accept the mounting bolts and shock mounts of the various teletype equipment. All three of these "furniture" units are securely screwed to the sides and floor, and undoubtedly contribute to the rigidity of the entire shelter. Above the operating bench is an equipment shelf holding a spare typing unit, the BC-614 speech amp, C-808 control unit, and the O-39 oscillator.

Fortunately, all of the discrete electronic units and the teletype units were designed and installed to be easily removed. After 50 years, everything slipped off its shock mount or out of its cabinet with ease. Most interconnecting cables are in good shape, but all of the CD-307 cords were brittle. They fell apart in my hands, and will be replaced. The location of the BC-610 causes some problems. It is in the rear corner of the shelter, and the transmitter's innermost corner floor mounting bolt is inaccessible with ordinary tools. A special T-handled socket wrench, with a 44 inch shaft, is called out in the bill-of-materials for the sole purpose of removing this one bolt. The manual describes how to gain access to the BC-610 for repair purposes: remove all but the front right floor bolt and pivot the transmitter 90 degrees. Not the most field-friendly approach. An access door in the shelter wall would have been easier, and would not have compromised the shelter's security. I was able to remove all of the equipment by myself, except for the BC-610H, which at this writing is still in place.

Removing the wooden cabinetry was another matter. The screws fastening the operating bench together were so badly rusted (no Navy brass here!) and so inaccessible that the operating shelf had to be forcibly removed, but no damage was done. The storage cabinet on the left was easier, but had to be disassembled for removal. Both pieces of furniture are in very good shape. The overhead equipment shelf was easily taken out as well, but it demonstrates another built-in design flaw: the entire shelf hangs from threaded rods attached to a heavy steel strip fastened along the ceiling. The strip starts at the front end of the shelter, but it ends just above the shelf and does not extend the full length of the shelter. Thus the end of the shelf



Block diagram of GRC-26A Communications System

hangs in midair, right where the steel strip ends. (It's easier to see than explain). Here is the problem: the monster 125-pound O-39 oscillator is in exactly the wrong place. Look closely at photos on the website, and you will see how the end of the shelf sags under the weight of the O-39. This has pulled the ceiling down, actually breaking some of the wooden ceiling structure. The problem is aggravated when the shelter is in motion, bouncing up and down, greatly increasing the weight of the oscillator. Thus some repair of the roof is needed here. But the real problem is that a modification needs to be done to shore up the shelf, at least for transit purposes, so it doesn't happen again.

An interesting discovery I made while disassembling the interior of the shelter, and when examining the exterior: except for some welds at the outside corners, the entire structure was put together, and can be taken apart, with ordinary hand tools. I used nothing more than screwdrivers (sometimes as chisels!), pliers and a hammer. It truly shows its World War II heritage: easily and cheaply constructed, rather than forward-looking to the development of hardware that requires its own set of special tools. Working on it is a pleasure because results are easy to obtain.

The repair challenges are:

1. The interior floor: It is badly decomposed and needs to be replaced entirely. Fortunately, it does not form a part of the overall structure. It consists of overlapping plywood sheets, with a total thickness of 3/4 inch, fastened to cross stringers that run across the width of the shelter. Green linoleum covers the plywood, and probably looked quite good in its day. The cross stringers seem in good shape. Under the floor I found a layer of copper coated steel screening as mentioned above. Replacing the floor can be done from the inside. It appears that the 401 pound BC-610 will not have to be removed from inside the shelter: the floor can be replaced in sections, and the BC-610 can simply be shifted

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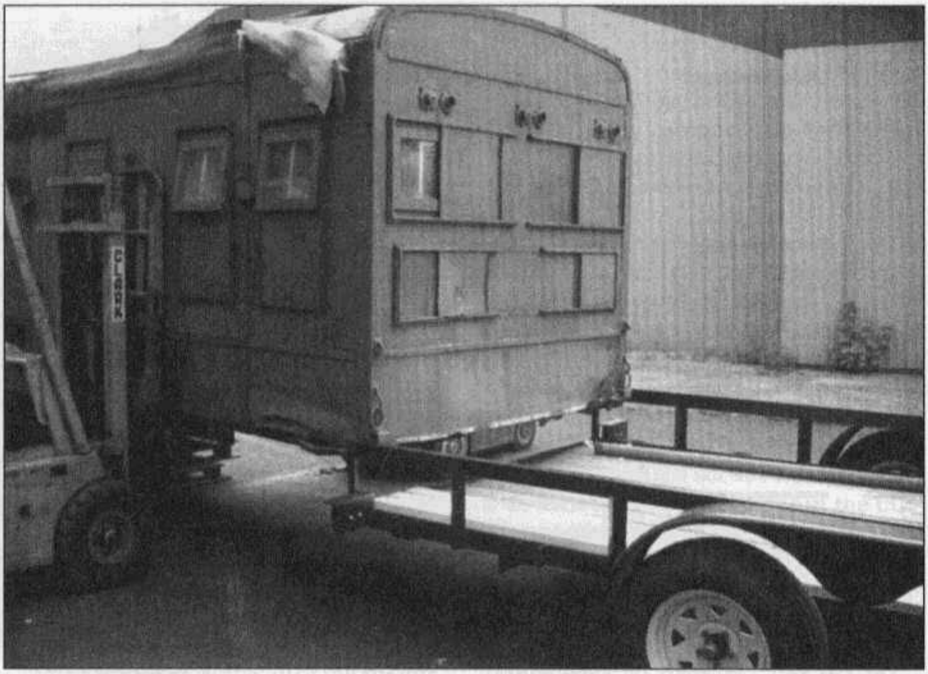

The GRC-26A manual recommended that the shelter be slid onto the trailer from the rear.

across the floor.

2. The ceiling: the extreme curvature at the sides of the ceiling is achieved using parallel strips of wood. It is these strips that bear the weight of the equipment shelf, and they are broken at that point. The roof has no internal center bracing, and is further weakened by a large "sunroof". Some means will have to be devised to permanently support the shelf end to prevent future failure. Heavily painted or varnished canvas over plywood is the roof's final face to the weather, and needs to be replaced, perhaps with a layer of roofing paper under new fabric. Otherwise the roof is OK.

3. The exterior. Visible in the photos is the damage to the metal and the wood along the bottom edges (see Dale's article or the website). Some damaged outer panels, both plywood and 1/16 sheet steel need to be replaced. In order to do so, the shelter cannot stay on the trailer bed with the side railings obstructing the most important work area. It needs to be raised.

V. Status as of late October:

As of this writing the shelter is empty except for the BC-610. All other equipment is in a separate storage bin at the same facility in New Jersey. The plan going into winter is:

1. Raise the empty shelter into "dry-dock", plan the reconstruction of the exterior, but do nothing until the cold weather passes. Possibly do the floor immediately.

2. Spend the winter repairing the cables, cataloging the spares and accessories, and refurbishing the electronic equipment, piece by piece. This may take a while because the Teletype gear needs to be cleaned, unstuck, lubricated, etc. Also the plastic strips on the BC-610 coils all suffer from a kind of rot, which has turned them to dust. (Any suggestions?)

The author standing in the shelter doorway.

3. Early in the spring do the external repair, which hopefully will have been sufficiently planned to go easily.

4. Reinstall the gear and fire it up!

Hopefully, by the time you read this, the problem of raising the empty shelter above the side railings will have been solved. The challenge is to lift the shelter above the trailer and rest it across 4x4's on the angle iron railing, exposing the areas that need the most work. It now rests on 3 lengthwise-laid 16 foot 2x4's on the trailer bed.

Exactly how to do it has been the subject of a lot of head-scratching on the part of Rob Flory, K2WI, Skipp Tullen, K2PXQ, and myself. How would you do it? We came up with a solution and we intend to try it. If it works, all will be revealed in Part 2. ER

Notes and Bibliography:

1. Teeters, Signal Corps Radio 197, Electric Radio, December 2000.
2. Hutchens, About the BC-610 Transmitter, Electric Radio, February 1992
3. Gagnon, Time Capsule Found at Fair Radio Sales, Electric Radio, July, 2001

Other BC-610 articles have that appeared in ER. They are listed by issue and page:
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A Low-Cost Regen

by Bob Dennison, W2HBE
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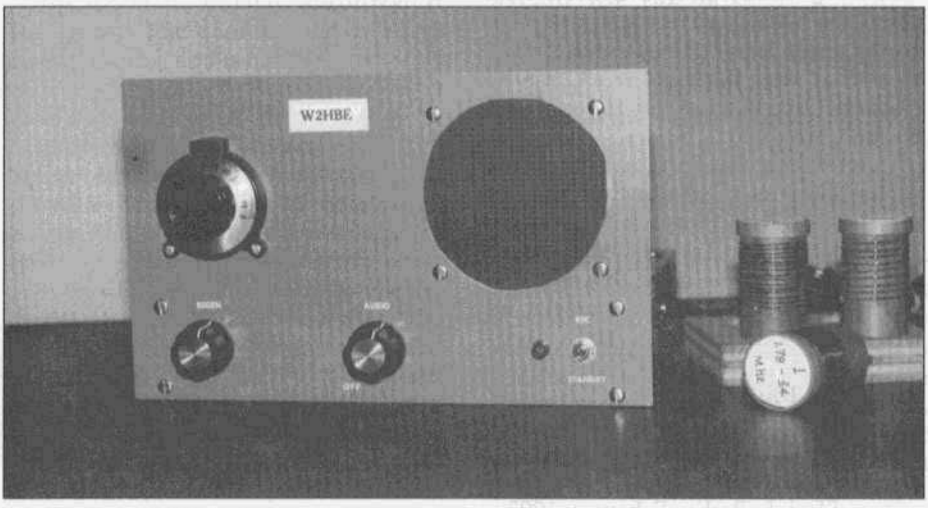
Westmont, NJ 08108

I've built about a dozen regens in the last twelve years and I thought it was time to retire. Then I received a letter from a ham in California wanting to know where he could obtain one of those high-inductance detector plate chokes. I have been lucky and have had my share of these chokes. These were once quite common, made by UTC, Stancor and Thordarson. But, alas, these are now very hard to find. I decided it was time to design a radio in which all the parts are easy to find. I set a goal—all the parts must be available from the current parts catalogs.

I got out my catalogs and started ordering parts. I remembered all those handsome dials made by National and Millen. All are gone! Then, in the Mouser catalog I found a nice little dial made in Japan with a 0-100 scale and an 8 to 1 ratio. I decided it would have to do. Next, I needed a flexible coupling to connect the dial to the tuning capacitor. I hit on the idea of using a short piece of plastic tubing with 1/4" ID. This might work if you use a very short length and the tuning capacitor has almost no friction. But the tuning capacitor finally selected had excessive friction so I was forced to use a commercial coupling. It will pay to look for one. Check your friends or go to a hamfest.

The next big problem is the tuning capacitor. I wanted to specify a readily available unit but here I ran into a really big problem. I found only one catalog that listed variable capacitors. There was one that looked like it might do so I ordered it. I am sorry to have to give you the sad news. This tuning capacitor was about the size of a walnut—probably intended for use in a woman's purse. The shaft was only .187" in diameter and flatted on two sides. It was a shock! But by now I had gotten too involved in this project to back out. Tighten your seat belt!



Front view of the low-cost regen

View from the rear

If you really want to build a radio, you're going to have to find a suitable tuning condenser. They are out there but you will have to search for it. Most AC/DC sets have a 2-gang tuning condenser. Try to find one with a 1/4" shaft that doesn't have a dial cord drum welded onto its shaft. You can remove rotor plates to get the desired capacitance. I modified my capacitor so that the front section had a range of 7 to 148 pF and the rear section 7 to 77 pF. The large section is used to tune the two lower frequency bands while the smaller section is used on the two higher frequency bands. I had to mount the tuning capacitor on a bracket so its shaft would match that of the dial.

Power Transformer

You can still obtain power transformers that provide a 125 or 150 volt winding and a 6.3 volt filament winding but they are not cheap. I found a neat solution to this problem. There are still many sources for filament transformers. Mouser sells a 6.3 volt, 1 amp filament transformer for less than $5. Simply connect two of these back to back as shown in Fig. 1. In my set, I mounted one transformer on top of the chassis and the other directly below it so that the same two screws hold each in place.

The Schematic

The schematic is shown in Fig. 1 and the coil data is shown in Fig. 2. In order that each band may be spread out over a reasonable range, it is necessary to (a) choose the proper size tuning capacitor, (b) use the proper size inductance, and (c) shunt the tuned circuit with a capacitor to limit the upper end of each band. The following example will illustrate the procedure. Consider the coil for band 1 which we desire to tune the range 1.7 to 3.5 MHz. The larger section of the tuning capacitor has a range of 7 to 148 pF. The input capacitance of the detector tube is 5.4 pF and the socket and wiring add a few pF so the total is about 8 pF. The minimum capacitance (ignoring Cx) is 7+8 or 15 pF. For 148+6 pF to tune to 1.7 MHz requires an L=57 uH. At the high end of the band the frequency would be 5.4 MHz. But we wanted 3.5 MHz. So we add Cx and try again. After several trials, we let Cx=27 pF (note: we want to use a standard RETMA value). Now we find L=50 uH, f_2 =3.7 MHz. The coil ended up with 40-1/4 turns and tunes the range 1.78 to 3.4 MHz.

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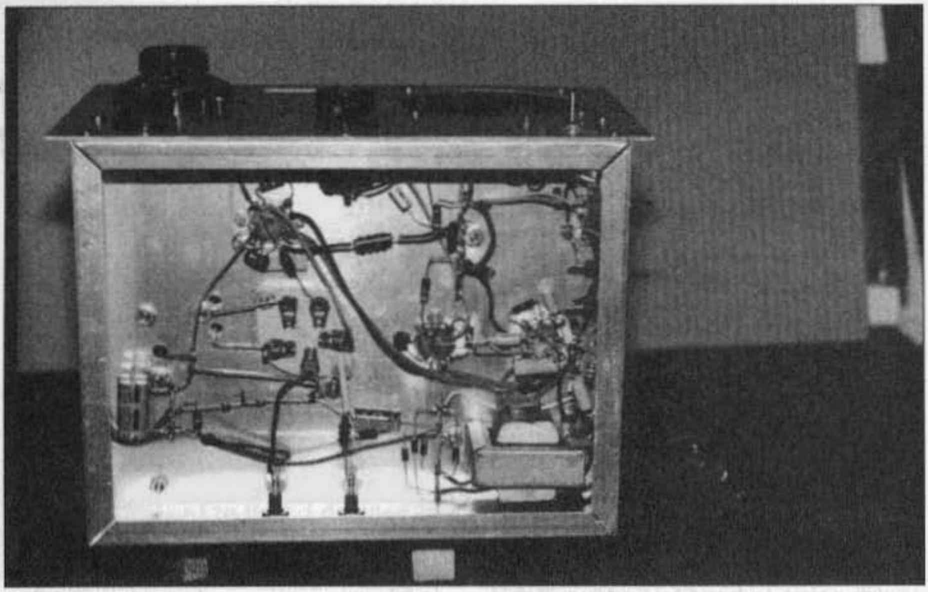


Underside view

For the two higher frequency bands, I used the smaller section of the tuning capacitor which has a range of 7 to 77 pF. A jumper inside the coil form selects the desired section of the tuning capacitor.

