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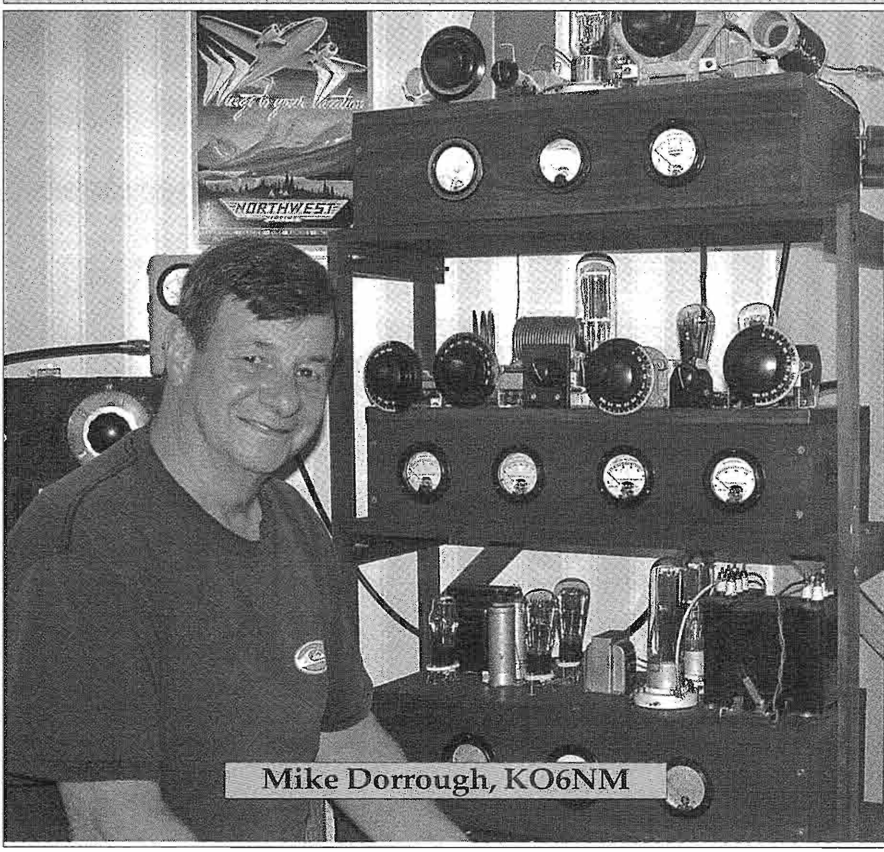
ELECTRIC RADIO

celebrating a bygone era

Number 200 January 2006



Mike Dorrough, KO6NM

ELECTRIC RADIO

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

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

Regular contributors include:
Chuck Teeters (W4MEW), Jim Hanlon (W8KGI), Tom Marcellino (W3BYM), Bruce Vaughan (NR5Q), Bob Grinder (K7AK), Bill Feldman (N6PY), Dave Gordon-Smith (G3UUR), Dale Gagnon (KW1I), Brian Harris (WA5UEK), John Hruza (KBØOKU), Hal Guretzky (K6DPZ)

Editor's Comments

Winter 2006 Operating Events

I would like to call attention to the announcements in the magazine this month about the Classic Exchange and the American Wireless Association AM QSO party. Both events are next month, in February, and I am really looking forward to them. I am hoping for a large turnout this year. During the AWA event, be sure to listen for the AWA "flagship stations" because they are either running historic equipment or historic call signs. Working one of them counts extra, see the article on p. 45 for all the details. Quoting from Gary Carter's article, "...The first is W2AN, the club station for the Antique Wireless Association, located at the AWA Museum annex. On 75 meters they will be running James Millen's personal transmitter that he built in the 1930s. On 40 and 20 meters they will be using other transmitters from the AWA stable. The other flagship station will be Jim Hanlon (W8KGI) in New Mexico using James Millen's original call sign W1HRX, courtesy of the James Millen Society." Jim Hanlon is a longtime ER author, and I am sure everyone will want to work Jim on phone with the special call.

The Classic Exchange has run for many years now, and usually these two events are the highlight of the winter season for AM and vintage CW operators.

The Electric Radio Heavy Metal Rally will have occurred by the time this issue is printed, and I will have the results as soon as all the logs have been received. I am hoping for good conditions as I am writing this.

BPL Updates

I've had requests for more information about recent Broadband Power Line developments. I am working on a new update, and it should be ready for the February 2005 issue. Keep Those Filaments Lit! 73, Ray, NØDMS

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Cover: Mike Dorrough–KO6NM (aka No Money Mike)–is checking out Martha's Breadboard Deluxe Transmitter at the QTH of Gary, WA9MZU. Gary recently constructed the circa 1935 rig which will be featured in an upcoming ER article. Mike has a special interest in vintage transmitters and has saved dozens of broadcast transmitters from becoming landfill. Many Hams all across the country consider Mike to be the West Coast's "gold standard" for AM audio.

The R-725 Cover-Up

By Chuck Teeters, W4MEW
110 Red Bud Lane
Augusta, GA 30907

The R-725 military HF radio receiver was the R-390A receiver without mechanical filters in the IF strip. It was a product of the Cold War, and was one of the most successful cover-ups the government ever instituted. The R-725 was an essential part of the F9c antijam crypto system and a radio that the National Security Agency took an active interest in. NSA's problem, however, was how to put a secret classification on an item that is 98% the same as ones built in the thousands, has instruction manuals all over the place, and had even been sold surplus overseas. The fact that several hundred R-725s would be ordered on a government contract and was an eleven year step backwards in technology to the R-390A's predecessor, the R-390, could draw unwanted foreign interest, unless it was kept secret.

To appreciate the problem, you have to go back to the mid-fifties. The Russians had hydrogen bombs, ICBMs, a strained relationship with the USA and they were flexing their muscles with communications intercept attempts and jamming. In the fifties, all overseas communications was HF SSB radio, as there were no satellites, no Internet, no cell phones, and no underseas telephone cables. NSA was confident that our crypto systems were secure, but the Russian jamming could be critical in an emergency when instant communications would be a necessity. To alleviate the problem, the Signal Corps Labs at Fort Monmouth N.J. started a program called "Tropicom" that consisted of improved HF antennas, bigger HF transmitters, and a spread spectrum antijam system. The spread spectrum system was developed by MIT's Lincoln Labs and coded as the F9c, and proved to be the answer to the Russian jamming.

The F9c system transmitted a digital signal as noise. By spreading the noise over a wide band, with the proper phase relationships, the transmitted signal was very weak in a normal receiver, and in many cases, below the atmospheric noise level. At the intended receiving location the noise signal was unspread back into the original digital signal. The proper unspreading, frequency and phase wise, of the received signal resulted in stacking up a strong exact copy of the transmitted signal. As an added benefit, the receive unspreading of the F9c signal spreads any interfering signals, resulting in a significant improvement in the desired signal to interference ratio.

The F9c signal is a random noise signal generated, in the original equipment, by a 144-stage, looped feedback digital crypto-key generator, and combined with the digital intelligence in a bank of PSK modulators. The repeat cycle was 3 minutes and 41 seconds, which would not meet today's NSA requirements, but in the precomputer days was considered acceptable. When combined with the very low detectability of the radio frequency noise signal and the pretransmission encoding with existing crypto equipment of the digital signal information, the F9c was considered to be the ultimate in a secure system.

A requirement for installation was that the F9c signal had to be generated in close proximity to the HF radio transmitter, and similarly, the F9c received signal had to be descrambled adjacent to the HF radio receiver. For the initial F9c radio tests, the Fort Monmouth, NJ, test transmitter site (run by W2WSN), 14 miles west at the Earl Naval Ammunitions Depot, was used, as it was a secure site. The receiving F9c was at the Deal, NJ receiver test site (run by W2VQR) 6 miles south of Fort Monmouth. Testing was done with a Collins AN/FRT-26 15-kW transmitter, and an AN/FRR-40 receiver assembly, which consisted of an R-390A and CV-157 converter. The results were poor until the R-390A was replaced with an R-390, the problem being the mechanical filter phase shift differences with frequency. With the '390, the system worked up to expectations.

The Army HF radio facilities at San Francisco and Washington DC were used for the service test. Signal Corps HF radio stations were set up with all the crypto equipment at the com center, and no unencrypted signals were sent to or from the remote radio sites. The Washington station had the voice crypto equipment located in room 5A91O of the Pentagon, while the transmitters were 18 miles South at Woodbridge, VA. The receivers were 25 miles Southwest at LaPlata, MD. The remote radio sites were connected to the com center via a microwave link. The Woodbridge transmitter site and the LaPlata receiver site were physically secure, but were not crypto secure. The NSA F9c liaison officer to the Signal Corps was Robert Kearns. When he toured the radio sites, he found many problems with a crypto installation and little chance of modifying the sites to meet NSA requirements without extensive rebuilding. At a joint Signal-NSA conference, Kearns convinced his bosses to change the classification of the F9c from crypto to secret. This would allow the installations at the radio sites to proceed with no obvious physical or operational changes at the radio sites, and would avoid calling unwanted attention to the sites. The F9c equipment was listed as an experimental transmitter-exciter and receiving-converter. The test was successful and a production contract was given to Raytheon.

As the F9c was installed and put into service around the world, many situations came up that gave Bob Kearns a bit of gray hair. One in particular was the Signal Corps HF radio relay station in Eritrea, a section of Ethiopia, that was built in an old Italian Navy radio facility. Due to the space needed for the F9c, which in the vacuum tube days was 96" rack cabinets side by side, a lean-to type addition was added to the facility. Just after the completion of the installation, the Ethiopian government said the Emperor, Haile Selassie, would like to visit the site. Since the addition was fenced in with a very secure chain link fence, the site Commander, Captain Mal Crandall, had a bunch of rabbits placed in the F9c fenced area. He told the emperor, during the tour, that American soldiers liked rabbit stew, and that the very secure fence was necessary to keep out wild boar that also liked American rabbits. Apparently the rabbit hutch story was accepted, as nothing ever came of the emperor's visit, however Mal Crandall was thereafter known through out the Corps as the official "Keeper of Signal Corps Rabbit Hutches".

As the F9c installations progressed, a shortage of R-390 receivers developed. Any time a '390 was sent to depot, it was usually marked "R-4, salvage" and a new R-390A was shipped back. In a stupid move, Signal Corps procurement tried to buy back surplus '390s. NSA and Kearns went through the roof when they heard of the attempted buyback. A joint Signal-NSA conference decided that the solution would have to be a new receiver. That's how the R-725 came into being. Since the R-390A was still in production, the 725 would use all the 390A components except the IF mechanical filters. Several other minor changes were incorporated. NSA wanted the R-725 classified secret, but this would cause problems in contractor qualification since the R-390A was unclassified, and was built at nonsecure facilities. This could generate a lot of unwanted interest in the R-725 receiver contract. Kearns asked Signal "What other unclassified equipment would need such a receiver?"