At this point, I encountered major difficulties. The set was overwhelmed by a strong local BC station and I couldn't turn the Regen control down far enough. When you have two unrelated problems in a radio it can be very frustrating. The solution was to add a wave trap in the antenna lead (and it needed a low L/C ratio) and the cathode-tap on the coil had to be much lower. The 6BH6 tube has much higher g_m than the old 57 used in the early QST sets so instead of placing the cathode-tap three turns from ground, only 1/2 turn does the job. And, remarkably, the next two bands also needed tapping at only 1/2 turn.

Chassis and Panel

I prefer aluminum rather than steel because it is so much easier to drill and punch. The chassis measures 7x9x2. The front panel measures 9.75x6 and is .062" thick. I painted the panel gray and labelled the panel controls with decals. All other controls, tubes and the ANT and GND terminals were marked with typewritten labels.

Coils

The simple regen offers another advantage to the beginner. Only one coil is required on each band. Less work and less storage problem. I suggest you wind coil No. 3 first and save coil No. 1 till all the others are done. When all are working, cement the turns in place using coil dope or Duco cement. If you have a calibrated signal generator, you can make a graph showing frequency vs dial setting for each coil.

Conclusion

Occasionally, I get a letter from someone who complains that he built a regen set and never could get it to work. I have built at least 20 regens and they all worked. If you look at the old QST's and ARRL Handbooks you will see that people have been building and using regens for more than 75 years. They do work and they are fun! ER

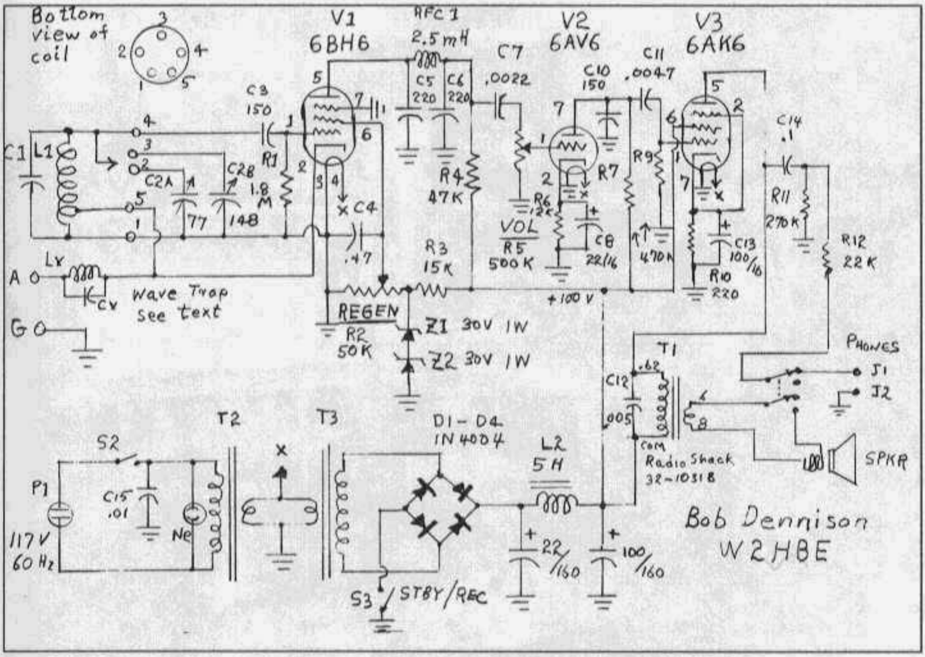
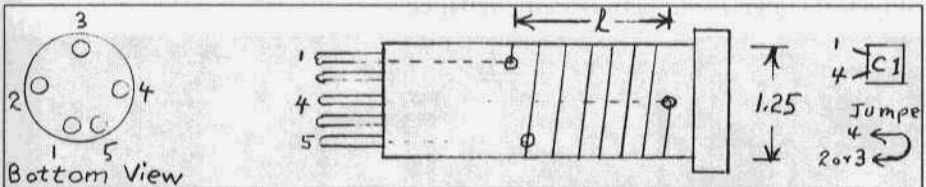


Fig. 1. Wiring diagram of the Low Cost Regen



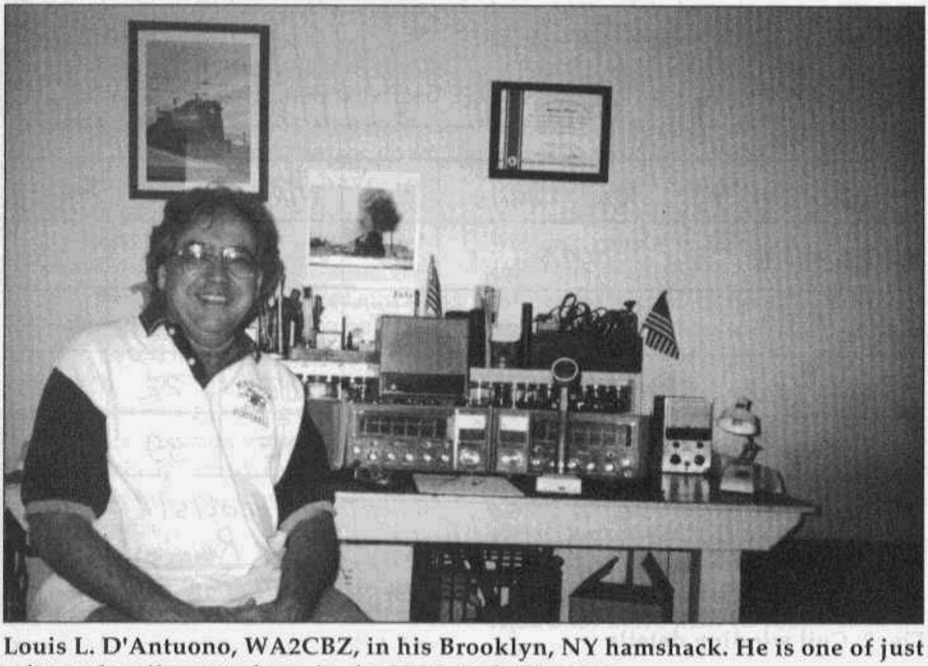
FREQUENCY	NO. TURNS	TAP	WIRE	C1	JUMPER
1.78 - 3.4	40.25	.5	24E	27	4-3
3.3 - 7.1	22.5	.5	22E	18	4-3
6.4 - 10.8	14.75	.5	22E	22	4-2
9.7 - 14.6	8.75	.25	22E	39	4-2

Coil 1 is close wound. On other coils l = 1.25
Coil forms provided by Antique Radio Labs
5355 S. 275 West, Cutler, IN 46920

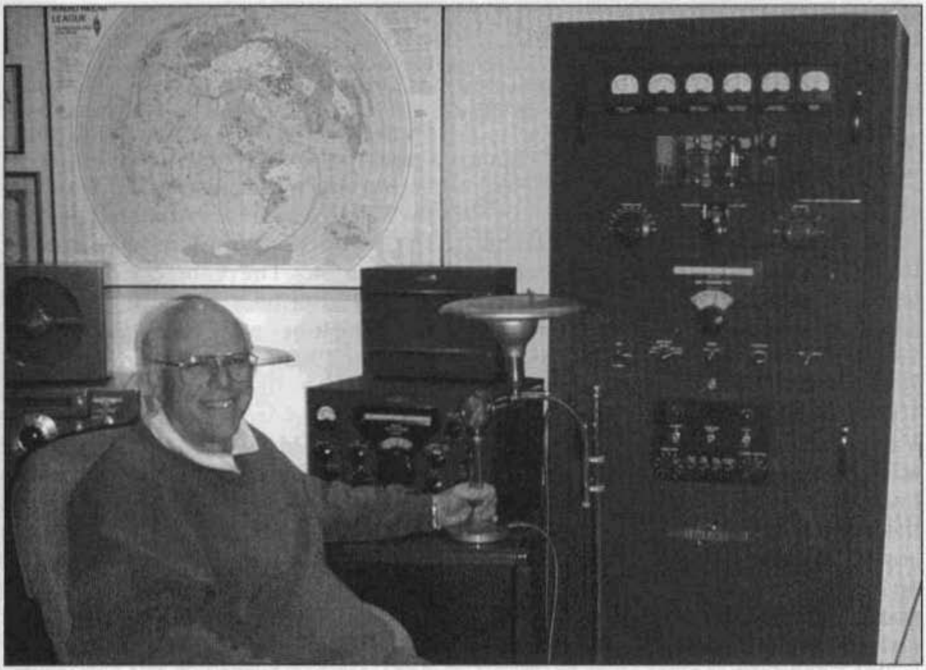
Fig. 2. Coil winding details

continued on page 41

Doug Morgan, KH6U, in his Kailua, Hawaii hamshack. He is a long-time vintage collector/AM'er. *Photo by Dave Curry, WD4PLI.*



Louis L. D'Antuono, WA2CBZ, in his Brooklyn, NY hamshack. He is one of just a few subscribers we have in the New York City area.



Dennis Petrich, KØEOO in his new hamshack Within the last year or two, he's moved his considerable collection of boatanchors from San Jose, Calif. to Minnesota. *Photo by Tom Moll, NØBS.*

Twenty-three year old Rich Sudney, KB8TVB, one of our younger subscribers, in his vintage-equiped hamshack. *Photo by Tony Sudney, K8PVW.*

The Gates Vanguard

by Gary Kabrick, W7GMK
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While cleaning out the closets at the local TV transmitting facility where I work, I came across back issues of *Broadcast Engineering Magazine* from the 1960's. As I flipped through the August 1965 issue I saw an ad for the Gates Vanguard I 1 KW AM transmitter. The Vanguard I is without question the most odd looking AM broadcast transmitter I have ever seen. Little did I know that the Vanguard is also odd on the inside as well. Thanks to Barry publishing the ad in ER I have been able to assemble a good bit of information from a few knowledgeable people around the country who have either worked on the Vanguard or have helped with the research.

Jack Sellmeyer, renowned consulting broadcast engineer, says that the Gates Vanguard I used a 4CX3000A tetrode operating in linear service as the output power amplifier with an efficiency of 20 to 25 percent. It was driven by a modulated exciter running on the order of 20 watts. He has the following to say about the Gates Vanguard I, "The genesis of the product came from a desire to reduce the tube count. It is my belief that the unit had its origins in a research program at Collins Radio in the late 1950's. A Collins five kilowatt HF amplifier (possibly a 204-C) was retrofitted with a medium wave output network and driven by a medium wave exciter to investigate the possibility of developing a single tube AM transmitter. Several months were spent on the investigation and a Working Paper was written describing the performance including THD, IMD, PA efficiency and overall efficiency and heat loads. The noise and distortion performance were quite good when operating into a test load, but were highly dependent on the RF load and the RF environment (proximity of other stations received from the transmitting antenna, etc). The report concluded that it would not be a practical method of reducing tube count, citing poor overall efficiency, load sensitivity and high heat load to the building as negative factors. Collins decided not to pursue the approach. Oddly enough, a high level marketing person left Collins Broadcast for Gates and the Vanguard I appeared in the Gates product line a short time later! Overall, it was not a successful product. I would estimate total production at 250 units or less."

He also says, "The marketing department attributed the poor sales record to the size and looks of the radio. It looked more like a cigarette machine than a broadcast transmitter. It was subsequently repackaged into a regular equipment cabinet, much like the other radios they were building at the time. It was probably 30 inches on a side and six feet in height with the meters across the top. It was hyped as the new and improved "Vanguard II". There was very little, if any, difference in the circuitry between the two units. A few units were sold before the product was discontinued in the late 1960's. I have a hazy memory of seeing a few on the test line in 1969 when I worked for Gates. I believe they were sold outside the country, to Iran I believe."

Much of the e-mail I have received about the Vanguard is that it was a good sounding transmitter, and that no one liked it much. Barry Mishkind has some photographs of the Vanguard, and even one showing the inside, on his web site at: www.oldradio.com. ER

VINTAGE NETS

Arizona AM Nets: Sat & Sun, 160M 1885 kHz at sunrise,75M 3855 kHz at 6 AM MST, 40M 7293 kHz 10 AM MST; 6M 50.4 MHz on Sat. at 8 PM MST; 2M 144.45 MHz, on Tue. at 7:30 PM MST.

West Coast AM Net meets Wednesdays 9PM Pacific on or about 3870kc. Net control alternates between John, W6MIT and Ken, K6CJA.

California Early Bird Net: Saturday mornings at 8 AM PST on 3870.

California Vintage SSB Net: Sunday mornings at 8 AM PST on 3860 +/-

Southeast Swap Net: Tuesday nights at 7:30 ET on 3885. Net controls are Andy, WA4KCY and Sam, KF4TXQ. This same group also has a Sunday afternoon net on 3885 at 2 PM ET.

Eastern AM Swap Net: Thursday evenings on 3885 at 7:30 ET. This net is for the exchange of AM related equipment only.

Northwest AM Net: AM activity daily 3 PM - 5 PM on 3875. This same group meets on 6 meters (50.4) Sundays and Wednesdays at 8:00 PT and on 2 meters (144.4) Tuesdays and Thursdays at 8:00 PT. The formal AM net and swap session is on 3875, Sundays at 3 PM.

K6HQI Memorial Twenty Meter AM Net: This net on 14.286 has been in continuous operation for at least the last 20 years. It starts at 5:00 PM PT, 7 days a week and usually goes for about 2 hours.