The ANI ARD-15, an updated Adcock HF direction finder, was suggested as an answer to Kearns' question. By updating the Adcock antenna into an electronically rotated, instead of a physically rotated antenna, phase discrepancies could distort the pattern, and there would be a justification for the R-725. NSA and Kearns bought off on the project, and a new DF unit was underway, destined be shipped to HF radio stations around the world complete with spares, such as R-725 receivers. This would require ordering about twice the number of receivers needed but was still a cheap way out of the security requirement.

To go along with the new DF system, a new equipment training team was organized at Monmouth, but never deployed, a Signal School training program was started, and a Program of Instruction was published for the new course, complete with pictures of the R-725 in the school training environment. The only fly in the ointment was that NSA awarded the R-725 production contract, not Signal. Kearns hit the ceiling again. He said they might as well label the '725 as part of a crypto system. However as the '725 was part of a new direction finder system, nobody took notice of the contract award. Similarly, the few Signal School students that attended the R-725 course were either National Guard or Reservists that were returning home after graduation. Again, there was no foreign interest detected in this discrepancy.

The F9c preformed flawlessly and went through two follow-on versions within 3 years. Both of these revisions incorporated improved key generators and were solid state. The elimination of vacuum tubes reduced the size from 9 racks to 2, and the power consumption dropped from over 3500 watts to under 250 watts. System reliability jumped from 95% to over 99.9%. Version three incorporated a transmitter-receiver feedback loop with automatic transmitter power output control, and an up graded automatic synchronizing system. NSA could never find any foreign interest in, or any attempts to find information about the F9c.

By 1971, technology bypassed the HF radio links with worldwide submarine telephone cables, and geostationary synchronous equatorial satellite repeaters. However, the F9c hung on a bit longer as the first Army satellite systems used the F9c. Version four, a 48" cabinet, the AN/URC-55, was used with the Hughes AN/MSC-46 Satcom terminal for several years before being replaced by newer systems.

So, while the R-725 didn't do much for the Cold War direction finding, it did outstanding duty in providing secure, jamproof communications for the Department of Defense, the White House Signal Agency, and the State Department. But now, the Army HF radio sites are closed, the Army HF frequencies belong to shortwave broadcast and communications stations, the R-725 is a favored high fidelity AM receiver, and the F9c is only a memory to those who developed and worked with the system. But, that memory will always include NSA's Robert Kearns, who bent the rules to let us get the F9c into service, and found a way to build the R-725 receiver under foreign noses with out causing any ripples on the troubled waters of the Cold War. Rest in peace Bob.

<u>*ER*</u>

Rebuilding the 1946 Allied Radio Knight Kit Ocean Hopper

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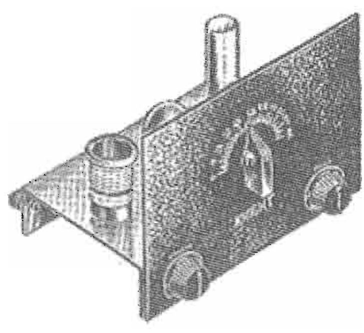
During the last fifteen years of researching, documenting, and rebuilding the last of the Allied Radio Knight Kit Ocean Hoppers released in 1954, I occasionally would "bump into" its predecessor, the Ocean Hopper (OH) that was discontinued in 1953. That OH used two tubes, a 12J5GT and 117P7GT, and used a total of six 4-pin, plug-in coils to cover its frequency range, including two coils that covered the AM BCB. Questions concerning it arrived via regular mail and email and some of those included photos. Dave Minchella (KE2GE) sent me a construction article from Radio Experimenter, and I found it described in the 1946 Edition of Allied's Radio Builder Handbook. Like so many of my projects, I started to get curious about this earlier OH, and finally bid on one I found on eBay in May '00. However, I underestimated what these **rare** OH's are worth, and was overbid.

I kept my eyes open for one and was fortunate enough to have the highest bid for one I found on eBay in Aug. '05. It was in very good shape for its age, **had all six original coils**, and was unmodified. It arrived about two weeks later, was not working (as advertised), and had several component- and wiring-related problems (see comments below). Based on the date-codes, this OH was built in late '48 or early '49. The tubes appeared to be original.

In terms of historical perspective, Allied Radio had at least **four** generations of Ocean Hoppers:

- A 2-tube 6J7 and 6C5 using an ex-



THE NEW MODEL "OCEAN HOPPER" KIT

A new, completely redesigned "Ocean Hopper." Efficient engineering has produced this easy-to-build kit, worthy of its name. Modern design permits multi-tube performance with the use of only 1—12J5GT tube as regenerative detector, and 1—117P7GT tetrode power amplifier and half wave rectifier. Operates on 105 to 125 volts, AC or DC, without the use of power wasting line cord resistor or ballast tube. Use of plug-in coils permits all-wave coverage at low cost. Frequency range is 9.5 to 550 meters (550 kc to 31.5 mc). Has main tuning control, electrical band spread control, and combination sensitivity control and on-off switch. Output transformer matches any PM speaker or headphones. Cadmium plated chassis measures 5½"x9"x2". Clearly marked, black crackle panel is 7"x9". Kit is complete with all parts; punched and formed chassis, tubes, 2 coils for broadcast band, hardware, wire, solder, and full instructions. Less speaker and short wave coils, listed below. Shpg. wt., 8 lbs.

83-225. Complete with tubes. NET........................$16.75

60-680. Four SW coils covering 9.5 to 217 meters. Wt., 2 lbs. NET............$1.85

81-631. 5" PM speaker. NET......2.12

Ocean Hopper ad from the 1947 Allied Radio Catalog.

ternal AC or DC power supply (circa 1939)

- A 2-tube, 12SJ7GT and 70L7GT, powered from 105-125 VAC or DC.
- A 2-tube, 12J5GT and 117P7GT, powered from 105-125 VAC or DC (1946-1953).
- A 3-tube, 12AT6, 50C5, and 35W4, powered from 105-125 VAC or DC (1954-1967). This was the last of the OH line.

This OH is a 2-tube regenerative receiver covering the AM BCB, and 9.5–217 meters (1.4 – 31.5 MHz) using six 4-pin, plug-in coils. The tube compliment includes a 12J5GT regenerative detector, 1/2-117P7GT beam-power audio output, and 1/2-117P7GT 1/2-wave rectifier. It is powered off of the 105-125 VAC (or DC) line and the chassis is "hot"– one side of the line is connected to the chassis through a 0.25µf capacitor. The OH is constructed on a 5-1/2" x 9" x 2" U-shaped cad-plated chassis. The 7" x 9" "black crackle" front panel controls are a regeneration control in the lower right-hand corner, an uncalibrated, relatively small main tuning knob in the lower left-hand corner, and a calibrated 0-100 band-spread with a relatively large bar knob in the middle. The white silkscreen lettering is easy to read against the black background. The main tuning capacitor is a standard 140-µµf value and the band-spread capacitor is 35µµf. The 3 to 30-µµf antenna trimmer is located under the chassis – inconvenient, but pretty common for this generation of regenerative receiver. The audio output transformer will drive a speaker for **strong** local sta-

The 1946 Allied Radio Knight Kit Ocean Hopper has been reduced to kit form. After cleaning with wet/dry sandpaper, the chassis was coated with "Krylon® Crystal Clear Acrylic." If you look closely, you can just see the "line graining" on the chassis from the small hand-held electric sander.

tions or high-impedance headphones can be used. The regeneration control adjusts the detector's plate voltage. The tube's filaments are series connected with a 2-k, 10-W equalizing resistor across the 117P7GT's 0.09A filament to match the 12J5's 0.15A filament current. At 115 VAC line voltage, both tube's filaments are running a bit low. In the 1947 Allied Radio Catalog No. 112, the OH sold for $16.75 which included the tubes and the two AM BCB coils. The optional SW coils were $1.85.

Incidentally, by (at least) 1951, the front panel had changed to gray hammertone with dark green silkscreening—the same color-scheme that was used on the front panel of the next-generation 12AT6/ 50C5/35W4 OH when it was introduced in 1954.

A few words about the wiring-related problems are in order. At first blush, the OH didn't work because there was no B+ on the regeneration control. The wiring error appeared to be in the vicinity of the triple-section filter capacitor and 117P7GT socket. Since I had decided from the beginning to completely rebuild this OH, I quickly clipped out the two 0.1-µfd capacitors that connected the headphone jacks so that I could get a better look at the wiring beneath. It was clearly wired wrong. I corrected the wiring and brought it up on a Variac, and the OH was now working. Inspecting the solder joints on the 2-k, 10-W resistor and miswired filter capacitor led me to believe that it had been originally wired that way—not changed at a later date. I made the assumption that this OH had never worked. The rest of the soldering and components looked like several owners had tried **many** times to fix this radio but had never discovered the original wiring error. Imagine my surprise when I discovered that the original Allied Radio 4-page assembly "manual," no. 38-035, copyright 1946, that came with this OH, indicated the same wiring error!!! This OH had indeed been wired wrong from the get-go, and everyone that tried to fix it followed that wiring diagram! I believe that all 1946-generation wiring diagrams will be wrong as is the wiring diagram used in the article in the 1950 "Radio Experimenter."

Rebuilding the OH was straightforward and presented no problems. Each of us will approach a rebuild differently, but here are a few things I decided to do:

- The biggest amount of time rebuilding the OH was the steel chassis—several hours were spent removing the bulk of the corrosion. Before I did that, however, I needed to use a propane torch to remove a "puddle" of solder that a previous owner had applied to connect the rotor of the bandspread cap to chassis ground. Deep pockets of corrosion were cleaned with a small stainless steel wire brush and a Dremel® tool. The steel chassis was eventually cleaned top and bottom with wet/dry sandpaper using a small hand-held electric sander and then coated with "Krylon® Crystal Clear Acrylic". Please reference "Cleaning Up the Knight Kit Ocean Hopper" listed in **Selected References** at the end of this article for additional details.
- The front panel was cleaned in warm soapy water with a very soft cloth. The front panel isn't pristine, but the black wrinkle ("crackle") finish and silkscreen lettering is in very nice condition considering its age with just a couple of minor "nicks". The back of the front panel is black enamel and several coats of "Meguiar's Cleaner/Wax" (available at auto-care counters everywhere) were applied. The nicks on the front panel's edges and one on the front of the panel were touched up with a black Sharpie® marking pen.
- The knobs and headphone jacks were cleaned with "Novus No. 2 Plastic Polish" (available from Antique Electronic Supply (AES) in 2-oz. (S-C217) or 8-oz (S-C227) containers). A little goes a long way.
- I really didn't like the J-shaped busbar wiring for the ground. As a result, I abandoned the bus bar, added terminal

strips, and revised the wiring. I rewired the OH to minimize the under-chassis "clutter". The grounds are now "cleaner" without the filter capacitor's charging current going through it. Terminal strips were replaced with Radio Shack P/N 274-688 (pkg. of 4). The individual components were mounted on the terminal strips and soldered before installing them into the chassis. The terminal strip's mounting hole was enlarged to accommodate the 6-32 hardware.