Colorado Morning Net: An informal group of AM'ers get together on 3875 Monday, Wednesday Friday, Saturday and Sunday mornings at 7AM MT.

DX-60 Net: This net meets on 3880 at 0800 AM, ET, Sundays. Net control is Jim, N8LUV, with alternates. This net is all about entry-level AM rigs like the Heath DX-60.

Eastcoast Military Net: It isn't necessary to check in with military gear but that is what this net is all about. Net control is Ted, W3PWW. Saturday mornings at 0500 ET on 3885 + or - QRM.

Westcoast Military Radio Collectors Net: Meets Saturday evenings at 2130 (PT) on 3980 + or - QRM. Net control is Dennis, W7QHO.

Gray Hair Net: The oldest (or one of the oldest - 44+ years) 160-meter AM nets. It meets on Tuesday nights on 1945 at 8:00 PM EST & 8:30 EDT. http://www.crompton.com/grayhair

Vintage SSB Net: Net control is Andy, WBØSNF. The Net meets on 14.293 at 1900Z Sunday and is followed by the New Heathkit Net at about 2030Z on the same freq. Net control is Don, WB6LRG.

Collins Collectors Association Nets: Technical and swap session each Sunday, 14.263 MHz, 2000Z, is a long-established net run by call areas. Informal ragchew nets meet on Tues nights on 3805 at 2100 Eastern and on Thur nights on 3875. West Coast 75M net that takes place on 3895 at 2000 Pacific

Collins Swap and Shop Net: Meets every Tuesday at 8PM EST on 3955. Net control is Ed, WA3AMJ.

Collins Collector Association Monthly AM Night: The first Wed. of each month on 3885 kHz starting at 2000 CST (0200 UTC).

Drake Users Net: This group gets together on 3865 Tuesday nights at 8 PM ET. Net controls are Criss, KB8IZX; Don, W8NS; Rob, KE3EE and Huey, KD3UI.

Drake Technical Net: Sunday's on 7238 at 8PM Eastern time hosted by John, KB9AT

Swan Users Net: This group meets on 14.250 Sunday afternoons at 4 PM CT. The net control is usually Dean, WA9AZK.

Nostalgia/Hi-Fi Net: Meets on Fridays at 7 PM PT on 1930. This net was started in 1978.

K1JCL 6-Meter AM Repeater: Located in Connecticut it operates on 50.4 in and 50.5 out.

JA AM Net: 14.190 at 0100 UTC, Saturdays and Sundays. Stan Tajima, JA1DNQ is net control.

Fort Wayne Area 6-Meter AM Net: Meets nightly at 7 PM ET on 50.58 MHz. This net has been meeting since the late '50's. Most members are using vintage or homebrew gear.

Southern Calif. Sunday Morning 6 Meter AM Net: 10 AM Sundays on 50.4. NC is Will, AA6DD.

Old Buzzards Net: Meets daily at 10 AM Local time on 3945. This is an informal net in the New England area . Net hosts are George, W1GAC and Paul, W1ECO.

Canadian Boatanchor Net: Meets Saturday afternoons, 3:00 PM EST on 3745.

Midwest Classic Radio Net: Sat. mornings on 3885 at 7:30AM Central time. Only AM checkins allowed. Swap/sale, hamfest info and technical help are frequent topics. NC is Rob, WA9ZTY.

Boatanchors CW Group: 3546.5, 7050, 7147, 10120, 14050. 80 on winter nights, 40 on summer nights, 30 and 20 meters daytime. Nightly "net" usually around 0200-0400 GMT. Listen for stations calling CQ BA, CQ GB.

Wireless Set No. 19 Net: Meets the second Sunday of every month on 7.175 +/- 25 kHz at 1800Z (3760 +/- 25 kHz alternate). Net control is Dave, VA3ORP.

Hallicrafters Collectors Assoc. Net: Sundays, 1730-1845 UTC on 14.293. Net control varies. Midwest net on Sat. on 7280 at 1700 UTC. Net control Jim, WB8DML. Pacific Northwest net on Sundays at 22:00 UTC on 7220. Net control is Dennis, VE7DH.

Nets that are underlined are new or have changed times or frequency since the last issue.

How to Repair a Transmitter

by Jim Hanlon, W8KGI
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w8kgi@arrl.net

Part Four

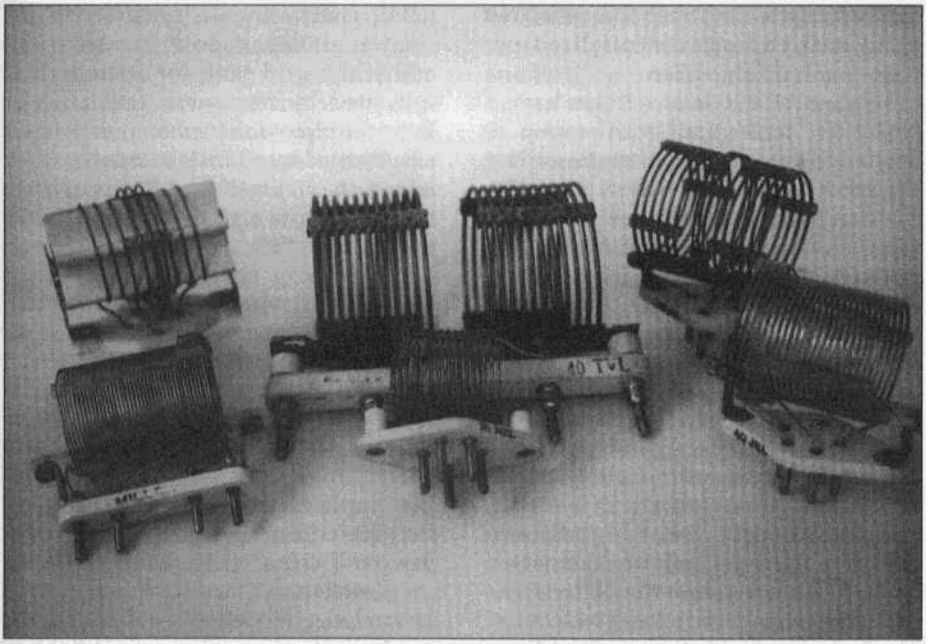
Plug-in Coils, Find 'em or Make 'em

Plug-in coils were quite popular in older, multiband rigs before the TVI shielding requirements made it inconvenient to open up the cabinet lid to change coils. Rigs in my collection that use plug-in coils include my Lettine 240, Millen 90800, Hammarlund 4-20, Globe King 275, McMurdo Silver 701 and the earlier Meissner Signal Shifters. Several manufacturers including B&W, Bud and Coto-Coil made extensive families of plug-in coils, and a number of transmitter manufacturers (Millen and Meissner) made them for their own rigs. Variations include different power levels. B&W made the "Baby" line (e.g. 80-MEL for 80 meter, "midget, end link") for 25 watt stages, the "Junior" line (e.g. 40 JCL for 40 meter, "junior, center link") for 75 watt stages, the B-series for 150 watt rigs, the T-series for 500 watt rigs, and the HD-series for 1 KW rigs. You may find some of them pictured in the B&W ad in the rear of your ARRL Handbook, and I'll include a picture of some plug-in coils so you'll know what to look for at the next flea market. The 25 and 75 watt coils generally come on a 5-pin, vacuum tube style, ceramic base. The coils for the Millen 90800 and the 150 watt and larger coils come on a ceramic "jack bar" with their pins spaced out in a single line. Fortunately the hardware on all of these coils is simple enough so that if you can't find originals you can make your own replacements with readily available materials.

Beyond the commercially manufactured coils, there were also a lot of wind-it-yourself coil forms on the market. You can still find a lot of home-wound coil forms in those boxes under the tables at the better flea markets, and if what is wound on them doesn't suit your fancy you can unwind them and start over.

One good source of forms for smaller coils is the bases of burned-out glass tubes. Wrap the tube in a towel and break the glass with a hammer, then dig out the tube guts, glass and adhesive from the inside of the base, unsolder the leads and you have a ready-made coil form. If it is too short, lengthen it or make it a larger diameter with some PVC pipe. I checked some of my B&W air core coils on my Boonton 160 Q-meter on 40, 20, and 10, and the presence of a PVC pipe inside them did not effect the coil Q (loss) much at all, so it should be safe to use for a coil form. If you don't have any burned-out tubes, AES sells 4-pin and octal tube bases.

You can also mount a coil horizontally on top of an old tube base. You may be able to find some B&W miniductor at the flea market, a ready made air-core coil just waiting to be cut to size and mounted. Or you can wind the coil on a bit of PVC pipe, or wind it on some waxed paper wrapped around the pipe, run four beads of airplane glue spaced 90 degrees down the length of the coil, and slip it off the "form" after the glue dries for an air-core coil. You can also use strips of polystyrene for support or even for the strips that form the jack bars on the Millen and the higher powered "B&W" coil versions. For the jack bar coils, banana plugs from the flea market hardware table will serve admirably as pins. That's what my commercially made B&W TVL coils use



Plug-in coils. Top row left is a 75 watt rated Coto Coil CS-620-C, 20 meter unit with a fixed center link. Top center is a B&W 40 TVL, 40 meter, 500 watt unit with room for an externally supported center link. Top right is a B&W 20 JVL, 20 meter, 75 watt unit with a variable center link. Bottom left is a Millen 43082, 80 meter, 75 watt unit with a fixed end link used in the Millen 90800 transmitter. Bottom center is a B&W 20 MEL, 20 meter, 25 watt unit with a fixed end link. Bottom right is a B&W 40 JEL, 40 meter, 75 watt unit with a fixed end link.

for pins in their ceramic jack bars. See specifics in the transmitter examples from your ARRL Handbook for the proper number of turns, wire size, coil diameter and length for the various bands. AES sells Magnet Wire in smaller gauges, 21, 22, 24, 28, 32, 36 and 40. For larger gauges you can use antenna wire and even 1/4 inch copper tubing from the hardware store.

A plug-in coil boatanchor should never be retired for lack of coils. There are just too many ways to find or make coils that will put it back on the air. Scout around at the flea markets, ask friends, advertise in ER or on the Boatanchors reflector, and innovate. You will get or make what you need.

Neutralization

Triodes, when they are used as straight-through, grounded-cathode RF amplifiers (as opposed to frequency multipliers), have sufficient coupling from output to input via the plate-to-control-grid capacitance so that they are guaranteed to oscillate. Some beam tetrode and pentode amplifiers are also marginal in this regard. To counteract this tendency to oscillate, a signal 180 degrees out of phase with (that is the negative of) the signal which causes the oscillation is deliberately fed back from the plate tank to the grid tank to "neutralize" the amplifier. Your ARRL Handbook discusses the circuits used to accomplish neutralization and how to adjust them in the High Frequency Transmitters chapter under Stabilizing Amplifiers. I will briefly explain here how to adjust a classic, capacitive neu-

continued next page

tralized triode amplifier and also how to adjust a capacitive neutralized tetrode/pentode amplifier.

Single tube triode amplifiers have a "balanced" tank circuit, with a common, grounded-rotor and split-stator tuning capacitor and a dual coil in either the plate or the grid circuit. The coil center tap and the capacitor rotor are at RF ground, the tube element (control grid or plate) is attached to one end of the tank, and the neutralizing capacitor to the other end. This balanced tank circuit produces the needed 180-degree phase shift between the voltage on the tube side and the voltage on the neutralizing capacitor side. A push-pull amplifier will have balanced tanks in both the grid and the plate circuits, and the two neutralizing capacitors are connected across the circuit from the plate of one tube to the grid of the opposite tube. The technique for adjustment of these capacitors is the same for both single tube and push-pull amplifiers, with the provision that the capacitors in a push-pull amplifier must be adjusted together, starting from the same common position and being changed by the same amount, in order to keep the amplifier circuit "balanced."

You will need to couple a signal sensor to the output circuit in order to make your neutralizing adjustments. The old timers used a low powered flashlight or panel bulb, coupled to the output link. The ARRL handbook also shows a link, crystal diode rectifier, meter circuit that will work well. Heath recommends using a grid-dip meter on its "diode" range tuned to the output frequency of the amplifier. You can also use an oscilloscope if its vertical amplifier has enough bandpass to work at the amplifier signal frequency. You should adjust the neutralization on the highest frequency band that your amplifier covers, and it will then hold for the lower frequency bands.

To perform the neutralizing adjustment, remove the B+ voltage from the final amplifier, supply RF drive and adjust the grid tank for resonance as indicated by maximum grid current. Tune the plate tank for maximum output as indicated by your signal sensor. Now adjust the neutralizing capacitor(s) to null the output signal. This adjustment should be satisfactory for operation on all bands.

As a check, remove the signal sensor, attach the output to a dummy load, reattach B+ to the amplifier, and tune it up to full power as you normally would. As you tune the plate current through its dip, you will notice that the grid current is also going through a peak. If the amplifier is properly neutralized, the plate current dip and the grid current peak will occur for the same setting of the plate tank capacitor. You may want to make a slight correction in the neutralizing capacitor adjustment to achieve this peak-dip coincidence, but be sure to turn off the B+ and the grid drive before touching the capacitor. I have also found that the level of the 20-meter, fourth harmonic of my Globe King 275's push-pull final, as indicated by channel 2 TVI, is critically dependent on the neutralizing adjustment. A perfectly balanced, push-pull amplifier theoretically cancels all even harmonic output, so the neutralizing adjustment that minimizes the fourth harmonic is apparently also the one that optimizes the amplifier's balance.

Beam tetrode and pentode amplifiers, for example the 6146 final in the DX-60, can also be neutralized to improve their stability. Generally the circuit that provides the 180 degree out of phase signal is in the grid of the final or the plate of the RF driver, and the neutralizing capacitor is just a wire placed in the vicinity of the final amplifier tube's plate electrode. The adjustment procedure for a tetrode/pentode amplifier is the same as for a triode. Remove B+, supply RF drive and adjust the grid and plate circuits for resonance and maximum output indication on your signal sensor. Then adjust the position of the wire/neut condenser for minimum output. At that adjustment and with B+ reattached, the amplifier's plate current dip and grid current peak should be coincident and the amplifier should show no sign of instability (bouncing grid or plate current) when either the driver plate/amplifier grid tank or the amplifier plate tank current is tuned.