• Unlike the original, I used 20GA solid wire to rewire the OH.

• I used new 6-32 binder-head screws, large-pattern hex nuts, and internal-tooth lockwashers, in addition to new hardware for the 50-k pot and the bandspread and main tuning caps.

• With the exception of the RFC, all discrete components were replaced. I made no attempt to find NOS replacement components from the 1940s. The tubular capacitors were 400-V units from AES. I obtained original-looking carbon resistors from the same source.

• The original wafer octal sockets had broken pins so they were replaced with two AES part number P-ST8-127 (P/N P-ST8-128 can also be used). The original 4-pin wafer socket for the coil was carefully cleaned and reused.

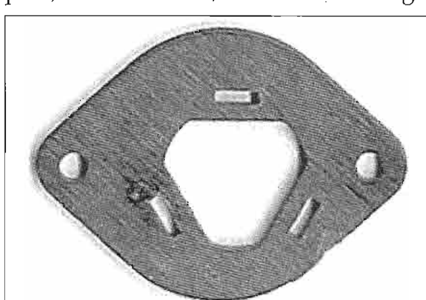
• The original 40-20-20–µfd, 150-150-25–volt, triple-section, FP-type, twist-lock filter capacitor (1" dia. x 2-1/2"L) manufactured by Guideman Co. tested OK, but its age prevented me from using it in the rebuild. It was replaced with a higher-voltage, NOS, Mallory 40-40-40 µfd, 300-300-100–volt, triple-section (1" dia x 3"L) electrolytic capacitor that I found on eBay.

WARNING: the metal case of the filter capacitor is connected to one side of the power line—a potentially lethal condition. What's worse is that the original cap's insulator was offset-punched which caused an interference-fit between the mounting hardware and the cap's metal case. The OH's chassis was shorted to one side of the AC line since the day it was built! I replaced the defective insulator with AES P/N S-H121 for 1" dia. FP-type cans. **Even if you use a polarized line-cord, I would highly recommend that an isolation transformer be used with this OH.**

• The original 50-k regeneration control and switch were electrically OK, but hard to turn and noisy. In addition, there appeared to be a "bad spot" at the optimum point of operation. I thought the pot was a "goner." I disassembled the pot and cleaned the carbon element with a stripped-down Q-tip® and Caig DeoxIT D5®. I then applied a 2nd coat with the other end of the Q-tip and put the pot back together. What a **HUGE** difference!! I rebuilt the OH using the original regeneration pot.

• I discarded the original unpolarized line cord and replaced it with a 2-wire, polarized line cord. I have used a black Radio Shack P/N 61-2852 6' line cord, but any 2-wire polarized cordset can be used. The wider of the two pins on the plug is neutral and should be connected to the switch.

• This OH uses two standard off-the-shelf sets of Insuline Corporation of America (ICA) 4-pin, plug-in coils—two for the AM BCB and four for SW. The coil sets that came with the radio are indeed original and OK, but they certainly show their age. The coil sets are designed to be used with a 140-µµf, main-tuning capacitor. The pinouts are different than the Alden coil sets that I have used in the past, and as a result, are not interchange-



The original OH filter capacitor insulator was incorrectly punched.

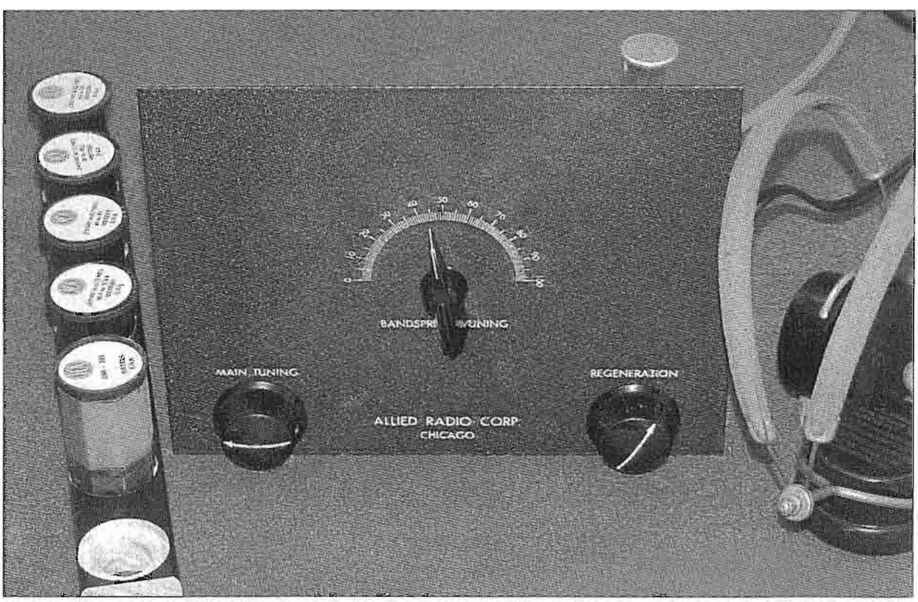
able (the tickler/feedback polarity on pins 1 and 2 is reversed). I scanned the ICA logo from the best coil and created artwork for all six coils. I printed them on 20-lb Goldenrod paper and then rubber-cemented them to manila file folder stock. I then used a circle template and cut them out with scissors. The end result is quite acceptable even though the fonts can't be duplicated. The coil rack was made by my "radio-builder penpal" Bob Ryan in Hemet, CA. The coils are marked as follows:

- ✓ 300-500 Meters (461.6 µHy)
- ✓ 190 – 310 Meters (147 µHy)
- ✓ 85.7 to 174.4 Meters (3.5 Mc to 1.72 Mc) (54.1 µHy)
- ✓ 40 to 81 Meters (7.5 Mc to 3.7 Mc) (13.6 µHy)
- ✓ 20 to 42.2 Meters (14.5 Mc to 7.1 Mc) (3.1 µHy)
- ✓ 9.5 to 23 Meters (28.5 Mc to 13 Mc) (0.7 µHy)

• In my opinion, this radio has an "Achilles' Heel." I don't particularly care for the uncalibrated main tuning. Repeatability is nonexistent—especially in the SW bands. On the AM BCB, the bandspread doesn't even need to be used, so it's awkward having a relatively small main-tuning knob in the lower left-hand corner. It's interesting to note that the Allied Radio Knight Kit DX-ER, the OH's smaller "brother," got it right—main-tuning with a calibrated scale in the middle with the uncalibrated bandspread in the lower left-hand corner. Even though I don't plan to spend a lot of time using my new OH, I committed a bit of "**heresy**" — **I reversed the main tuning and bandspread caps**! The next owner can reverse them in the interest of "**historical accuracy**," but I'm now much happier with a calibrated main-tuning dial.

• The Allied radio 4-page assembly "manual," no. 38-035, copyright 1946, that came with this OH, indicated an L-bracket used to mount the 3-30 µµf antenna trimmer underneath the chassis. No L-bracket was on this unit or two others that I have photos of. Like mine, one other unit had the antenna trimmer mounted to the antenna post, so I rebuilt it that way.

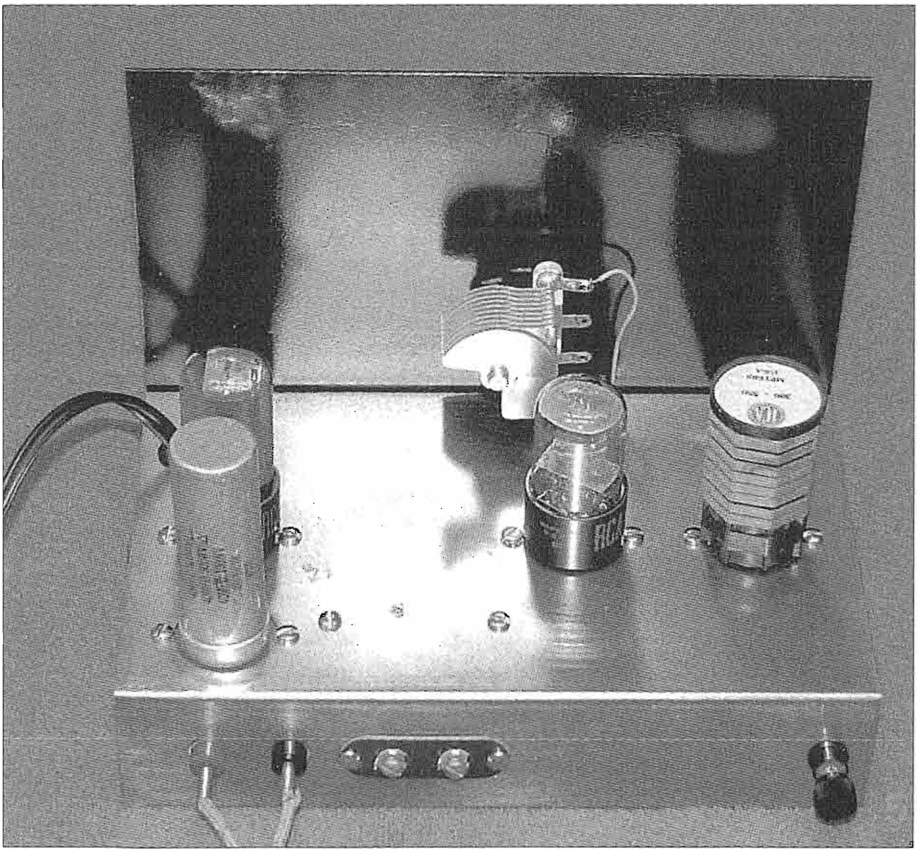
After I finished the last soldered con-



Front View of the completed 1946 Ocean Hopper

nection, I checked them all for cold solder joints, etc. Everything looked OK, so I proceeded to check the wiring against a **redrawn** schematic and assembly diagram. Finding no problems, I installed the 300-550 meter coil, set the bandspread to 9 o'clock (max capacity), main-tuning to where I knew our local KFI 640 was from the original testing that I did, regeneration control at 11 o'clock, connected an external speaker, and slowly increased the Variac. As always, I was the main-tuning and regeneration and reduced the antenna coupling a bit. The audio quality was good and there was adequate volume for the stronger stations. When the antenna tuning was loosely-coupled, selectivity was OK.