Stabilizing an Unneutralized Tetrode/Pentode Amplifier

Most rigs using tetrodes or pentodes in the final, 807's, 6146's, a 4D32 or 813, 6DQ5's for example, depend upon good placement of parts and internal shielding to minimize the feedback between the plate and grid circuits so that neutralization is not necessary. You can tell if an unneutralized amplifier has a tendency to oscillate several ways. The simplest way is to tune the rig up, preferably into a dummy load, and to observe the amplifier plate and/or grid current while you are tuning. If the amplifier is stable, the currents will vary smoothly as you make the tuning and loading adjustments. If either of the currents hops up or down, that indicates that the amplifier is breaking into self-oscillation. Another way to find instability is to tune up with a transmatch (antenna tuner) between the transmitter output and the dummy load and to include an SWR meter between the transmitter and the transmatch. If the transmitter starts to put out an off-frequency parasitic signal, the tuner will be a poor match for that frequency and the SWR will abruptly pop up to a high value.

If your rig is unstable, you have two choices. You can live with it if you are able to arrive at a set of tuning adjustments that result in stable operation. But watch out for transients that might occur on turn on and turn off or keying—look at the wave envelope with your oscilloscope for funny peaks and listen for strange clicks. If you can't or don't want to live with it, you need to fix it.

If your transmitter was originally well designed it probably wasn't unstable originally. Something changed to make it unstable. So your job is to find and fix that something. Unwanted feedback is usually controlled by shielding and by bypass capacitors and chokes. Check the shielding on your rig. Make sure that it is all there as originally intended, that it is properly positioned and tightened down, and that the electrical connections at the places where it attaches to the chassis and to other metal parts are clean. My 32V-3 came to me with much of the internal shielding missing. I built replacement shielding for it as best I could, working from pictures that I found in the manual and in advertisements and from marks and brackets that I found in the rig. When I finished, I had eliminated its TVI, but the final was still exhibiting classic symptoms of instability. After I got tired of "living with it," I opened it up one more time and found that one of my shields was not well snugged down to the edge of the deck separating the driver stages from the final plate tank compartment. When I improved that fit, my instability problem completely disappeared.

If you've tried everything and your rig still shows signs of instability, you may want to consider neutralizing it. There are a couple of ways to proceed. In his June 1962 QST article "A 'Novice Gallon' or General 150 Watter," Lew McCoy floated above ground the side of the driver plate/final grid tank tuning capacitor that would normally be at chassis ground. He physically insulated the capacitor rotor from ground and connected a 150 pF capacitor from there to ground. That allowed him to get the required 180 degrees out of phase sig-

continued next page

nal from the rotor side of the capacitor. For a neutralizing capacitor he used a tab of metal about 1/2 inch wide and 3-1/4 inch long bent into an L that was 3/4 inch long at the bottom that he mounted on a standoff insulator between his two 6GJ5 final amplifier tubes. He adjusted the position of the tab until the final was stable when he tuned it.

I recently did a similar job on my DX-40. The DX-40 6CL6 driver is coupled to the 6146 control grid through a pi-match tuned circuit. The side of the pi-match attached to the 6CL6 plate is 180 degrees out of phase with the other side that is coupled to the 6146 grid. I ran a piece of stiff hook-up wire from the plate side of the pi-match up through a hole in the chassis and next to the 6146. I attached my oscilloscope to the RF output connector, removed B+ from the final plate and screen, tuned up the grid drive, adjusted the plate tuning condenser for maximum indication on the scope, and then adjusted the length and the location of the neutralizing condenser wire for a null in the scope pattern output.

Another way is called "link neutralization" in the ARRL Handbook. My brother and I used it on a plug-in-coil Lettine 240 whose 807 was singing its own tune. We wound a second link from insulated hookup wire around the final plate tank coil and connected it to a similar link wound around the oscillator/driver plate coil. It takes a little cut and try, but when you get the links properly connected so that the signal from the 807 plate is bucking the grid drive (the required 180 degree phase shift) and you adjust the position and size of the two links properly, the amplifier will be neutralized and will stop oscillating. We glued the links into position, and of course we had a set of links on each band's coil set.

When do you need a Transmatch, a Harmonic Filter

A transmatch or antenna tuner is not a part of your transmitter, but it is another external accessory that you may need to get your rig on the air. Unlike today's solid state rigs that are designed to work into a 50-ohm load with no more than a 2-to-1 SWR, most vacuum tube boatanchors have the ability to match a much wider range of loads. For example, my Heath DX-100 is rated to match resistive loads from 50 to 600 ohms. A rig with a pi-match final plate tank usually can load a wide variety of coax fed, unbalanced loads. On the other hand, if your rig includes a low pass filter in its RF output like the DX-60 or if you intend to use an external low pass filter as insurance against TVI, you really should present a matched load to the filter. Because I run a center-fed Zepp antenna with a two-wire, balanced feed line and I use a low pass filter, I use either a homebrew balanced tuner or an Ultimate Transmatch, a Murch 2000, with a balun to transform my feed line impedance to a 50 ohm load. I use a Heath HM-102 or a Radio Shack SWR meter on the input side of my tuner and I adjust the tuner for zero reflected power as indicated by a 1.0 standing wave ratio.

The ARRL Handbook has directions for building several different types of transmatch in the Transmission Lines chapter, and you can also buy one if you prefer. You should select one that will interface well with your antenna's feed line. A balanced tuner like the Johnson Match Box is a good choice for a balanced, two-wire feed line. A T-circuit like that found in the Ultimate Transmatch and in many of the MFJ tuners works well for coax line. A husky balun on the antenna side of a T-circuit will also allow it to match a balanced line.

If you are using a trap dipole or vertical or some other antenna that presents a low SWR load to your transmitter at one or more of its harmonics, you really should check for harmonic

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Radio Service in the Golden Age
1930's through the 50's

by Bruce Vaughan, NR5Q
504 Maple Drive
Springdale, AR 72764
NR5Q@aol.com

Episode 6

The LP Record

Frank Flynn's big black Cadillac pulled into a parking space near the front of my store. It was almost 5:00 pm, very close to my closing time; I knew something big was brewing. Mr. Flynn was the manager of the Ft. Smith office of Arkansas Radio, Philco distributor for the State of Arkansas. Frank normally did not call on dealers—he had salesmen for that duty.

I watched the middle aged, portly gentleman step from his car, don his black topcoat, retrieve a heavy leather brief-case from the back seat, lock his car, and step toward my modest little shop.

After the usual greetings, Frank said, "Bruce, is that little coffee shop in the 'dime store' open this late?"

"Yeah, I'm sure they are, the store closes at six. I'm ready for a cup myself—I'll go ahead and lock up for the day, then we can take our time."

No sooner had our coffee been served than Frank turned to me, and in a confidential voice said, "Bruce, you are not going to believe what I am about to tell you. All Philco dealers are about to get a big jump on competition. We have developed something that is truly revolutionary—and only Philco has it. We have invented a phonograph record that has amazing fidelity, and plays for ONE FULL HOUR—there's 30 minutes of music on each side. We call our new invention the LP record, LP for 'long play'—get it? Furthermore, "Frank, continued, "The LP record runs much slower. It revolves at only 33-1/3 RPM and requires practically no needle pressure. The pickup is light as a feather. Do you realize LP records will last at least ten times longer than present day records?"

Frank waited for some sort of answer, preferably one expressing enthusiasm, amazement, and admiration of the Philco Corporation. It did not come.

My exposure to the revolutionary products of the Philco Corporation dates back to the 30's. The summer after graduating from High School I worked for a few weeks for the Famous Hardware Company—Springdale's largest hardware store. The Famous was a franchised dealer for both Zenith and Philco. The company first began selling Philco radios in the early 30's. When they got a chance at a Zenith dealership they jumped on it immediately. A move that proved both wise and profitable.

During my brief tenure there, Philco was spending a lot of money plugging their 'amazing' record player that literally played music on a beam of light. This was years before the laser was invented, however, Philco advertising copy writers managed to convey the idea that somehow, someway, Philco record players reproduced sound by using a light beam—and they did. The pickup head on their record players was immense—triangular in shape, about the size of a deck of playing cards, only thicker. This large head served a twofold purpose; it contained the 'Rube Goldberg'* electronics, and due to the immense size, helped conceal the fact that sound was still reproduced by a stylus riding the record grooves.

continued next page

The electronics consisted of a light source, a lens to focus the light, a small first surface mirror attached to the upper end of the needle holder, and a PE cell. The needle was located in the apex of the triangular head, the light source on one of the base corners and a PE cell on the other corner. You can see that with all this mess pushing a needle into a record groove, long record life was a myth.

Now, please understand, Philco advertising did not say that a needle never touched your records; they said that you played your records on a beam of light. They thought that the average reader would believe that Philco was scanning the record with light rather than a needle. Anyway, the idea died a year or so later and was forgotten by all but the few who bought the machines.

Perhaps I should take a few paragraphs and explain more fully the distribution system as it existed in the years before discount stores, and so-called fair trade laws. It's a far different business climate than that of today—a completely different world.

In the 'Golden Age of Radio' very few manufacturers sold direct to the retail dealer. In my state for example, Philco was sold by Arkansas Radio, Zenith by Williams Hardware Company, and RCA by the Frank Lyon Company. These state distributors were free to set up 'franchised dealers' as they wished. Normally, towns with a population less than 10,000 had only one dealer for each major brand. However, this arbitrary figure was left entirely to the discretion of the distributor. To the best of my knowledge a distributor could grant franchises as he saw fit—but small towns seldom had two dealers for the same make of radio. Few manufacturers of radios sold direct to the retail dealer. Two that did were GE and Magnavox. I'm sure there were others, but those are the ones I remember.

Thus, coming out of World War II as a new businessman I was bucking 'the establishment.' Old, well-financed stores had 'tied up' most choice franchises. I had to look for radios to sell that were somewhat less popular with the general public. Fortunately, the 'Famous Hardware' let Philco slide into their number two slot when they bought out our local Zenith dealer, thus obtaining the Zenith franchise. As a matter of fact, they slowly quit stocking almost all Philco products.

During this time, Philco was big in the radio parts business as well as in radios and record players. By 1948 I was using several hundred tubes a month, selling about two dozen 'farm packs' (batteries) a month, and was slowly building up a good trade in radios. Where the 'Famous' was buying perhaps $300.00 worth of Philco products a month, I saw the possibility that Arkansas Radio just might be willing to grant me a franchise to sell Philco's if they got most of my parts business. I was right. My parts bills alone usually ran over $2,000.00 a month.

This was a period when stores literally had to fight their way into the radio business. Then, as now, the bottom line was money. If you could afford to place a large enough order, state distributors would often 'open up' a new dealer. The word 'franchise' as applied to radio and television vanished into oblivion back in the sixties when our government decided that franchising was not in keeping with the current laws governing business, but in the late 40's and 50's a franchise was considered a necessary part of any retail business. There was one big problem with the franchise idea—loyalty between retail merchants and state distributors was rare indeed. In a future column I'll tell you how I lost/surrendered the Philco franchise.

I would be amiss if I did not mention one company that stood tall and straight amid this field of stubble—I refer to the

Magnavox Company. Perhaps others have different opinions—fine. I am giving you the facts as I experienced them.

Magnavox was sold factory direct. There were no middlemen. To become a Magnavox 'Home Entertainment Center' you were required to maintain a shop, an attractive showroom of approved size, full line of Magnavox products, and trained service technicians. Magnavox dealers were required to stock an adequate supply of Magnavox parts for all products in the line. You had a retail price that was firm. There were no sales, or dumping of merchandise, other than those sponsored by the company on a Nationwide basis. Though your markup was somewhat less than most other major brands, your profit potential was greater because competition did not undersell you. The normal markup for a Magnavox dealer averaged around 27%, with big-ticket items being a bit more and promotional items somewhat less. However, if you decided to sell a $200.00 TV for $189.00 (for example) and if you advertised the price, or if another dealer got hold of a sales ticket showing you sold the set for less than retail, you could be cancelled out as a dealer. A Magnavox truck would show up at your store, pickup your unsold merchandise, write you a check, and say "good-bye." At least this was the story told to dealers when they 'signed on' with the company. I never actually knew of this happening, but I never knew a Magnavox dealer who cut his retail selling price.

This was really more of an advantage for the buyer than for the Magnavox dealer. The modest markup was calculated to allow dealers to make a profit and maintain a reliable business. Those buying from other dealers, especially at discount stores, often found themselves with no service, poor service, and often overpriced service. This was seldom true when you purchased a Magnavox. Magnavox was certainly not perfect, but once I obtained the Magnavox franchise I was never tempted to look for another line of electronics. My relationship with Magnavox was profitable and relatively trouble free.

Today, it is far different. Almost anyone can buy any brand of electronics. Most merchandise is sold in a box, and the warranty may very well be between you and the manufacturer. Markup is wild and shysters abound.

Let's return now to the story of Philco how they invented the LP record. Frank and I returned from the coffee shop and he laid out his 'program' for me. I was to purchase a number of LP record player attachments immediately. It was a modest request—a dozen or so player/attachments. "Hold on a second," You might say, "LP records were not yet available." Philco had thought of that. They had a Philco demonstration record with all types of music on it that we could sell for only $1.95, provided of course that the customer bought the record player attachment for $29.95. Philco had only one product that played LP's—the $29.95 attachment that connected to any radio. I bought a bunch and sold 'em all, even though the customer had only one record. It seemed that in those days, everyone wanted to be first.

Customers were safe. Within weeks almost every dealer in town, with the exception of RCA, had some sort of LP record playing attachment for sale. The LP took off like a rocket, and record stores were soon well stocked with LP's. Why did RCA not jump on the bandwagon? They rushed to market with a little 45-RPM player. It never caught on with serious music customers, but was an instant hit with teenagers, and a godsend to 'Juke Box' operators. As for the LP being a Philco invention—my research indicates that the microgroove record was invented by Peter Carl Goldmark, and was a product of

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HV Probe Adapter

a simple way to use a hamfest special

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If you need to measure high voltages and don't have the test equipment, then you maybe interested in this article. When I say high voltages I'm specifically talking about values from 1,000 to 10,000 volts although this adapter and HV probe can be used at 1000 volts and below and will safely measure to 30,000 which is beyond the average ham needs.

Over the past few years I've destroyed several DVMs attempting to measure voltages within their capability. For instance most DVMs have a 1000VDC range and I have managed to burn out these instruments with less than 1000VDC applied. The internal spacings on the PC boards and/or rotary switches are under rated being too narrow for these potentials.

When dealing with high power Class C finals, Class B linears, high power modulators, high voltages are encountered. These are usually in the range of 1,500 to 4,000 volts. Even the typical 100 watt transmitters using 600-800 volts may be a problem to measure. Therefore how do you measure such values. The highest range I have is on an antique EICO VTVM of 1,500 volts and 1,000 volts on both a Keithly 160 and HP 427A. If you have a Triplett VOM and HV Probe as described in this article you will be able to measure 6,000 volts full scale.

Well I do have the Triplett HV Probe which is rated for 30KV and when used with the matching VOM will yield 20K ohms per volt. Unfortunately I don't own the matching VOM and have become very sensitive to using my other instruments for high voltage measurements. The Triplett HV probes are very often seen at hamfest (you can't miss there large size, rocket shape and red color) and nobody seems interested in them. They usually can be purchased for a low price anywhere between $5 to $15. I think they are worth every penny even at $25. The probes are ruggedly built and have a built-in attenuator resistor. The resistor is actually two 300 meg ohm units in series the size of a pencil.

The physical calibration setup is shown in Figure 1 and the circuit for the adapter and probe is shown in Figure 2 along with the calibration hookup. No rocket science here as you see it's a simple series resistance string to ground. The object here is to select a value as low as possible to sample across using the lowest range in the measuring meter. In my case I have an HP 427A VOM. This meter was another hamfest purchase for $25. It has some very nice low end DC measurement ranges of 0.1, 0.3 and 1.0 volts full scale. This meter is solid state, and portable; able to run on just two 9 volt batteries. The original size battery is still available for a cost of about $25 if you are a purist. Another feature that you want in the measuring meter is very high input resistance. The HP 427A has a 10 meg ohms input resistance for all ranges. This value is typical for most VTVMs and high end DVMs. Of course there are the FET input meters that even go higher.

With approximately 600 meg ohms in the total measurement circuit, there is no fear of loading down the high voltage circuit being measured. The HP 427A is

Figure 1.

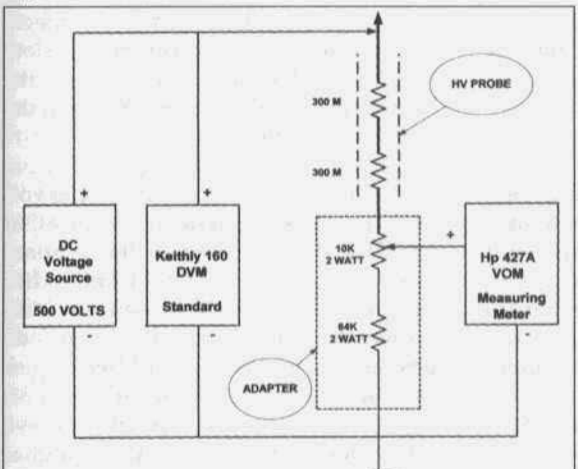

Figure 2.

looking across roughly 70K ohms with its 10 meg ohm input impedance. This ratio of 142 to 1 induces minimum loading.

Calibration uses a Keithly 160 DVM as the standard. It is connected directly to the source of high voltage. Any Hi Z input meter of known accuracy can be used as the standard. If your standard loads the measurement circuit, remove the HV probe and set the voltage source to 500 then remove the standard and connect the probe—then make the cal adjustment. After a few cycles of this, the adapter will be calibrated. There is no need to calibrate to the maximum adapter/probe capability. This is based on the verification of the measuring meter's input attenuator (range switch). In other words you must check out and establish whether the meter input range switch is accurate i.e. verify the ranges and needle accuracy. The accuracy of this whole method is based solely on this verification. The HP 427A is set to the 0.1 scale, i.e. 1,000 volts full scale. To verify the higher scales simply change the input range switch to 0.3 and 1.0 and the needle will drop off to the 500 volt reading on the corresponding scales.

I've been using the HV probe and adapter for about a year with no ill effects. After all not much can go wrong with a string of resistors having 5 micro amperes of current flowing through them at 3000 volts. To aid in the measurement I also labeled the meter's front panel and adapter box

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The "Not So Scratchy" Apache

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Back in late May of 1959, I made my very first contact as a novice using an Apache transmitter. Now, before anyone starts thinking about over power and VFO operation, let me say that this was K9BPV's (ex W2ZSK) Apache and he plugged in a crystal for the 40 meter novice band and cut the power back to 75 watts input (the requirements at that time). Using his S20R (highly modified) as the receiver, I was able to work KN9SPO, who lived one state over (he was in Illinois and I was in Indiana).

From that day on, I always wanted an Apache. The closest that I got for years was my second primary station (original novice station was a Globe Chief 90A and Hallicrafters S-107) which included the Apache's older brother, the DX-100, that I obtained in early 1960.

Well, a few weeks ago, I suddenly became "Apache poor"! I obtained two Apache(s) for doing some repair work for a local amateur, then, another one (along with the Mohawk that I was really after) in a trade "deal".

After redoing the first two, I put one of them on the air. Reports from stations that I worked on 75 meters (and who were not local) said that the audio sounded "OK". Then, I worked a friend of mine. He asked if I were going through puberty again! The audio sounded fine, but certainly did not sound like me. Although I definitely have a higher pitched voice than many, the "scratchy" Apache was taking it much higher.

Well, I "pulled" the book and took a look at the schematic. Also, my friend sent me e-mails with all sorts of sites on the Internet that talked about modifications for the Apache audio. After taking a look at the various "suggestions", I decided to go it on my own.

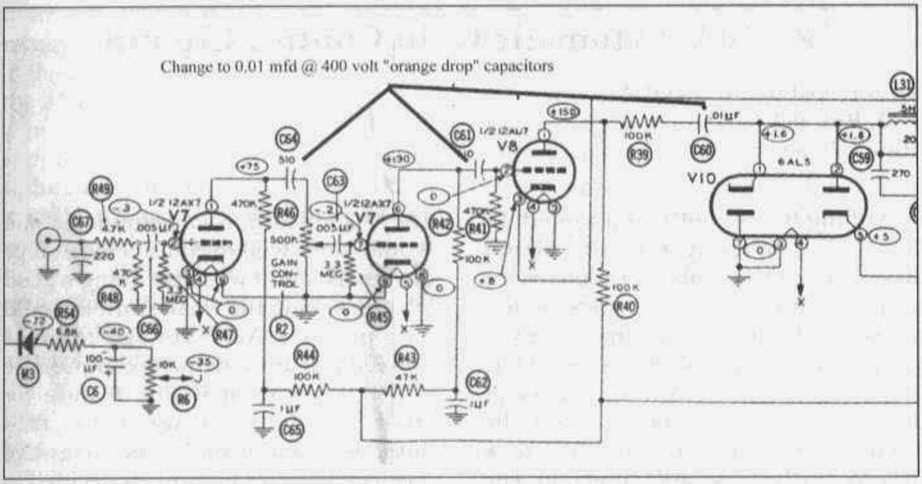
Now it is a fairly well known fact that disc ceramic capacitors are not the best things for audio, and Heath used a few of them in the Apache. Also, to get some decent "lows", a "fair" amount of capacity is needed.

Although some of the Internet suggestions said to eliminate the "clipper" stage, I decided to try to avoid this if at all possible. Frankly, I was looking for a very simple method of improving the Apache audio without having to do a lot of modifications. This is keeping with my beliefs of the "principles of the conservation of my finances and energy" (you can read "cheap and lazy").

Looking at the schematic, there are three capacitors that are very "subject" to cause problems. Two of them are low value, and the third is a disc ceramic. All three are coupling capacitors in the lower audio stages.

What I did was to change capacitors C60, C61, and C64 to 0.01 mFd 400 volt "orange drop" capacitors. C61 and C64 are 510 pF capacitors in the original circuit and C60 is a 0.01 mFd disc ceramic. All three of these capacitors are located on the terminal board located next to the audio preamplifier stages. You may ask why I used 400 volt capacitors. Well, I just happened to have quite a few on hand! You can use higher voltage capacitors, but I wouldn't go any lower.

I took one end of each of the 510 pF capacitors loose and bridged the 0.01



mFd capacitor across the terminals. That way, if I ever decided to return the transmitter to its original configuration I could do it with a minimum of effort.

The 0.01 mFd disc ceramic capacitor is "buried" although it is also on the same terminal board as the other two capacitors. To replace this one, I took loose the wire that goes to pin 1 of the 6AL5 and the input to the "low pass filter". Then, I connected the "orange drop" from the side of C60 that connects to R39 (100K) and the wire that I removed from the terminal board. The capacitor "floats", but, if you keep the leads short enough, it "self-supports" from the terminal board very nicely.

After these three capacitors were changed, my "local" friend was contacted. He said that the audio was much more "natural" sounding. Then, I submitted it to the "acid" test, the local 3880 morning "net". Well, the stations that are the most critical of how the AM signal sounds gave it "rave" reviews! My friend e-mailed me that I had finally "arrived"!

I have described this modification to several other amateurs. Those who have made the modification have e-mailed me that they also are getting "rave" reviews on their audio.

I do not know if those stations are setting their audio levels the same as I do, but I am setting the audio gain control (behind the key jack) at about 40 percent. The gain control on the front panel is at about 8 o'clock. The reading on the meter in the modulation position is about 150 mA on peaks. That seems to give about 100 percent modulation without over-modulating.

I know that there are many modifications that have been suggested on improving the Apache's audio characteristics, some are very complicated and some are fairly simple. This one is about as simple as it gets. If you are looking for a way to make your Apache sound better, and are basically "lazy" like me, you might just try this modification. It sure works for me! ER

Clatternet: 850 shift RTTY roundtable, on 10137 kcs USB Saturday, starts 0930-1000 Pacific time.

A complete index of the entire 12 years of ER is available for viewing or downloading at the following website: http://www.qsl.net/n9oo

R-390A Automatic Gain Control Circuits

by Ray Osterwald, NØDMS
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Although the Collins-designed R-390A is a fine receiver, several circuit design areas have caused problems for civilian users like me who prefer to use the equipment for amateur radio or SWL purposes. Two of these that always come to mind are the lack of a product detector for SSB and CW reception, and the strange AGC response of the stock receiver in the "fast" AGC position. The product detector problem has been solved for the most part with the excellent aftermarket units now being offered—see the ER ads for full details. However, as far as I am aware, AGC distortion has never been fully addressed. Modification articles have appeared over the years, and there have also been third-party AGC generators produced. The favorite of these seems to be audio-derived AGC circuit, which uses the separate line audio output to drive a diode bridge mounted on the rear panel of the mainframe as an external AGC generator. It makes a nice, quick-responding AGC. A user can actually control the AGC attack time with the line level gain control. The problem I've had with audio-derived circuits is what do you do when you are zero-beat with a strong carrier and don't get any audio to make AGC voltage? Or how about in AM when a strong carrier is present without modulation and you get AGC, but not enough? I have always thought that an RF-derived AGC generator with a very fast attack characteristic and selectable decay times without the distortion of the stock circuitry would be nice in the R-390A. Ten years ago I published an AGC mod that had those features, but I did so by merely disconnecting the delayed AGC. The AGC distortion was eliminated, and would work well for the average range of signals, but it was also doing a good job of masking the weak stuff. It would also produce AGC voltage for tube noise. It was an inadequate compromise that traded one irritating feature for another, but I felt it was better than nothing. When I installed the Longwave mechanical filter upgrade, I decided to fix the AGC problem once and for all and have a receiver what would stand up with the best of them. This article is about the results of my work. The bottom line is that I added a zener diode to the cathode circuit of the AGC rectifier to produce a different kind of delayed AGC.

Let's look at the AGC circuit design first. I have no idea of what the Collins designer was originally trying to accomplish; I can only speculate from the information available 51 years later. Figure 1 is copied from the technical manual, and I have added part of V504, the 4th IF amplifier. Find the junction of R545, R546 and C546. I have drawn a big box around this location. AGC voltage is developed at this point as in hundreds of other receivers. When the IF signal swings positive, the AGC rectifier tube conducts. IF coupling capacitor C546 has a negative charge across it. When the IF signal goes negative, the tube stops conducting. The charge acquired on C546 has flow to DC ground through R545. As it does, the junction of R545 and R546 MIGHT become negative with respect to chassis ground. I say "might" because there is a positive voltage at the junction of R545 and R546 that is designed to delay the generation of negative AGC voltage until a certain input signal level is reached. The cause of the AGC problem in the R-390 is the circuit used to clamp the AGC a "few" volts positive.

In Figure 1 I have added the suppressor circuit of V504. According to the circuit description in the technical manual, the junction of R546 and R547 is connected to the suppressor grids of the AGC IF amplifier and the 4th IF amplifier so that their suppressors act as positive voltage clamps. This arrangement is supposed to "prevent the AGC line from going more than a few volts positive." The R546-547 junction is connected to a B+ voltage divider made up of R544 (2.7 meg), R546 (180 k), and R545 (100 k). The voltage divider makes the plate of the AGC detector idle with a positive voltage offset. This prevents development of negative AGC bias until the positive offset is overcome. The suppressor clamp is supposed to prevent the line from going too far positive. Using the pentode suppressor grids this way as voltage clamps is not conventional. Here is a description of how it works:

Years ago in the vacuum tube days, it was common practice to make the pentode suppressor grid do weird things in the design of wave shaping and computing circuits. The R-390 designer might have borrowed from this practice. The function of the suppressor grid in a pentode is to prevent electron flow between the plate and the screen. Anything that gets hot inside a tube can emit electrons, including the plate structure. This is called secondary emission. Secondary emission is also caused when high-velocity electrons flowing to the plate "knock" other electrons free of the plate structure. However it happens, secondary emission causes a space charge, or a cloud of free electrons, to form between tube elements. We usually think of the plate as an attractor, but without the negative gradient appearing between the suppressor grid and the plate that has been set up by the zero-potential suppressor grid, the plate can become a virtual cathode and emit electrons. These carry over to the screen grid, and the resulting electron flow adds to total screen current. In a normal pentode amplifier, any increase in screen current causes a decrease in plate current.