The performance of this Ocean Hopper is on a par with the 12AT6/50C5/35W4 OH, but the regeneration characteristics are somewhat smoother. Controlling the detector's plate voltage provides better regen characteristics than

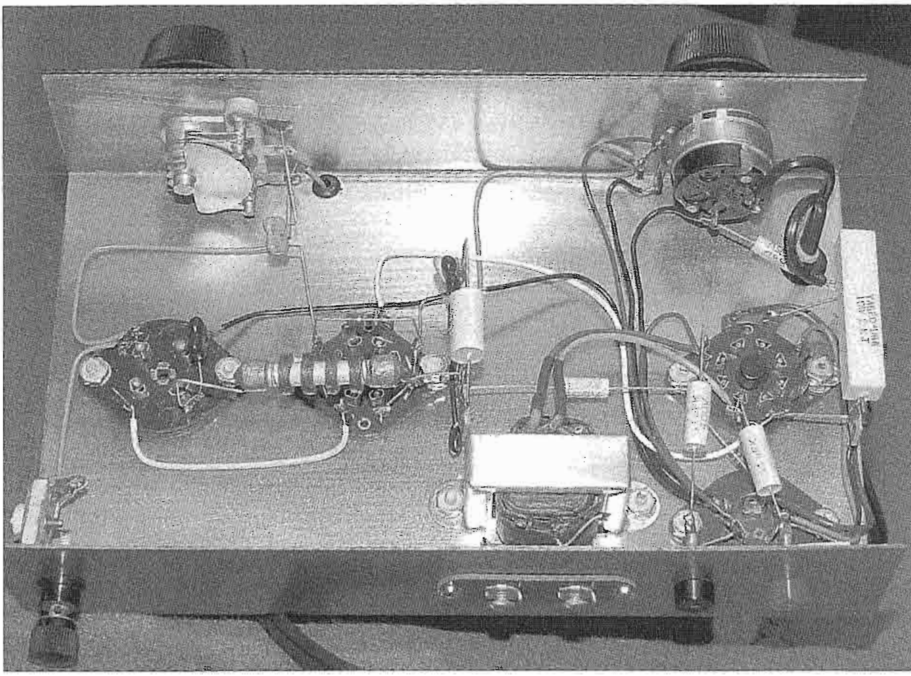


Rear view of the completed Ocean Hopper. The 117P7GT is "hiding" behind the filter capacitor and the 12J5GT is to the left of the 300-550 meter coil. The larger 140-µµfd, main-tuning capacitor has been installed in the place of the bandspread capacitor.

very pleasantly surprised to hear KFI as the OH came to life (a "rite of passage" for **all** my regens). At 115 VAC, I peaked placing the pot across the tickler/feedback winding. I also found that to be the case in my homebrew regens and the

Allied Radio Knight Kit Space Spanner.

I have successfully selected type 19, 30, 955 and 957 acorn, 1H4G, 1G4GT, and 1G6GT tubes for their regeneration characteristics in my homebrew regen sets, 12AT6s in OHs, 12AT7s in Space Spanners, and this OH is **no** exception. There's a wide variation in regeneration characteristics and gain among 12J5/12J5GT's I tried and I would highly recommend swapping it out until you find one that "behaves" the best. The selection has to but if I have the time I will use a Heath Model IG-102 RF Signal Generator and monitor the 117P7GT's grid with an oscilloscope. That way, you can measure gain plus watch the detector characteristics as the regeneration control is increased. In addition, there's also quite a variation in gain between the 117P7GTs I tested, so select one for the highest audio gain. In the case of the 117P7GT, the TV-7D/U's reading will suffice. If I have the time, I will connect a B&K Model



Bottom view of the rewired Ocean Hopper. The open-frame mounting bracket for the output transformer was cleaned with steel wool. The regen pot, 4-pin wafer socket, relocated bandspread cap, antenna trimmer cap, headphone jacks and speaker terminal strip, antenna binding post, and RFC are the original components. The capacitors and carbon resistors are from AES. The 2-k, 10-watt resistors are from my "junk box."

be done in the unit – don't depend on a tube checker as there's no correlation between the tube checker reading and detector performance. For example, a NOS Ken-Rad 12J5GT with the highest reading in my TV-7D/U was a "dud" as a detector. You can select them "by ear," 3001 Audio Generator to the 117P7GT's grid and measure the audio output with an AC voltmeter. If I do this, I'll pull the 12J5GT and connect an 82-ohm, 5-W resistor across pins 2 & 7 of the 12J5GT's socket to act as a filament load. I ultimately selected a NOS RCA 117P7GT and RCA 12J5GT for best performance—remarkably better than the original tubes that came with the radio. Several OH owners that have emailed me complaining about the poor performance of their radios have been pleasantly surprised by how much better their OHs performed by selecting 12AT6s and 50C5s.

In terms of "**historical accuracy**," I will admit that I took a lot of "**liberties**" rebuilding my OH—"**liberties**" that many ER readers may not appreciate. Having said that, I am very pleased with the final result and performance of this OH, and in adding it to my growing OH "family."

As a closing comment, this 12J5GT/117P7GT OH would be relatively easy to "clone." There are no unique components and standard off-the-shelf, 4-pin (or even 5-pin) coil sets designed for use with a 140-µµf, main-tuning capacitor can be used, or you can use the Alden coil set described in ER issue #148 to wind your own. The sheet metal is relatively easy to fabricate and straightforward dimensionally. There are (only) a total of 28 holes between the front panel and chassis. Send me a large SASE or email me, and I will send you a copy of the 1950 "Radio Experimenter" article and the sheet metal drawings.

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5. Knight 2 Tube "Ocean Hopper," Allied Radio Builder's Project 4-page booklet No. 38-035, copyright 1946. Includes schematic, notes on construction and operation, parts list, and wiring diagram.

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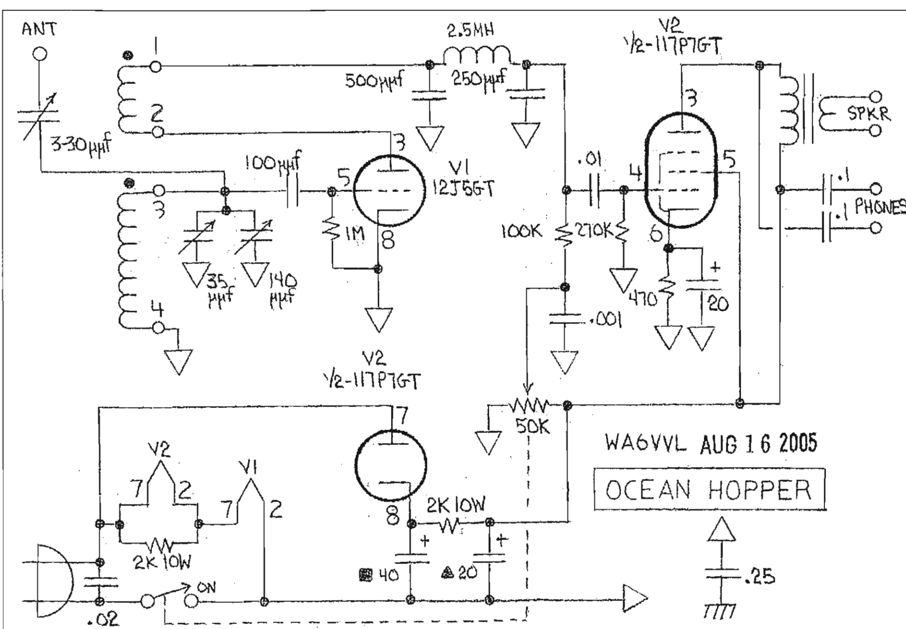

Schematic of the 1946 Allied Radio Knight Kit Ocean Hopper

The AM Broadcast Transmitter Log

Part 7, Broadcast Audio Equipment

By David Kuraner, K2DK
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Last month we discussed the audio devices employed in a typical broadcast installation as well as some low cost alternatives for the amateur station. We now continue with a discussion of the magic within the boxes: implementation and monitoring to insure that the magic is working correctly.

The Audio Processor vs. Distortion

By changing the audio characteristics of the original signal, by definition, you have distorted it. The art and science of audio processing is to make that change pleasing to the ear rather than offensive. Compression, limiting and clipping all produce distortion by-products which are harmonics of the original audio frequency. Take, for example, the simple diode clipper. With strong clipping, you can turn a sine wave signal into a square wave rich in harmonics. This is why many of the vintage receivers employing diode noise clippers sound awful.

There are two common ways to process analog audio which will permit those by-products to be filtered out and not appear in the signal output. The end result is a louder signal, due to greater audio energy and minimal harmonic distortion. The first is commonly used in sideband rigs in the form of ALC. The second is the Dorrough Electronics Discriminated Audio Processor (see **Figure 3**) and the Optimod scheme of segmented audio-band processing.

Admittedly, the ALC is a rudimentary form of processing at RF frequencies. The real processing in many modern rigs is done at the IF level so the distortion by-products are far removed in frequency and are easily filtered out. One scheme for professional audio compressors actually converted the audio (baseband) to a double sideband suppressed carrier at 455 kHz, performed compression, and reconverted it back to baseband. The harmonic distortion created by the compression was well away from 455 kHz and very easy to filter.

The DAP and Orban series of processors does its magic in baseband. The audio spectrum is divided into segments and then processed. This way, the harmonic by-products produced can be filtered out easily. If a 1-kHz tone is processed, it will generate the 3rd, 5th , 7th etc. harmonics. So, now you have the original 1 kHz along with 3, 5, and 7-kHz signals, and beyond. But, if you only process the immediate audio spectrum around 1 kHz and filter everything else out, the extraneous by-products do not appear. Do this with minute segments of the audio spectrum and combine the filtered output, the distortion products will be gone and the audio baseband will have much more energy and will be perceived by the ear as being much louder than the original. Adjusting the output level of each segment provides EQ.