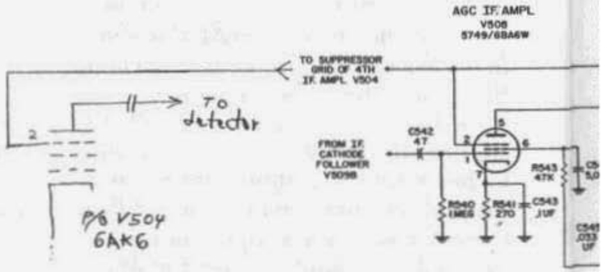
Through experimentation it was discovered that by making the suppressor grid positive with respect to the cathode, which deliberately increases the screen current, the tube would turn into a constant current source. Figure 2 is an example of this action, but note that this is NOT the configuration used in the R-390A. The triode switch tube, V1, charges the capacitor "C" in the plate circuit. A trigger, or "gate in" signal starts the charge sequence. The normal load resistor of the triode has been replaced by the pentode acting as a constant current source. Essentially, the capacitor is charged through the plate resistance of the pentode. Another way of thinking about it is that the plate resistance is in series with the B+ supply. The plate resistance is held more or less constant by the action of the positive bias on the suppressor adding to the screen current. Any increase in screen current causes a decrease in plate current, and a change in plate resistance.

I think Collins adapted part of this design method to the R-390 AGC circuit. By connecting the output of the B+ voltage divider to the two suppressor grids, in theory, the junction of R546 and R547 shouldn't ever go more than about 6 volts positive with the bias values used on V508 and V504. If it does, screen current in V504 and V508 increases, the screen impedance decreases, and the voltage at the R546-547 junction is prevented from rising.

The positive voltage offset on the AGC detector delays AGC rise in the R-390. In most R-390A receivers this is about 6

continued next page

Figure 1. Stock R-390A Circuitry



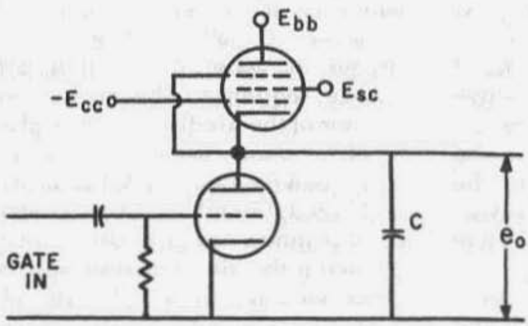
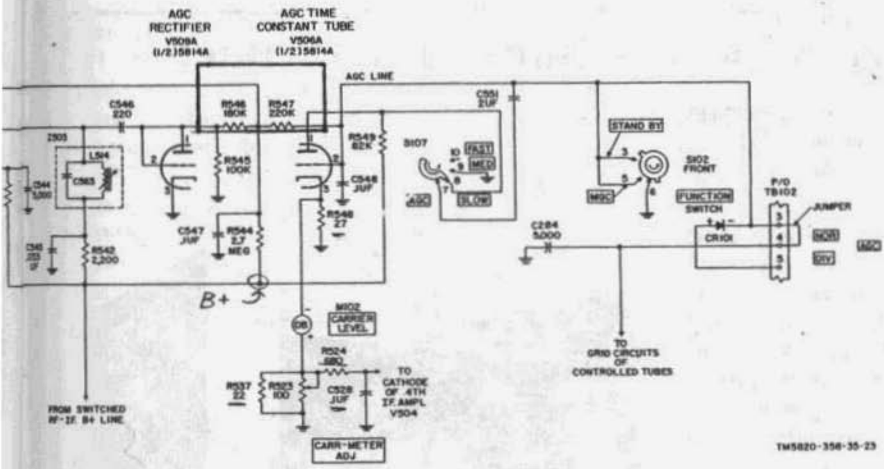


Figure 2. Using the pentode as a constant-current source

This is because it takes some finite amount of time for the space charge between the cathode and plate to disappear and for the tubes to start acting as normal pentode amplifiers when the suppressor potential is low. This acts like a "release clamp" and the hysteresis action holds the junction of R546 and R547 slightly positive just long enough for the AGC-controlled stages to go into distortion. Then the AGC takes hold all at once, producing a "pop" in the received audio. I also found that the infamous distortion in AGC-fast is caused by R-C charge integration across C548 working together with the hysteresis loop in the suppressor clamp circuit. During certain conditions, like rapidly changing CW signal levels, or syllabic SSB speech waveforms, the AGC current waveform lags significantly behind the rise time required to prevent RF distortion. At times, the AGC can actually be slightly positive, adding to RF distortion, rather than preventing it. The hysteresis time delay is never the same from one cycle to the next because of the dynamic conditions in the plate, screen and grid circuits of 4 tubes.

volts. The voltage can be reduced somewhat by contact potential in the AGC rectifier. So, for AGC bias to appear at the grids of the controlled tubes, the positive offset voltage first has to be overcome, plate potential has to swing thru zero, and then it has to go far enough in the negative direction to deliver enough AGC voltage to prevent distortion.

By watching the charge across C548 in the AGC-fast position with a fast-triggered oscilloscope (unavailable to the designers in 1949), I was able to discover that there is some hysteresis associated with the suppressor clamp.



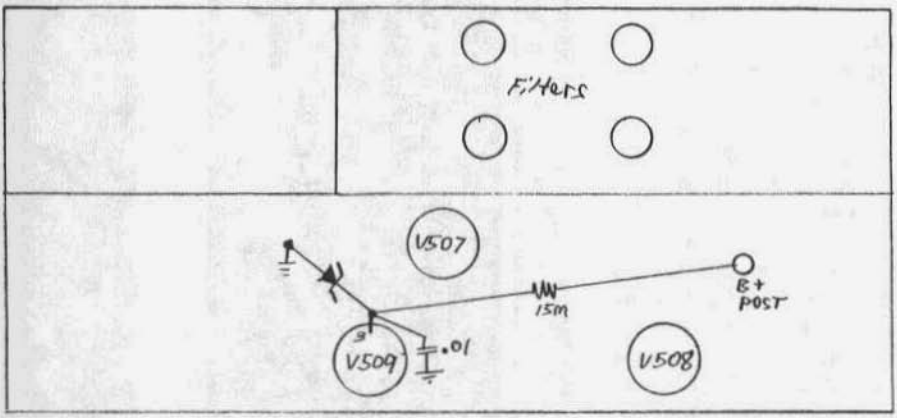


Figure 3. Bottom of IF chassis showing modification details.

All I did to fix the problem was to redesign the delayed AGC circuit for zener diode bias in the cathode of the AGC detector. See Figure 3. Since there is very little zener bias current, a large value resistor connected directly to the B+ line and a cathode bypass capacitor is all that is necessary. The 1N4738 is an 8.2 volt zener. With my particular receiver, this amount of bias at the detector cathode delays AGC until 1 microvolt (uV), or -107 dBm, input is reached. AGC idles at -.8 volt at the RF amplifier signal grid with no signal, which is about right for a remote-cutoff pentode like the 6DC6 or 6GM6. AGC rise is delayed until 1.1 uV is reached, or about -104 dBm. The AGC rise time is about .5 microseconds.

In the stock R-390A AGC is delayed until a 5 uV (-93 dBm) threshold is reached. This is roughly an S3, allowing for 6 dB per "S" unit. I feel this is too much delay. If it is assumed that the average minimum discernible signal is about -127 dBm, or .9 uV, then there is a 34 dB range with no AGC control available. This gives strong, fast-rising signals a good chance to produce AGC overshoot and RF distortion. The Collins 75A-4 uses a 3 uV (-98 dBm) AGC delay and seems to work well. The S-line receivers use about 1.5 uV AGC delay. In a receiver with .5 uV sensitivity at HF,

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A Broadcast Transmitter Primer

by Chuck Teeters, W4MEW
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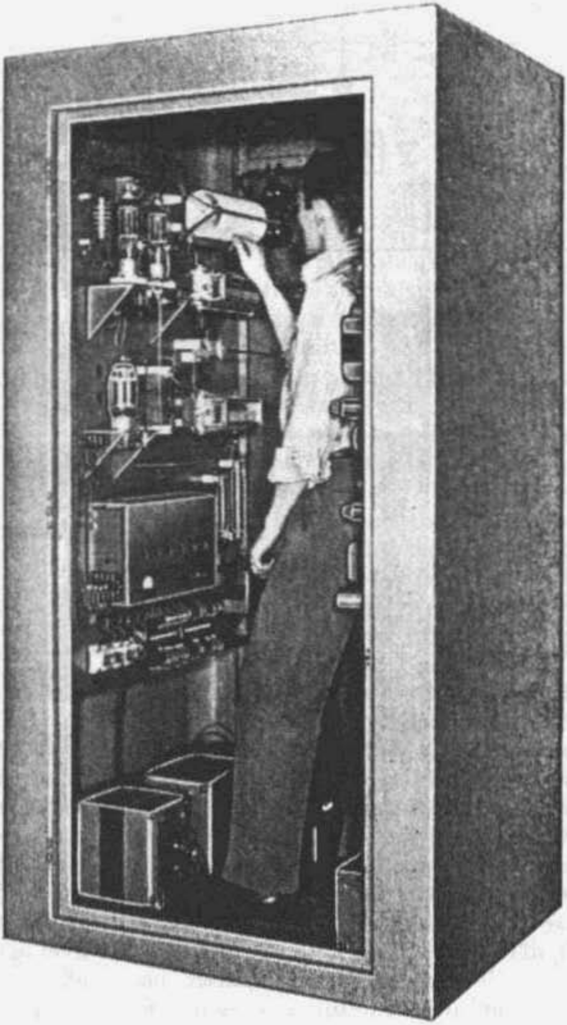
Most hams know little about BC transmitters, except they are big, good looking things that sound nice on the air. When one shows up for sale they jump at such a big beautiful electronic do-dad without knowing what they are getting into. (Our esteemed editor being one who jumped—check ER 147) I've had a little experience with them as I've done five conversions to 75 meters, most recently a CCA AM-1000D one KW. Back in the late sixties I reworked a Raytheon RA-250 for 75 meters. Then an RCA BTA-500M. I bought an ITA-1000A that was real, real cheap. About 6 years ago I converted a Gates 250GY to 75. For 15 years I had a one third interest in a class 3B station with two AM transmitters that I kept going on 1410. In 1946 I had to rebuild a WECo 250 watter after a fire. So, I would like to pass on some comments about BC transmitters that I know a little about, 250, 500, and 1000 watt units from 1940 to 1960 so you may be better prepared when you chase after that big monster.



Try this with your Globe King! The Gates 250GY has 59 cubic feet inside its cabinet.

First, about the big part, they really are big. In the forties and fifties stations wanted to impress the public and the equipment was massive. For example the "little" Gates 250 watt transmitter from 1952 is 78" high, 40" wide, and 34" deep, and I say little because it is compared to others of the same vintage. A Gates kilowatt from the fifties is 72" wide. The CCA 1000D we moved last year had to have the wiring harness disconnected and the cabinet cut in half. The Gates 250 is a lightweight at 900 lbs. The RCA 250 weighs 1340 lbs and the Raytheon 250 is 1425 lbs. Move up to a kilowatt and the Gates is 3100 lbs. Newer ones like the CCA (1965) shed a few pounds but are still heavy at 2052 lbs. Remember none of these things will fit through a 30" doorway.

To move these things, about one fifth to one fourth of the weight can be removed. Doors, trim panels, blowers, transformers, chokes, and reactors usually come out with no problems, many just sit in the bottom but mark wires, and locations. For safety and a little more weight reduction remove tubes, crystal ovens, plugin relays, timers, meter panels, and anything else that plugs in. If the transmitter is still in service you have to disconnect the AC input, which is three-wire 220 volt service, hard wired, no plugs on these things. Also locate three other connections in addition to the antenna, the audio input, frequency monitor feed, and the modulation monitor feed. And guard the instruction book as they are very hard to come by these days. I spent over a year looking for info on the CCA before Greg, KX4R stepped in and graciously helped me out.

RF wise these things are simple, a crystal oscillator, buffer, driver, and PA. Newer transmitters combine the buffer and driver. Tubes are 807s, 813s and a pair of 810s in the final on the older 250 watt stuff, and 833s in the kilowatts. Newer ones use tubes like 12BY7s, 6146s and 4-400s. The finals run two tubes in parallel. There are two or three tuned circuits, buffer plate maybe, driver plate for sure, and the PA tank. All are tuned to the output BC frequency. The first two are small and easy, they usually are tuned by variable capacitors or

How to Repair a Transmitter from page 24

inductors by either a slug or shorted turn. Remove about half the capacitance and inductance if it was tuned above 1200 kHz to get it to 3885 kHz. If it was tuned to the low end of the BC band cut both down to one fourth. A grid dip meter makes it easy.

The final tank is a pi-L or pi-T section with a second harmonic series tuned trap on newer units. Most are tuned by inductance change. Some of the old 250 watt units use variable caps. If it uses variable inductance tuning and you have some big variable caps go for a conventional output pi using handbook values. If not, try putting the variable T section loading inductance in the tank circuit, remove half the fixed input capacitance and put about 1400 pFd on the output side of the pi. Remove the rest of the T section, original tank coil and second harmonic trap. The grid dip meter is again the way to go. There will also be a multi-tapped RF choke across the output, or a link on the tank which is the pickup for the modulation monitor. Keep it if you can as it is useful. It provides a 10 watt sample of the output. Metering is normal and very complete with a multifunction meter to check everything, with separate meters for high voltage and final plate current, an FCC requirement. You may find an RF amp meter that is not connected to anything. It is not a real RF meter but a uA meter that was connected to a remote thermocouple at the antenna base.

The audio is two stages in the newer and three stages in the older transmitters. All the audio stages are push-pull. All run class A except the last, the modulator which is class B if the modulator uses triodes, usually 810s, or 833s. The newer stuff uses 4-400s operating AB1. All have negative feedback around the whole audio chain. The audio input is through a 600 ohm transformer. There is no gain control, the input level was adjusted externally. The normal level required is between

continued on next page

10 and 16 dBm, about a tenth of a watt. A nine volt battery and a carbon mic in series connected to the input will work fine for testing. The modulation transformers don't have RF final plate current running through the secondary, they are capacitance coupled across a reactor or choke to the final. This keeps the transformer from saturating and killing off the low audio frequencies. The tetrode finals have a 50 henry or so choke in the screen feed so there is no screen winding on the modulation transformer.

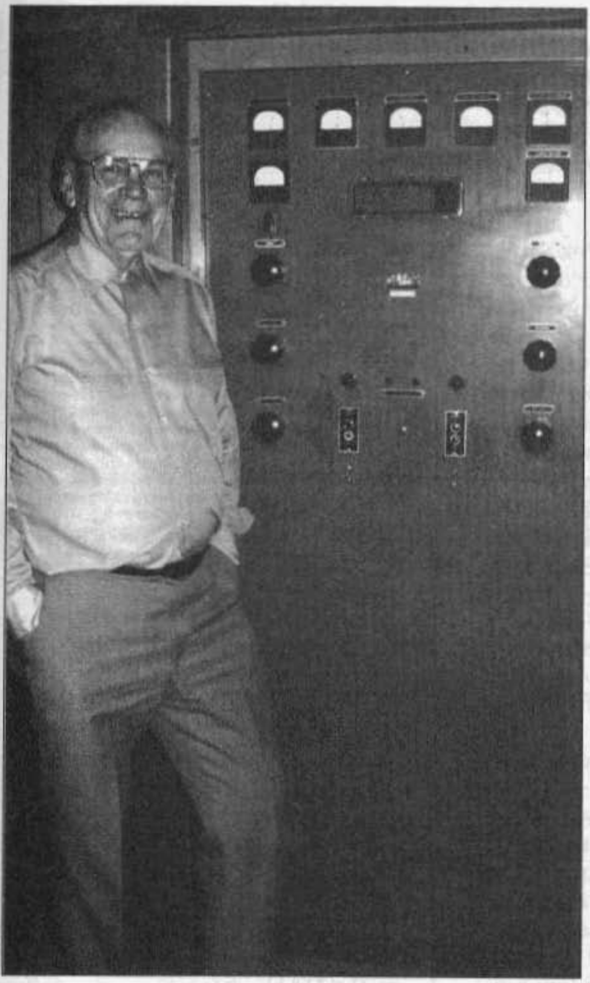
There are usually three power supplies, a HV of 1500 to 3000 volts for the PA and modulators, a B plus of 250 to 750 volts for the rest of the RF and AF stages, and a bias supply of negative 100 or so for the modulators. Newer Collins and a few others use the fixed bias on the PA also. In most the RF stages including the final use only grid leak bias. The low level audio stages use cathode bias. There is no protective bias on the final as these units were not built for CW. The protection is overload relays, which take care of excitation failure, arc over, and miss tuning. High voltage power supplies are full wave using mercury vapor rectifiers, 866s and 872s/8008s. Filters are choke input with oil filter caps. The power supplies have big, by ham standards, bleeders resisters, dissipating about one fifth of the output.

Older transmitters have filament adjust pots and voltmeters on the PA and modulator tubes. All the transmitters have a power output adjustment. The old ones run the PA voltage up and down with a big pot in the ground return. New ones use a loading adjustment for power control. Normal range is at least 5% over and 10% under rated power. A lot of these units have a power output cut back for night time operation, 1 KW to 250 or 250 to 100 watts out. If so, there will be some relays that switch the power transformer primaries to reduce the output voltage. (ITA used a screw in heater element, just like the old BC-610s. CCA uses a Variac) The power cut back gives you a low power tune up capability.

If the transmitter was built before the days of unattended remote control operation, (and not modified later) the control ladder is not too complicated. A panel mounted switch/circuit breaker in the 220 line and/or a relay to make the fine connection controlled by a panel switch usually labeled START or FILAMENT. This puts power on the filament transformers, bias power supply, time delay relay, and blower if there is one. The time delay, usually about 45-60 seconds is to let the heater cathode and mercury vapor tubes warm up. When the TD operates it makes power available to the plate relay through the interlock chain which includes the door switches, blower air switch, and any other covers or doors where you can get inside. The plate relay is controlled by a PLATE or CARRIER switch. Various pilot lamps, usually with 3S6 110 volt bulbs, indicate what is going on with big bright 1" indicators marked with things like FILAMENT, READY, INTERLOCKS, PLATE, and OVERLOAD.

There will be at least 2 overload relays, one in the PA filament return and the other in the modulator filament return to open the plate relay and shut down the transmitter. The more deluxe have overload relays in the low and high voltage power supplies negative returns also. The Super Deluxe models will have automatic reset relays connected to the overload relays, that cycle them two or three times before a shut down. (I disconnect the recycle stuff and let the overloads shut the beast down the first time, much safer that way)

Later units, or modified ones, have more relays and external metering connections for remote unattended



Cliff Kurtz, N6ZU, with his Gates 250GY. He operates it on 75 meters.

operation. There will be a start relay for sure, and connections for the remote start, interlock check, remote plate relay control, remote overload reset, remote power output adjustment, and a remote power cut back relay control. Some units will have a local-remote switch to select which input controls the relays. The FCC mandatory meters, the PA plate current and voltage will have external connections, in the ground lead of the panel meters. The feed is usually 1 mA for a reading equal to full scale on the transmitter meters. For ham operation, the remote plate relay control makes a fine push to talk control point. A coax or open relay, mounted on the top by the antenna connector, connected in parallel with the plate relay will take care of antenna transmitter-receiver switching and disabling.

Powering up a BC transmitter is fun. Pull all the rectifier tubes, and disconnect the primary of the bias, low, and high voltage transformers. Put the power to it and if things are OK filaments and pilot lamps will light, the blower will run, and after a while the time delay will operate, usually indicated by a READY lamp. Open the doors to check the interlocks. Close all the doors and the plate switch should operate the plate relay. Remove the power and connect up the bias transformer primary, put in the bias rectifier, and start again. Check bias voltages on the modulator grids, find the adjustment and set it as far as it will go negative.

Preheat the mercury vapor rectifiers by plugging them in and running the filaments ONLY for 20 or 30 minutes. Connect up the primary of the low voltage transformer, start up, let the TD cycle and hit the plate switch. Check the low voltage, tune up the low power RF stages and check for grid drive to the final. Power off and connect up the high voltage, switching the power cut back to low. If there is no power cut back connect a 1200-1500 watt 115 volt electric heater or hair dryer in series with the HV transformer primary. Put the power to the monster and hopefully you can

continued next page

tune the final for some output. The plate voltage meter should have a reading of half or less than normal. When you are happy with everything remove the electric heater and go for it. The final touches are adjusting the modulator bias, checking audio, and looking at the meters for normal readings.

So end of a fast lesson on broadcast transmitters. If you have never done it, there is probably no stopping you, so this should give you a head start. If you have done it you'll always wonder why you got rid of that monster. Broadcast transmitters are like boats, you are happy when you get it and happy to see it go. I didn't think I would ever try again, but I just found a Raytheon RA-250 that can be had for the asking. It's my all time favorite as it has motor driven tuning capacitors and is a great big beautiful brute. All I need is to talk the wife out of the spare bedroom. ER

Repair a Transmitter from page 24

radiation. You can't do that with the receiver in your own ham shack, it will always pick up your harmonics whether they are being radiated or not. If possible, ask a friend in your vicinity to listen for harmonics at twice and three times the output frequency of your rig. I haven't had a harmonic problem personally, probably because I use an antenna tuner that provides an additional degree of selectivity and harmonic reduction and because my Zepp antennas don't present a low impedance in the ham bands. If you have any concerns about suppressing second and higher order harmonics, there is a simple "half wave" filter that you can build, one for each band, that will attenuate the second harmonic by 30 dB, the third harmonic by 48 dB, and so on. These filters are described in the Nov-Dec 1949 GE Ham News and in the Radio Handbook (see sidebar). Lew McCoy built these filters in coffee cans, as he described in "Harmonics, Harmonics, Harmonics, How To Keep Them off the Air," QST, May 1960, pages 16 and 17. They kept a lot of Novices using boatanchor transmitters in the 50's and 60's from getting "pink tickets." ER

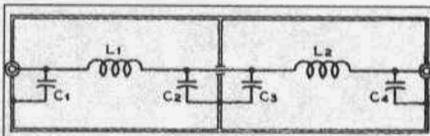


Figure 10
SCHEMATIC OF THE SINGLE-SECTION HALF-WAVE FILTER

The constants given below are for a characteristic impedance of 52 ohms, for use with RG-8/U and RG-58/U cable. Coil L_1 should be checked for resonance at the operating frequency with C_1, and the same with L_2 and C_4. This check can be made by soldering a low-inductance grounding strap to the lead between L_1 and L_2 where it passes through the shield. When the coils have been trimmed to resonance with a grid-dip meter, the grounding strap should of course be removed. This filter type will give an attenuation of about 30 db to the second harmonic, about 48 db to the third, about 60 db to the fourth, 67 to the fifth, and so on increasing at a rate of about 30 db per octave.

C_1, C_2, C_3, C_4—Silver mica or small ceramic for low power, transmitting type ceramic for high power. Capacitance for different bands is given below:
- 160 meters—1700 μμfd.
- 80 meters—850 μμfd.
- 40 meters—440 μμfd.
- 20 meters—220 μμfd.
- 10 meters—110 μμfd.
- 6 meters—60 μμfd.

L_1, L_2—May be made up of sections of B&W Miniductor for power levels below 250 watts, or of no. 12 enam. for power up to one kilowatt. Approximate dimensions for the coils are given below, but the coils should be trimmed to resonate at the proper frequency with a grid-dip meter as discussed above. All coils except the ones for 160 meters are wound 8 turns per inch.
- 160 meters—4.2 μh; 22 turns no. 16 enam., 1" dia. 2" long
- 80 meters—2.1 μh; 13 t. 1" dia. (No. 3014 Miniductor or no. 12)
- 40 meters—1.1 μh; 8 t. 1" dia. (No. 3014 or no. 12 at 8 t.p.i.)
- 20 meters—0.55 μh; 7 t.• ¾" dia. (No. 3010 or no. 12 at 8 t.p.i.)
- 10 meters—0.3 μh; 6 t. ½" dia. (No. 3002 or no. 12 at 8 t.p.i.)
- 6 meters—C.17 μh; 4 t. ½" dia. (No. 3002 or— no. 12 at 8 t.p.i.)

Ed. Next month part 5.

R-390A Automatic Gain from page 35

like a good R-390A, a 1 uV AGC delay is a good balance. Very weak signals are not masked and AGC control takes over quickly for most of the receiver's dynamic range. (This is assuming you have selective filters installed.) If a larger AGC delay is desired, install a different zener diode, perhaps 12 volts or so. I have not experimented to reference a given zener bias voltage to a particular AGC delay. As they say, "individual results may vary!"

Here are the steps to do the AGC modification:

1) V508: Connect pin 2 to pin 7. This connects the suppressor grid to the cathode for normal pentode amplifier operation.

2) V504: Connect pin 2 to chassis ground. Here the suppressor grid is ground-referenced.

3) Return V508 to 6BA6, the stock configuration. Some operators use a 6AK6 here to increase AGC loop gain, a common AGC band-aid.

4) Remove R544. This disconnects the voltage divider and the original delayed AGC circuit from the AGC detector plate circuit.

5) Install the zener diode, the 15 Meg resistor, and the .01 uF bypass at the AGC detector cathode, pin 3 of V509A per the diagram in figure 3.

6) Realign Z503.

7) Enjoy normal AGC!

It's interesting to note that Dr. Carl Zener first proposed the Zener effect in 1934. The Zener effect accounts for the electrical breakdown in solid dielectrics below 5 volts. Above 5 volts, the avalanche effect explains diode breakdown as described by K.G. McKay in Physics Review, 15 May 1954. One of the first products to evolve from single-crystal silicon experiments was the zener diode. National Fabricated Products made the first commercially available zener diode in early 1955. It would have been nice to see this AGC modification incorporated into production R-390As, because it certainly could have been possible.

I kept the audio-derived AGC generator in place for a while, but ended up removing it. It turns out that strong signals tend to cause distortion when the line gain is turned up too far. I think this is probably because of rectified audio getting onto the AGC line.

That's it for the R-390A AGC. My receiver is now working so well that I have forgotten all about the problems, and enjoy it for what it is, an often overlooked and underrated performer. ER

Radio Service from page 27

CBS. In all fairness, Philco did build the players for Goldmark and CBS. ER

*Rube Goldberg. Many years ago a cartoonist, Rube Goldberg, became famous for his cartoons showing very complicated ways of doing a simple job. For example, a cartoon might feature a machine that involved several mechanical steps to ultimately pour a cup of coffee, or scratch your back.

TUBE COLLECTORS GROUP FORMED: The new tube collectors association is now in operation. This is a non-profit, non-commercial organization of collectors & history enthusiasts focusing on all phases & vintages of tube design. The founding president of the group is Al Jones, W1ITX, who is known for his award winning tube collection. For more details & complimentary copy of the association's bulletin contact Al Jones, CA, (707) 464-6470, Ludwell Sibley, OR, (541) 855-5207, or mail request to POB 1181, Medford, OR 97501.

AMI Update from page 2
recent bill in the US Senate designed to insure "demilitarization" of surplus equipment. The bill is only intended to apply to equipment of military "significance", and not to obsolete equipment such as an ARC-5 set or ART-13 transmitter, according to the ARRL Legislative and Public Affairs Manager Steve Mansfield, N1MZA. As mentioned in a recent ARRL letter, this issue has also been of concern to vintage firearms collectors as represented by the National Rifle Association. Nevertheless, it might be a good idea to express our concerns to our senators about the possible loss of this heritage equipment to the sledge hammer. Certainly, a clarification of applicability should be part of the bill. While we don't want missiles going to potential enemies, it's clear that equipment such as an R-390 is no more a potential menace to our country than anything currently manufactured by Icom, Kenwood or Yeasu. The legislation mandating destruction of equipment capable of further military use is Section 1062 of the Department of Defense appropriations bill S.1438.

Finally, a reminder for the upcoming 2nd Annual AMI Heavy Metal Rally which will be held this year on the evening of Saturday, December 22. This QSO party is expressly for the purpose of showcasing our armada of restored Tall Ship broadcast transmitters, homebrew and military iron, meeting new friends and revisiting old acquaintances. While everyone is welcome, the rule of thumb is a transmitter weight of a minimum of 250 pounds or 250 watts! The event is from sunset on into the wee hours, and this year we're adding 75 meters to the mix. Suggested operating frequencies are 1885 kHz eastern USA, 1900 kHz western USA, 3880-3885 kHz and 3835 kHz, nationwide. As we did last year, a trophy will be awarded the winner of the most votes for "best sounding" station, as sent to and tabulated by the impartial judges at ER Magazine.