Implementation

If you are employing the older surplus analog equipment, adjust the input level to the compressor with normal speech to indicate within the normal range of compression. If you are fortunate and received the manual with the device then, of course, follow the instructions. Most equipment should have some form of analog meter on either the input or compressor function. And with modern digital equipment, the best thing is to read the manual. All too often even that becomes confusing, so expect to have to "play with it" until you understand the

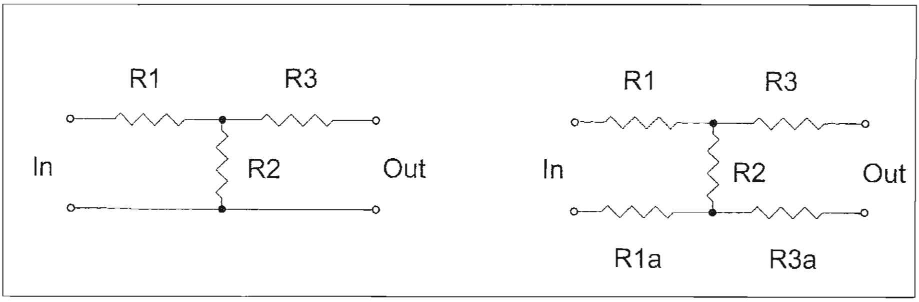


Figure 1: Audio Attenuation Pads. R1 = R1a, R3 = R3a
All values are in ohms.

dB Loss	R1, R3	R2
20	490	61
30	563	19
32	570	15

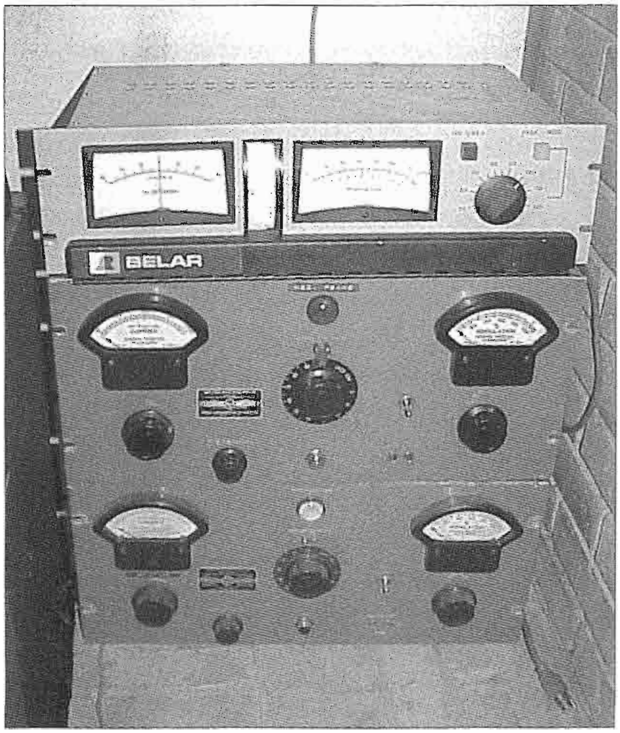
functions and adjustments. But, that is the fun of knob twisting and button pushing!

Adjust the level into the limiter so the limiting action is moderate, or within the "normal" range. Again, this is assuming you have no manual. The output of the limiter will be adjusted for approximately 100% negative modulation peaks. If you have a limiter such as the CBS Volumax or Orban 9000A, you can let your positive peaks hit 125% via the adjustment knobs or switches. The pitfall here is that your audio phasing had better be correct.

While on the subject of modulation percentage, consider that most receiver diode detectors will tend to distort negative modulation peaks greater than 90%. This is because, in a typical circuit, the diode is back-biased and will not conduct as the signal approaches zero. Thus part of the waveform is clipped and becomes distorted. Synchronous detection is far better for fidelity. The operating manual for the Orban Optimod hints at this as they are trying to adjust the settings of this processor to appeal to the broadcast listener and his envelope detector. They suggest that better audio is obtained from a station which limits the negative peaks to 85% and accepts a 1.5 dB loss in recovered audio. Although their entire sales promotion is geared toward the typical audio response of the "average" AM receiver, they never quite state that you are trying to work around the deficiency of the AM envelope detector. Still, the average amateur is going to adjust the modulation depth for 100% even though the 1.5 dB loss is not perceptible by the human ear. We all accept or ignore the inherent distortion of the diode envelope detector.

Often, in interfacing audio equipment, the signal needs to be reduced. If you wish to feed a professional audio chain into a vintage transmitter, not only do you need to reduce the input level, but it needs an impedance transformation and goes from a balanced to unbalanced signal. Unless the last audio device has provisions for unbalanced output, an isolation transformer with the secondary grounded on one side is a must. Fortunately, feeding into a high-impedance input from a 600-ohm source is called "bridging," and works just fine with no adverse effects. You can even bridge across the input to the BC transmitter, but when you feed into the high-impedance mike input of a typical vintage Ham transmitter, that audio is going to be very hot.

Sometimes you can get away with just adjusting the Ham transmitter's mike gain. The audio gain pot is at a very low setting and becomes a very critical adjustment. A better way is to place an attenuation resistor network, known as a pad, between the audio source and mike input, to reduce the audio level. Pads are either a "T" (unbalanced) or an "H" (balanced) configuration. See **Figure 1**. They can be used to both attenuate and provide impedance transformation. Calculated values for 20, 30 and the practical-to-implement 32-dB pad are given for both. This is for 600-to-600 ohm impedance. This may well come in handy if you wish to connect this equipment to a vintage, or even a modern Ham rig, with either a bridging or 600-ohm input. The last audio device in the chain will surely have an output level adjustment. Between this and the pad, you should be able to achieve a usable working level.



The more modern Belar AMM-1 AM modulation monitor is on the top of the stack in this photo. The General Radio model 1931 is on the bottom, and its RCA clone, model WM-43A, is in the center and was also made for RCA by General Radio.

Attempting to actually match 600 ohms to the high-impedance mike input with a pad for impedance transformation is not possible and fortunately, unnecessary.

Modulation Monitoring

All this processing does nothing for you if you don't know how it is affecting your signal. You need to know two things; the modulation percentage and the quality. For the amateur using a broadcast transmitter, the Heathkit monitor scopes are perfect and easy to connect inline with a coaxial "T" connector. You can also summarily connect any shop-type oscilloscope, which many prefer, but the attenuator feature of the Heathkits makes it so much easier. Ed Richards (K6UUZ) in ER #198, November 2005, authored his suggestions for generic oscilloscope conversion. They are readily available at Hamfests and eBay. (It seems that there are more available now than Heath ever produced!)

What occasionally does show up is the professional AM radio station modulation monitor. The AM modulation monitor shows the instantaneous positive and negative peaks on a meter. Additionally, there are provisions for indication of peaks exceeding a chosen percentage and for audio monitoring. All broadcast transmitters have provisions to feed the monitor with a sample of modulated RF. The General Radio (GR) model 1931A is

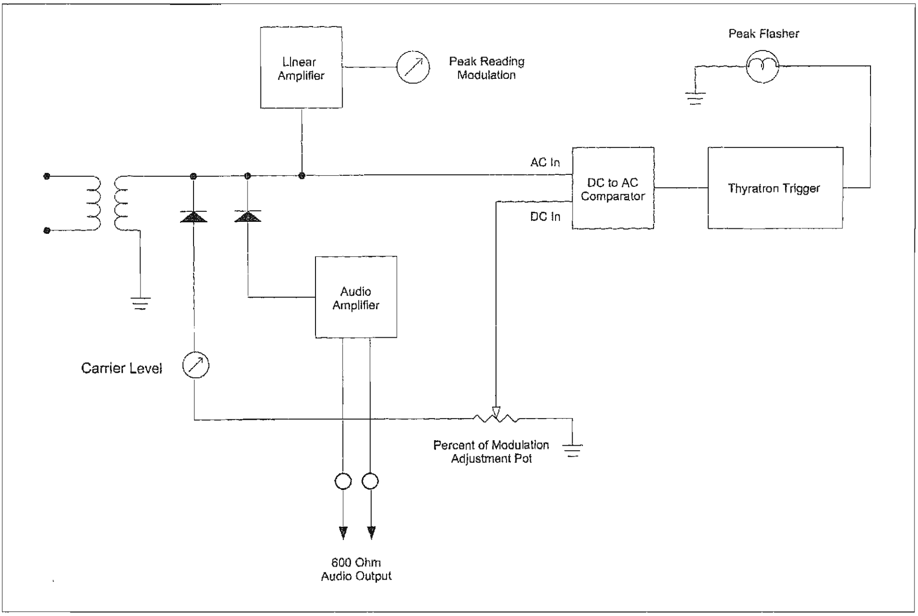


Figure 2: Elementary block diagram of an AM broadcast modulation monitor.

shown in the picture along with a more modern version, the Belar AMM-1. (The Belar includes a frequency-deviation meter for monitoring the exact center frequency of the broadcast station within 20 Hz of the assigned channel.) The description that follows is based on the GR model.

The sample RF is rectified by two diodes. One feeds a linear amplifier stage for audio monitoring while the other becomes a carrier level indicator. The later has a meter in its cathode circuit which reads the diode current proportional to the RF sample power. The meter reading is in percentage of carrier and when the input is adjusted for 100%, the correct level is applied to the peak reading meter circuitry. The AC component of the rectified sample is passed along through linear amplifiers to a calibrated, peak level reading meter, not unlike your peak reading watt meter. Some units have you reverse the meter connection to read positive or negative peaks while the more modern tend toward separate meters.

Additional circuitry includes a peak reading flasher. When the modulation exceeds the chosen amount, the lamp flashes. Again the AC component from the sample diode is fed into a linear amplifier. The DC component from the diode is what makes the carrier level meter show an indication. The amplifier stage compares the DC component to the AC component and when the AC exceeds the DC, the tube conducts and the flasher bulb is triggered via a Thyratron tube. The DC component is adjustable by a calibrated potentiometer, so the bulb is fired at any chosen modulation percentage. See **Figure 2**.

A rudimentary modulation meter was described by John Staples (W6BM) in the April 1992 (#36) ER, and he showed a simple audio monitor. Breck Smith (K4CHE), in the more recent August 2005, ER #195, shows a simple monitor using the Radio Shack amplifier. So, after you use it as a makeshift mike preamp, as described last month, recycle it as a modulation monitor. And, Tom Marcellino in September 2001 (ER #147) and June 2004 (ER #181) described his version of mod monitors. Bob Dennison

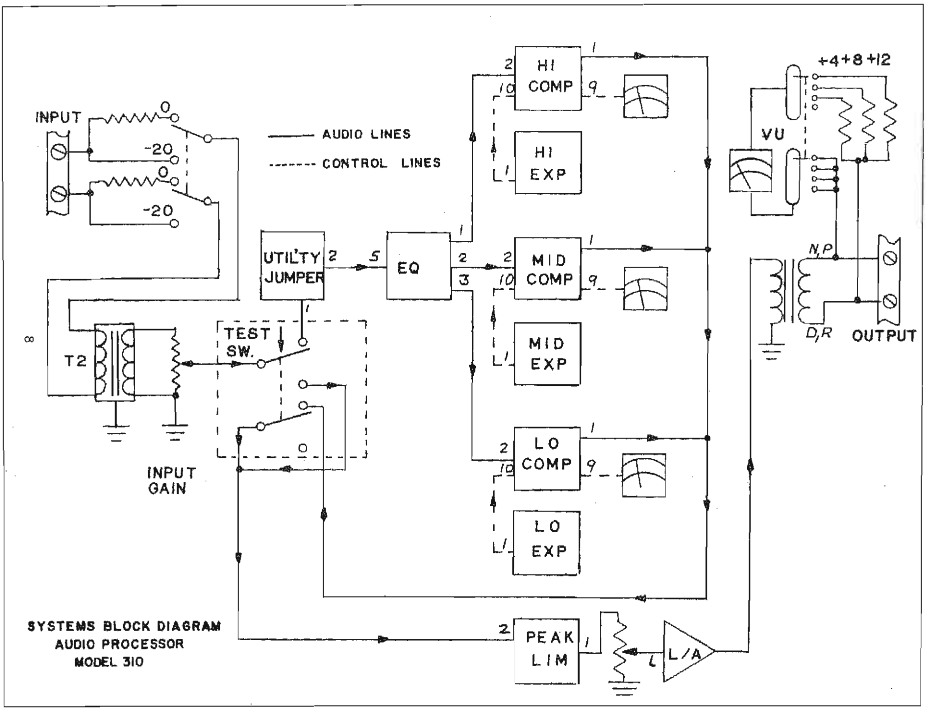


Figure 3: The Dorrough Electronics DAP-310 block diagram showing how the low, mid-range, and high parts of the audio spectrum are separated, processed, and recombined. It was a revolutionary concept and vast improvement over the existing technology.

(W2HBE) described a complete mod monitor in February and April, 1990 (ER numbers 10 and 12). I'm sure I missed a few others!

The Last Word

Well, there are no last words on this subject. Volumes have been written and I just touched a very small part. My last words are simply to work with what you have, keep it simple, and adjust the equipment to individual taste — mainly those of your listeners! Get someone who is familiar with your voice. It may sound good to you, but be "tinny" to others because the bones in your head accentuate low frequencies. Also, because new audio toys are appearing every other day, you can become obsessed with this equipment in a never ending quest for perfection.

If you have a really big basement and VERY UNDERSTANDING XYL, you can get two or more broadcast rigs. Feed the audio input with a distribution amplifier (DA) with separate adjustable audio outputs. I use a Aphex DA with four outputs. Two go to the BC rigs, one to a pair of DX-100s and the last to the HB cathode modulator or a modern transceiver. I get consistent audio reports that the DX-100s and HB rig sound just as good as the BC transmitters. I don't have the heart to reveal that it's the same audio chain. Now you know the secret. But the scary part is that I get similar audio reports when I use my HB rig with a D-104 and the series cathode modulator which limits its downward peaks to about 85%. Go Figure! 73, Dave, K2DK

ER

Milestones in the History of Amateur Radio

The Second ARRL National Convention

By Robert E. Grinder, K7AK
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A few amateur organizations rose to prominence before WWI. The "Radio Club of America" emerged in 1911 when a few adolescents interested in amateur radio decided to organize themselves. The group soon sprouted into an influential regional radio society, and following WWI, the Club began to hold meetings in New York City, which often drew hundreds of people. It also published in the 1920s a newsworthy monthly journal, entitled "Amateur Radio." About 1915, Hugo Gernsback, a prodigious publisher of radio journals, skilled writer, and enterprising merchant of radio parts, announced that he was forming the "Radio League of America." Given Gernsback's preoccupation with his business activities, the League was loosely organized, vaguely conceptualized, and poorly administered. It failed to survive.

Hiram Percy Maxim, a forty-four year old engineer, inventor, and entrepreneur along with Clarence D. Tuska , a lad of 18 years, met with 23 other amateurs in Hartford, Connecticut, on January 14, 1914 to create the Radio Club of Hartford. An outstanding amateur spark station might have a range of 100 miles in those days, so Maxim aimed to organize amateurs into relay teams in order that messages might travel hundreds of miles swiftly by radio. It proved to be a brilliant plan. First, it provided opportunity for amateurs to perform major functional roles in facilitating communications among members of society-at-large. Second, it enabled amateurs to associate collectively in an organization that offered opportunity both to share ideas and to provide a political force with which to represent their interests and to publicize their significance to society. On April 6, 1914, members of the Hartford Club decided to change the club name to "the American Radio Relay League."

Membership in the ARRL grew steadily until WWI, leveled off during the war while amateur operation was suspended and mushroomed rapidly after the ban was lifted on May 1, 1919. The ARRL Central Division held the first ever ARRL convention in Chicago, September 2-5, 1920. Three to four hundred members participated in the festivities. Thoroughly persuaded that conventions were a good idea, the ARRL Board sponsored its first national convention in Chicago, August 31 to September 3, 1921. Twelve hundred amateurs, representing all districts and nearly every state, gathered for four days of convention activity. President Maxim addressed the multitude on opening night, and at the grand banquet, eighty affiliated clubs from 36 states were represented (DeSoto, 1936, p. 71).

Certainly a bigger and better second national convention was warranted. Kruse (1923, p. 7), an ARRL Board member and frequent contributor to the pages of QST, thus spared not an ounce of hyperbole in promoting it: "We are going to have another joyfest of national proportions," he announced, "from September 11 to 15, 1923, the Edgewater Beach Hotel, Chicago, again becomes the home of a National ARRL convention." Warner (1923, p. 35) added "We've got ideas now for a convention that will most fittingly usher in the opening of the active 1923-1924 relay season." The second convention will be different from the first—"boresome features of former affairs are left out and the enjoyable things expanded. The banquet comes on the first night instead of the last, so everybody can get acquainted and get to know his fellows during the rest of the time." There will be no "dry business meetings." The technical meetings will be two in number and the speakers will be knowledgeable and entertaining. "Rag-chewing" opportunities will be abundant and mornings are "blank," so members can "chew the fat all night and sleep all morning without missing anything. . . . Come on and meet the bunch, in four days of sheer Amateur Heaven."

Kruse (1923) indicated that about 1,500 people were expected to attend the banquet. A ten dollars registration fee would cover the banquet, badge, technical sessions, parties, Wouff-Hong initiation, and trips to the railroad station. No tickets would be issued for admission to "radio exhibits," because, as Kruse (1923, p.9) noted, they "aren't going to be." "This is not a radio show," he proclaimed, "but four days of friendship and fellowship" (see Figure 1).

Surprisingly, Hiram Percy Maxim, perhaps the best known and most politically astute amateur in the nation did not attend the second convention. Although he was a co-founder of the ARRL and President of the organization, he reported in a speech read on his behalf at the banquet that arrangements had been made months earlier for him and his family to vacation in a "little log cabin in the wilderness" of northern Maine. Thus, he indicated, it had been impossible for him to forgo the vacation plans. The speech was upbeat: he called for the organization of a "World Amateur Radio Relay League," which brought the amateurs on hand to their feet in thunderous applause. He declared knowingly that "this convention is without question the most important event that has yet happened in Amateur Radio. It comes after two of the most active years Radio has ever seen, and it precedes two years which are unquestionably destined to produce achievements many times broader than have gone before" (Bolles, 1923, p. 14).

Figure 1: Delegates at the banquet of the second ARRL national convention, September 12, 1923. From QST, November 1923, Vol. 7, p. 15.

Clarence Tuska, Maxim's co-founder of the ARRL, and first editor of QST, made the convention, but he almost missed it. It seems that he attempted to travel by airplane from Hartford to Chicago, but had to shift his mode of transportation to a train after a minor crash in Buffalo (Bolles, 1923, p. 21).

Greetings to the convention were read from luminaries of the Department of Commerce and the Navy Department, and from Lee DeForest. Arthur H. Lynch, senior editor of Radio Broadcast, addressed the convention on the timely topic: "Hams—Past, Present, and Future." He assured the delegates assembled that Radio Broadcast recognized 'the honored place' held by the amateur in radio affairs." Schnell spoke on "Why Do We Handle Messages" (Bolles, 1923).

Importantly, Schnell was assigned the honor of introducing Leon Deloy, famously known as "French 8AB," who was one of the few Europeans who had been heard in the United States. Schnell said that he and Deloy first met during WWI, and that they had talked often of the day when transoceanic contacts would occur routinely between amateurs of both countries. Deloy was the first European amateur to attend an ARRL convention. He said he had come to the United States to visit American amateur stations and to better understand how they are constructed and operated. The information he acquired, he assured the delegates, would be invaluable to French amateurs since they had been allowed to operate transmitters only since the spring of 1922, and that even now, a year later, they were allowed to transmit only for experimental purposes. Consequently, they could not exchange or relay messages. A popular option, therefore, was that of endeavoring to establish transatlantic contacts with amateurs in the United States. He ended his remarks by saying "I feel confident that two-way communication between American and French amateurs will take place before many months" (Deloy, 1923, p. 16).

Presenters at the technical sessions represented an awe-inspiring array of "who's who" in amateur radio. For example, at one of the sessions, C. D. Tuska led off with a description of refinements in superheterodyne design. J. H. Miller of the Jewel Electrical Instrument Co. showed how to measure tube characteristics, and Karl E. Hassell of the Chicago Radio Laboratory spoke on "Underlying Characteristics of Receiver Design."

A talk on chemical rectifiers was underway when a janitor marched to the front of the room and proceeded to pull all the light switches. He informed the stunned audience that his union required that he shut off the lights at 11:00pm. The abrupt loss of electricity plunged the lecture room into complete darkness, ruined the discussion of rectifiers, and wholly preempted the featured speech of the evening, which C. H. Thordarson was to deliver on the design of radio transformers (Bolles, 1923, p. 21).

On the last evening of convention selected amateurs were inducted into "The Royal Order of the Wouff Hong." The historical record fails to indicate how initiates were chosen; presumably, the nomination process was influenced by ARRL leaders, convention organizers, and the first "Supreme Council" of the Royal Order (Fallain, 1924). Two criteria apparently dominated the selection process: likelihood of (1) attaining prominence in amateur radio, and (2) manifesting unwavering fealty to the ARRL.

The Royal Order of the Wouff Hong became a permanent ARRL fixture at the second national convention. The Order originated when a group of Flint, Michigan, amateurs decided in January, 1922, to add a special initiation at the second annual Michigan ARRL convention. F. D. Fallain, 8AND-8ZH, was appointed "Supreme Secretary" because he had helped develop an initiation for another "Order," named "The Ancient Order of Mop Handles." The Flint amateurs thus possessed a useful initiation ritual, but they realized that "Mop Handles" was too undignified for a radio organization. They wanted something new; hence, boisterous brainstorming sessions ensued, and after one of them, a bystander, who was not an amateur, yelled that he would get the Wouff Hong after them if they failed to quiet down.[1] The amateurs shouted in unison, "Wouff-Hong! That's it!" A few moments later the prestigious sounding adjectival phrase, "Royal Order" was tacked on to add an illusion of nobility to the ritual, and thereby, warrant a stately initiation for deserving amateurs into "The Royal Order of the Wouff-Hong."