So that wraps it up this month from the foothills of the Rocky Mountains.

73, and Mod-U-Later! **ER**

Probe Adapter from page 29
with the corresponding 1,000, 3,000, and 10,000 next to the 0.1, 0.3, and 1.0 ranges. This setup is very safe to use with the large plastic HV probe. It has been reliable giving consistent readings. The calibration is verified from time to time but there has been no need to recalibrate. This idea is applicable to many other voltmeters. Remember to have at least 10 meg ohms input resistance on the measurement ranges. Other meters probably will require a slight variation of the adapter resistor string to calibrate properly. **ER**

Editor's Comments from page 1
it was torn down for transporting, it fired up straightaway on 1440 and appeared to function just as the engineers at Collins intended it to. The next step was moving the driver stage to 1885. This was accomplished with no complications or difficulties. Where I'm having problems is in the neutralizing circuit and final output stages. As soon as I get this issue into the mail I'm going to begin 'picking brains' (consulting experts) and should have the 300G putting out RF on 1885 in short order. Next issue I hope to have a complete report on the project with some interesting photos. I think that everyone will find the 300G to be a very interesting rig. N6CSW

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FOR SALE: Collins S-Line aluminum knob inlays: small (exciter/PA tuning) - $1; 30L-1 - $2; spinner/plain (main tuning) - $3. Charlie, K3ICH, 13192 Pinnacle Lane, Leesburg, VA 20176. (540) 822-5643

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FOR SALE: Send SASE for large list of excess parts. publications, ham & test gear. K4AFW, 104 Glenwood Dr., Williamsburg, VA 23185

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FOR SALE: Naval rcvr's RAK, RAL, RAO, RBA, RBB, RBC, RBL, RBM, some checked, pwr splys available - $75 to $450, depending type condx. Carl Bloom, CA, (714) 639-1679 or 3778111@mcimail.com

FOR SALE: OEM Heath belts - $2.50 each shpd; or 10+ for $2 each shpd. Send check or money order. Roberta Hummel, 202 Midvale Dr., Marshall, WI 53559

FOR SALE: Manuals for old ham gear of the '30s to the '70s. Check WEB Catalog www.hi-manuals.com

FOR SALE: NOS TCS baseplates still in factory shipping wrap - 2/$15; RX cables - $10.+shpg. Carl, KN6AL, 32 96th Ave., 1E, San Diego, CA 92103. kn6al@earthlink.net

FOR SALE: 2001 COLLINS CALENDAR now shipping. 15-months, all color! $14.95 postpaid USA and Canada. Trinity Graphics, 5402 1/2 Morningside, Dallas, TX 75206. www.kk5im.com

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

NOTICE: T-368 Registry. For info w2zr@aol.com. Subscribe to the T-368 & BC-610 reflector at: http://groups.yahoo.com/group/T-368_BC-610

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

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FOR SALE: Older type electronic parts & hardware; free vintage flyer. Mail order since 1954. Bigelow Electronics, POB 125, Bluffton, OH 45817

FOR SALE: VM parts, new boxed electron tubes, new Heathkit parts, new panel meters. Norm, 1440 Milton St., Benton Harbor, MI 49022

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 e-mail<bugs@mnic.net>

FOR SALE: Parts, tubes, books, ect. Send two stamp SASE or email for list. Wayne LeTourneau, POB 62, Wannaska, MN 56761. wb0cte@arrl.net

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

FOR SALE: Tubes, NIB or tested good, priced low. SASE for list. WA7HDL, 167 Hwy 93 S, Salmon, ID 83467

FOR SALE: Time hour meter 230V 60C new - $10; Daven attenuator, variable, new - $10. Joe, W6CAS, CA, (916) 731-8261

FOR SALE: R-390A, exc condx w/case, SSB converter, spkr - $1200 / BO; S-38B - $70. Ron, MI, (517) 374-1107

FOR SALE: Serial #5911 TR7, PS7, (NB7, DR7, AVX7, narrow SSB filter in TR7), nice rig - $495 + shpg. W2AO, email: jensdad@webtv.net

WANTED: SW3 #33A and #35 coils. I will trade my extra coils SW3 coils. Hank Bredehorst, 2440 Adrian St., Newbury Park, CA 91320. (805) 498-8907

WANTED: Parts for a TMC GPT-750 xmtr. I need the AM modulator deck and other parts to restore this unit. John, KF2JQ (716) 873-0524 jprusso@acsu.buffalo.edu

WANTED: Long wire ants AT101, AT102, GRC-9; DY88/105; PP327GRC9, counterpoise CP12 & 13 GRC9; BC348 pwr conn PLQ102/103. KA1ZQR, 348 N. Main St., Stonington, CT 06378.

WANTED: Globe King 500 B/C; Viking Valiant I/II; Viking 500; Heathkit Mohawk. Frank, (916) 635-4994, frankdellechaie@sprintmail.com

WANTED: National SW-3 model1, version 3. Uses 32-32 30 tubes. Dean Showalter, W5PJR, 72 Buckboard Rd., Tijeras, NM 87059. (505) 286-1370

WANTED: Collins 32V & Collins 75A series; Globe Scout; National SW54. KBØW, CA, (916) 635-4994, frankdellechaie@sprintmail.com

WANTED: National Company emblems, escutcheons, logos from equipment. Also WW II rcvr's manufactured by National. Don Barsema, 1458 Byron SE, Grand Rapids, MI 49506. (616) 451-9874, dbarsema@prodigy.net

WANTED: 1950's Popular Electronics; 1961-65 Heathkit catalogs & Radio-TV Experimenter. John Curtis, WØCAR, 3146 S. Franklin St., Englewood, CO 80110. (303) 781-8027, wocar@arrl.net

WANTED: SCR602 components, BC-1083, BC-1084 displays, any APS-4 components. Carl Bloom, CA, (714) 639-1679 or 3778111@mcimail.com

WANTED: BC-191 for my ART-13 (or buy $300, must work). Bill Hill, W4ZXW, 510 E. 25th Ave., Cordele, GA 31015. (229) 273-7264

WANTED: AN-29 or -29B, BC-1387 (for SCR-536), BC-188 (p/o SCR-179). Joseph Pinner, KC5IJD, 818 Hill St., Kingston, TN 37763. kc5ijd@sprintmail.com

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WANTED: Plastic meter cover for B&K 707 tube tester 3/8"x4"x4-11/16". Allan Lurie, W9KCB, 605 E. Armstrong Ave., Peoria, IL 61603. (309) 682-1674

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WANTED: Tubes: Any quantity, clean, unused, small or lge. Please send list of types, quantities. **FOR SALE:** Tubes - send SASE for list AF; teletype parts. Fred Schmidt, N4TT, Typetronics, POB 8873, Ft. Lauderdale, FL 33310. (954) 583-0777, FX: 583-1340

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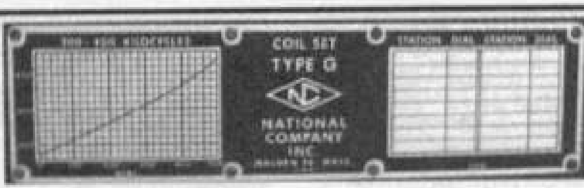

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WANTED: Orig Heath manuals for ham & test equip. Please state condx & price. Warren, K1BOX, POB 1051, Spruce Pine, NC 28777. (828) 688-1922

WANTED: Alignment service manual for R&S, EK-07 rcvr. Weber, 4845 W. 107th St, Oak Lawn, IL 60453

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WANTED: WW-2 Japanese military radio and radar of any kind. Yokohama WW-2 Japanese Military Radio Museum, Takashi Doi, 1-21-4, Minamidai, Seyaku, Yokohama 246 Japan. Fax 011-8145-301-8069, takadoi@carrot.ocn.ne.jp

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WANTED: Clean Mackay 3010C & Kenwood R599D w/all filters & manual. Ric, C6ANI, POB N4106, Nassau NP, Bahamas

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WANTED: Hammarlund HQ-180; Scott Special Communications rcvr; RCA Channalist. EA4JL, phone Kurt Keller, CT, (203) 431-9740 or k2112@earthlink.net

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(1) Publication Name: Electric Radio. (2) Publication No.: 1048-3020. (3) Filing Date: Nov. 10, 2000 (4) Issue Frequency: Monthly. (5) No. of issues published annually: 11. (6) Annual subscription price: $28. (7) Complete mailing address of known office of publication: 14643 County Rd G, Cortez, CO 81321-9575 (8) Complete mailing address of headquarters or general business office of publisher: Same as #7. (9) Full names and complete mailing addresses of publisher, editor and managing editor: Electric Radio Press, Inc. 14643 County Rd G, Cortez, CO 81321-9575. Barry Wiseman, 14643 County Rd G, Cortez, CO 81321-9575 (10) Electric Radio Press, Inc. 14643 County Road G, Cortez, CO 81321-9575. (11) Known bondholders, etc.: None. (12) Not applicable. (13) Publication Name: Electric Radio (14) Issue date for circulation data below: Nov. 2000. (16) Statement of Ownership will be printed in the Nov. 2000 issue of this publication.

15. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
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Produced by Floyd Soo, W8RO (ex-KF8AT)

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FOR SALE: RCA tube manuals, RC-15, RC-20, RC-25; ARRL Handbooks, 1965, 1968, 1972 & 1978. LSASE for list. Charles Brett, 5980 Old Ranch Rd., Colorado Springs, CO 80908. (719) 495-8660, brett3729@aol.com

FOR SALE: Collins drum overlays. 75A-2, 3, 51J#. For 75A-4 & KWS-1, specify new/old - $8.50 ea. 2/$15 ppd. Correct colors. Charlie Talbott, K3ICH, 13192 Pinnacle Ln., Leesburg, VA 20176-6146. (540) 822-5643.

FOR SALE: Repro Nameplates, R-390A generic - $9; 51J-3 and 51J-4 exact replicas - $12. Tom Marcotte, N5OFF, 242 Chestnut Oak Dr., Mandeville, LA 70448. marcotte@iamerica.net

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

FOR SALE: Homemade galena xtal radio &/or parts to make your own. L. Gardner, 458 Two Mile Creek Rd., Tanawanda, NY 14150. radiolen@aol.com

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: Heath Nostalgia, 124 pg book contains history, pictures, many stories by longtime Heath employees. (See BOOKS inside back cover.) Terry Perdue, 18617 65th Ct., NE, Kenmore, WA 98028

FOR SALE: Johnson & Hammarlund panels, cabs refinished. Done in same finish as new cars. Ranger-1, II (price, call), Valiant-1, HQ-180 (series), $250. + shpg. Visa/MC/AMX. Dee, W4PNT, VA, (540)249-3161, cell (540)471-7023 or w4pnt@vaix.net for jpg's

NOTICE: Visit HamRadioUSA.com a website dedicated to traditional ham radio & vintage radio resources. http://www.radioing.com. let's radio. W5AM

FOR SALE/TRADE: Transmitting/rcv'g tubes, new & used - 55¢ LSASE for list. I collect old & unique tubes of any type. **WANTED:** Taylor & Heintz-Kaufman types & large tubes from the old Eimac line; 152T thru 2000T for display. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS 66213. (913) 782-6455 or johnh.walker@prodigy.net

FOR TRADE: Two good RCA 833A's for one Taylor 833A; also looking for Taylor 204A, 813, 866B. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS 66213. (913) 782-6455 or johnh.walker@prodigy.net

FOR SALE: NOS British tubes 1930's to 1960's - send wants. David Boardman, VA2DVD, 10 Lemaistre, Sainte-Foy, Quebec G2G 1B4. (418) 877-1316, dbtubes.com

FOR SALE: Repair! Radio repair, tube or solid state. Reasonable charges. J. Dan Rupe, W7DDF, 998 Whipple, POB 697, Grayland, WA 98547. (360) 267-4011, w7ddf@yahoo.com

FOR SALE: Books, 200+ radio titles. Great prices. SASE or email for New Revised List. Paul Washa, 4916 Three Points Blvd., Mound, MN 55364. w0tok@msn.com

FOR SALE: DX-35, DX-40 reproduction crystal doors. $11.50 shipped. Texans add 8.25% sales tax. Glen Zook, 410 Lawndale Dr., Richardson, TX 75080

FOR SALE: Atlas 210X LE; Atlas 215X; Swan 700CX; all three w/pwr sply & spkr; Icom 211. All 9+. Gene, W7MXM, ID, (208) 522-5854

FOR SALE: 1936 style 5-watt transmitter kit with 40M crystal - $25. ppd. Robert Larson, W7LNG, 1325 Ridgeway, Medford, OR 97504. (541) 773-5214

FOR SALE: Nice, Hammarlund HQ-200, looks new - $225 +shpg. Ed Sauer, 787 N. Peterman Rd., Greenwood, IN 46142. (317) 881-1483

FOR SALE: Assorted parts for projects, restoration and repairs. List - $1. Joe Orgnero, VE7LBL, 1349 Leask Rd., Nanaimo, BC V9X 1P8, Canada

FOR SALE: Collins 30K-4 xmtr, unrestored 30K-4, includes coils for 4.5-18 mcs. Best offer, might trade. Pick up only in central Florida marmot@highstream.net or (321) 674-0525 before 9 pm EST

FOR SALE: Military Radios, etc. E-mail N1UDI@ATT.NET for a List or SASE. Ronnie Parker, 1357 Bridgeport, CT 06601

FOR SALE: Hallicrafters S40B, S108, HT32A; Collins 30L1; Heath DX60. **WANTED:** Heath IO-3220 Scope. John Thuren, AA5T, TX, (281) 530-6130, jbthuren@hal-pc.org

FOR SALE: 75A-4 with three filters and installed noise blanker, exc condx, orig manual, serial number 3579 - $1150. Spkr available. Will consider parting everything out if unit is unsold. Prefer pickup or arranged delivery rather than shpg. Steve, WA9ASZ, RR 3, Box 413, Bloomfield IN 47424. (812)863-2088, ssauer@bluemarble.net

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