At that first initiation in Michigan, chaos reigned; a Bible could not be found, so the first initiates took the general oath on a Sears, Roebuck catalogue. Schnell, nonetheless, approved the idea of presenting an initiation ceremony of the Royal Order of the Wouff-Hong at the second ARRL national convention. He agreed that it would both appeal to the delegates and honor selected amateurs—providing that it was staged in a relatively solemn and dignified manner (Fallain, 1924, p.24). The Flint amateurs rose to the occasion, even to the extent of wearing $1,200 worth of robes, wigs, and makeup, and those in attendance appeared to enjoy the ceremony immensely. Subsequently, after bylaws, rules, regulations, and procedures were codified, the ARRL Board officially sanctioned the initiation ritual of the "Royal Order of Wouff-Hong" as a permanent fixture of ARRL conventions (Fallain, 1924)

After observing the ceremony at the second national convention, J. K. Bolles (1923, p. 18), ARRL Publicity Manager, shared with QST readers his impression of it: "To the disinterested outsider it was a farce, put over with the skill of the average lodge, but to the ham it was something that struck pretty close to home. . . . A gentle touch of humor to be sure, but from start to finish there was not a sign of horseplay."

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[1]Hiram Percy Maxim promoted the "wouff hong" fable in the pre-WWI pages of QST. He aimed to inspire amateurs to attribute their ability to copy signals under adverse conditions to a transcendental force. He sought to create a cadre of superior amateurs who would act publicly as if the fable were real and as if it had enabled them to attain extraordinary reception. Perhaps he intended also to supply a psychological ploy whereby these amateurs could sidestep self-aggrandizing tendencies by expressing their dependency on the omnipotent "wouff hong." For example, Maxim (1917, p. 9) identified the "wouff hong" as "an instrument to be attached to a receiving set," and he stated simultaneously that "the animal actually eats up all the QRN and a large portion of the QRM also. . . . It is a dream no more. Hurrah for the wouff hong!" Specifically, then, the term designated metaphorically a mythical force for shoring up aspects of personal strength (e.g., operating skills) in time of need. When a bystander threatened to summon the "wouff hong" to quell noisy amateurs, Maxim had another convert.

ER

Design and Build

A Simple WARC-Band Converter, Part 2

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Time For Some Fun!

Let's start with something fun which will offer immediate rewards; building the LO, or crystal oscillator. A triode is all you need. Since my crystals were of unknown and, quite frankly, of dubious origin, all I knew about them was the frequency stamped on the top. One had a date stamp on the side indicating 1957! A quick check in an untuned circuit indicated either some were overtone crystals and/or some were a bit "poopy" on activity.

OK, build a tank circuit to resonate at the crystal frequency. What? How? It's simple. My experience is to use a plate Z of 200 to 500 ohms. Let's assume the 30-meter band from my circuit. That means an 18-MHz crystal. Using the nomograph previously mentioned[1], we need about 39 pF and 2.1 µH to resonate at 18 MHz. Now, keep in mind you will probably have a 10-20% tolerance on your capacitor, and there will be variables in stray and lumped constants which you just can't calculate, so try to get close to the indicated values and see what happens.

To start, let's wind the inductor. Grab one of your coil forms and wind 5 turns. Use something forgiving, like #28-32 wire, not so large you can't achieve the total turns in a single layer. Measure the L and write it down! Strip off that winding and wind 10 turns. Measure the L and, again, write it down. Strip that off and wind 20 turns, measure, and you've got it. From here you can extrapolate almost exactly how many turns you need. Hopefully, you will use similar forms for all coils so your turns count holds accurately. Yes, there is a coil winding nomograph too, but this is just a bit better, and a lot more fun.

Wind the desired L from your calculation of turns. If in doubt, throw on a couple of extra turns, you can always take them off, but you can't add. You might measure your coil to see how well you guessed and perhaps modify your reference. Solder the proper value capacitor across the coil, in parallel. Solder a resistor, 470 ohms is a pretty good resistor value, in series with your tank. Connect your signal generator across the entire assembly with the resistor in series with the "hot" lead. Connect your scope between the common ground and the junction of the tank and the resistor. This will allow you to measure the voltage divider comprised of the resistor and the tank. The resistance is a fixed value, so the voltage will vary solely dependant on the resistive impedance of the tank, which will vary with frequency applied. Select a convenient output from your generator, perhaps 100 mV or so, it really doesn't matter. Select a similar input sensitivity for your scope. Slowly sweep the generator across the general range of the desired tank circuit, and you should see a definite rise or peak in voltage at resonance. If there is no peak at all, and you are sure everything else is OK, your calculations are wrong, or you have a LC ratio which offers poor characteristics. Recheck your calculations. If resonance is a bit too low, you might go to the next lower value capacitor and see what happens. You could also remove a couple of turns from the coil. You will need to balance L and C to achieve Fr (frequency of resonance) exactly where you want it. Build a circuit about like the one shown

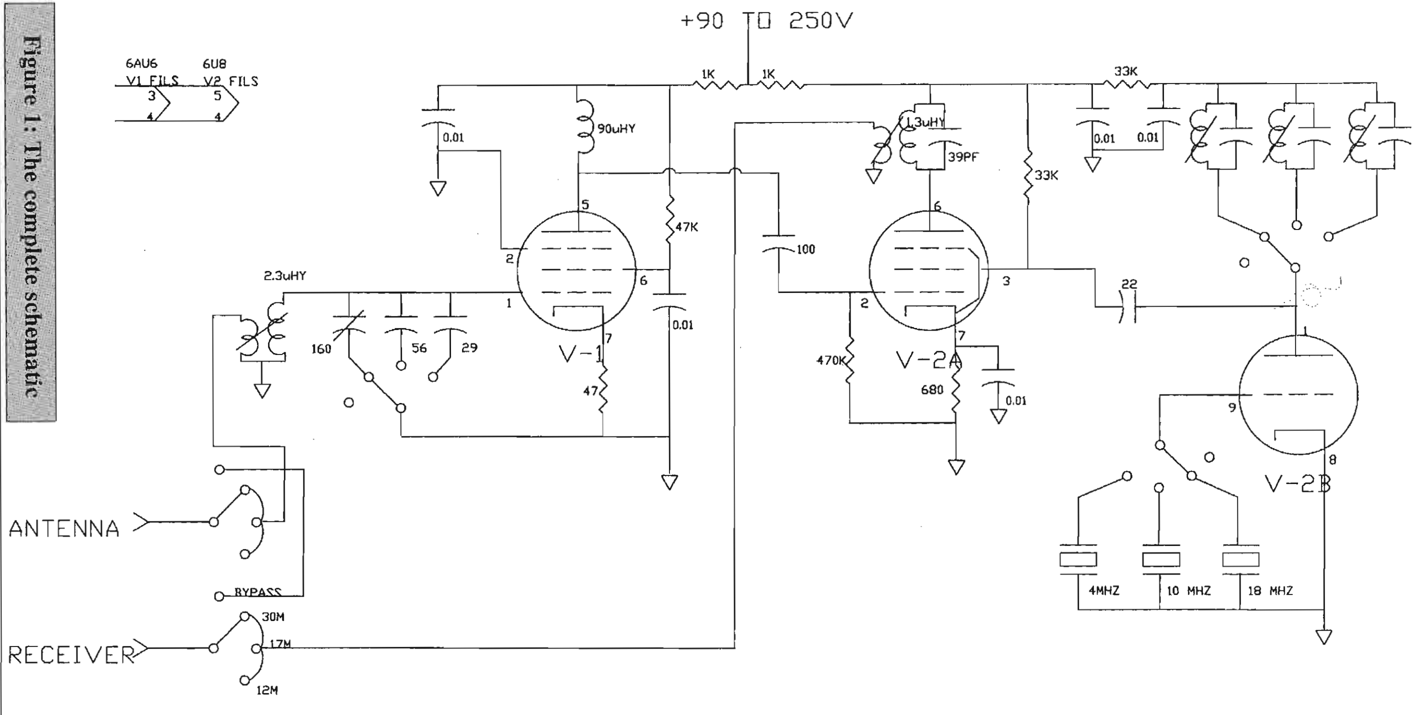


Figure 1: The complete schematic

in **Figure 1**, and connect the tank in the plate and the crystal in the grid circuit. Connect your scope across the plate of the tube to ground, be sure to use AC coupling on the scope, and apply voltage to the tube. With DC applied to the tube, the oscillator may just fire! If it doesn't, try tuning the slug and see if it fires. If it doesn't fire at all, many crystals like to see a tank which resonates higher than the frequency of oscillation, especially in overtone crystals. An 18-MHz crystal is not likely to be an overtone, which is why I selected this frequency as first choice. Most crystals above 20 MHz, however, are likely to be overtone. When you have the LO running, look at the waveform. If the plate-tank sine wave is not absolutely clean, but perhaps slants one direction, you may notice the slant changes as you tune the slug. This indicates the L/C ratio is less than ideal. You will want the purest signal possible, which you can listen to with your new ricebox or old general coverage Hammarlund, and if you can see the slant, you can probably hear the distortion. Balance the L/C ratio (more L, less C) to get a good sine wave at the operational frequency. The same approach will build tanks for the other bands, using the proper crystal for each tank. Be sure to label the tanks so you know which is which. The 10 and 18-MHz inductors will be very similar; the 4-MHz tank will stand out! The indicated oscillator circuit works fine with anything from 90-250V B+ supply, although tuning the oscillator at 250V and dropping the voltage to 90V may cause the oscillator to cease unless you retune the tank slug. You will probably have something between 8 and 20 V peak-to-peak at the plate.

The mixer tank should be next. In my case, the tank is to resonate at 28.125 MHz. Huh? To keep the converter simple, and operation even more simple, the resonant circuits are fixed-tuned. I have no interest in a "peaking" or other preselector type knob, although if you wish to make yours tunable, it will offer better performance on 12 meters. Both the 30 and 17-meter bands are very narrow, and are centered in the general neighborhood of 28.125 MHz. It is quite easy to build a fixed-tuned circuit which offers high Q and enough bandwidth to cover the entire band, and then some.

OK, a word on "Q," which is nothing more than a term for "figure of merit" when dealing with reactive circuits. It is not always the case that high Q is good, and low Q is bad, it depends on what you are trying to do. In this case, we are looking for high gain, good signal-to-noise ratio, rejection of non-desired signals, and we can easily tolerate a narrow bandwidth; so we want high Q. This high Q will also limit performance on 12 meters, which doesn't begin until 28.489, but I am not as interested in 12 as I am the other bands, and performance is still quite acceptable. In reality, Q is just a relationship of output versus bandwidth, therefore, high Q guarantees narrow bandwidth, and wide bandwidth requires low Q.

After winding a tank circuit for 28.125 MHz and confirming it's frequency as with the oscillator coils, install it in the plate circuit of the tube, and hang your scope across the tube. Now, since we want to align this circuit to the output frequency, and the mixer tube is to be tuned to the output frequency, it is a simple and accurate approach to apply the desired output signal frequency to the control grid, and measure the output signal at the tank. In this case, the tube is being used for nothing more than an amplifier. You should be able to tune the tank to offer a definite peak at "Fr" and jot down the gain figure of the tube. Running straight through, you may see a voltage-gain figure of eight, which you will never see when the complete mixer is working. Now, you will need an output link to couple to your receiver. Consider the coupling between the primary of this tank, (the tube side with the capacitor across it) to the secondary (which goes to your receiver antenna input) as nothing more than a transformer. The tank is fairly high Z, and develops quite a bit of signal. You need a low Z signal to feed your receiver, and quite frankly, you don't need the entire signal you have. That's good, because the laws of the universe dictate you can't have both.

The Z ratio of a transformer is the square of the turns ratio. Also, the voltage ratio is equal to the turns ratio. Now, if you have approximately 10 turns on your primary, which was designed as Z=500 ohms, and 3 turns on your secondary, you have approximately 50-ohms output Z, and will have 1/3 of your tank signal available for your receiver. Nifty, eh? I see you are shaking your head. Go ahead and try it at your design frequency. Measure the L of the secondary, either figure out the Z or look it up on a nomograph, and bingo, you have 50 ohms! Of course this only works perfectly at the design frequency, and when you make frequency excursions it will no longer be 50 ohms, but it will be close, and definitely close enough for a project such as this. Whatever you end up with as a primary winding, remember how many turns it is so you can calculate how many turns to put on the secondary. Best performance will be achieved if you end-couple the windings; however, overwrapping the primary with the secondary is permissible but less desirable. Always couple as lightly as possible.

Building On Previous Success

Now you have all the knowledge you need to build the input tanks. The point is to couple Fr for each band, at approximately 50 ohms to the input of the preamp tube grid, which will be very high Z. You can wind a tank of again, 500 ohms or so, this time as the secondary, and couple it to the primary with a 50-ohm link. You will notice this time the signal path is through a step-up ratio, giving more signal into the tube than you had at the antenna, not a bad situation, free signal! Using what was on hand, I selected a single inductor for the input circuits, and the proper input padder is selected by the band switch so that each padder is adjusted for the single band on which it is used. This scheme is another compromise, offering the poorest performance on 30 meters where the signals are best and my old receiver operates most efficiently at the bottom end of 28 MHz, and performs the best on 12 meters where the signals are poorest, and receiver performance begins to degrade near 29 MHz. A good balance is established without complications. If you like the purist's approach, or just for fun, you can build three complete input circuits if you are willing to donate that many coil forms to your project. Of course, you could use a link-coupled, air-core set of coils to provide the input match. I built one, it was quick, simple, and worked extremely well, but my chassis on-hand did not offer enough space, so I opted for this approach.

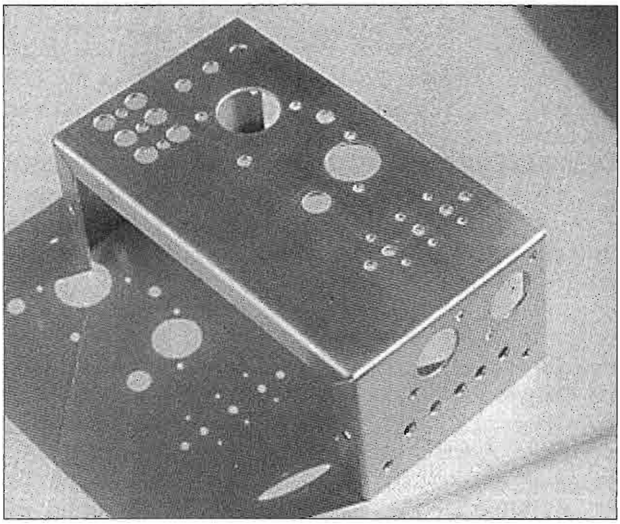
Oh, Did I Mention?

Engineering the preamp stage qualifies for a couple of hint comments, which you will use in other aspects of your design work when you encounter similar situations. For simplicity and performance, I selected to use a tuned input, and a common plate load, the RF choke. There is no need for tuning both input and output in such a simple project. One difficulty you will encounter is how you deal with such minute signal levels. Surely you can't watch them on your scope, as it doesn't have the sensitivity to react to a microvolt or so. There are a several reasonable options; you should consider them all and go with the one you are most comfortable. Eventually, you will try them all and see how each approach can best benefit you in a particular situation. Technically, you can select the input circuit L and C strictly by the charts and it should work. Sometimes you want to "see it work," or perhaps you are just trying to learn exactly what you are do-ing.

A grid dipper will allow you to tune the input circuit to resonance by reading the dip on the meter, and then spotting the signal with your receiver to be sure you are on the right frequency. This can be done even without power supplied to the circuit. Unfortunately, you still have not seen the circuit "work," you only believe it will. One handy approach is to build a "sniffer loop" and use your receiver as a tuning indicator. Since we are working on the input frequency, that means you will need to be tuned to the particular WARC band you are adjusting, sort of a "Catch 22," eh? I am betting you have another receiver around there! Make a convenient length of small coax cable, RG-174 or RG-58 is fine, with a connector on one end to mate with your receiver. Configure a three or four turn loop, perhaps 3/8" ID, of stiff insulated wire and solder it to the other end of each conductor of the coax. Insulate the connections between the coax and the loop, so it is totally isolated. Now you have a sniffer loop, which you can hold, or better yet, prop near the plate choke. Apply signal from your generator, grid dipper, whatever, to the input circuit. Even with improper stage tuning, you will hear the signal when you tune your receiver to the signal. Now, you can adjust the input circuit and listen to the amplified output signal in your receiver and quite likely even read its strength on the S-meter. Tune for maximum. Eventually, you will find the sniffer loop is a great sampling device when you want to listen to a signal without actually hard wiring to the circuit, you'll use it often. In a worst case scenario, you can drive the input circuit with the least signal you can observe with your scope connected across the preamp tube plate. A benefit of tube circuits is they are hard to overload. They will continue to amplify typically until the level of bias is met, in this case, about 0.35 volts, or when you saturate the plate load, and then they no longer perform accurately. Unfortunately, the tank circuit and perhaps even the plate choke may change characteristics with such large voltage/current flow, so the adjustment is not completely valid. Additionally, the scope probe, even at X10, will load the plate circuit and detune it slightly. Just touch up the circuit later with a "live" signal applied and read the converted output on the receiver S-meter.

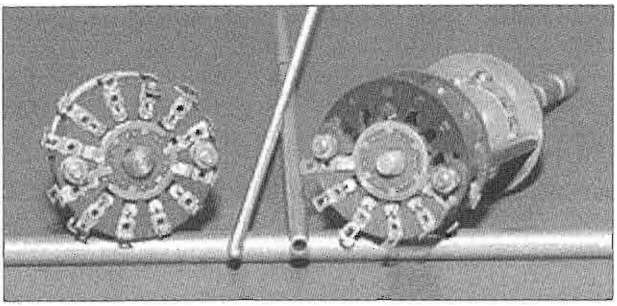
WARC Wrap

Now we have all individual compo-



Above: After determining parts placement to scale on paper, the layout is transferred to the chassis. Careful thought prevents having to add holes after component mounting starts.

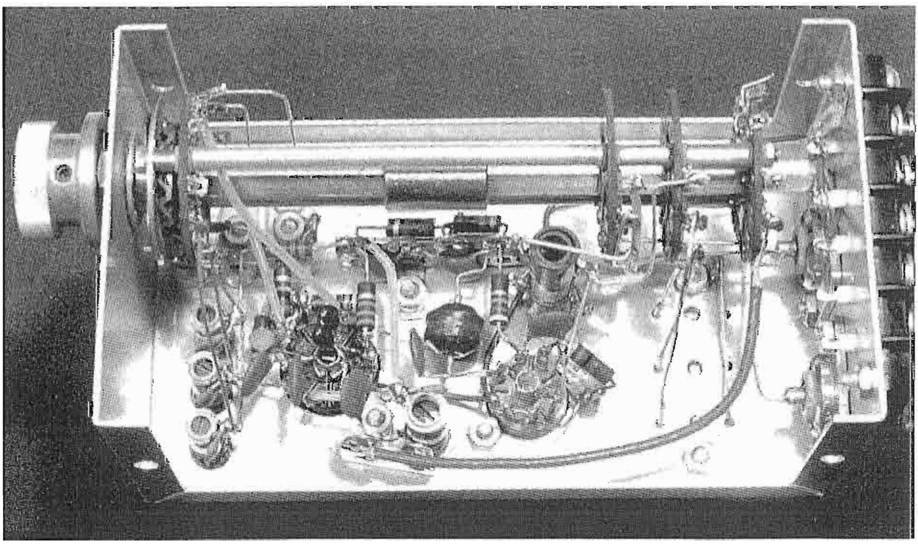
nents of the converter together, and saw them all work, at least individually. I always build "prototype" circuits so I can work out the details, optimize each stage, determine the size of the project and establish a good parts layout, then start a



final build after sheet metal work is done. When the end product is together, invariably things change. This is to be expected. Again, stray components and coupling effects change. In this project, final tuning was done by adjusting the coupling capacitor from the LO to the mixer to optimize gain and noise figure. Actually, noise figure is more important to me than gain. Mixers are funny devices, and the ratio of RF to LO is critical to achieve a good mix and maximum output. It is also the case that frequently the most output signal is

Above: Using a couple of old switches and saving the wafers and the front indexing plate, adding new stringers and spreaders makes the exact switch needed. Spacing and wafer location is determined by other component locations, keeping leads short. The stringer stock is 4-40 stainless steel threaded rod and spreader stock is 5/32" X .014" wall aluminum tube from Small Parts Inc., Miami Lakes, FL, 800-220-4242. The shaft extender is 1/4" round brass stock milled to wafer specs. Be sure to keep and use the insulated #4 washers from your original switch segments. Without the insulators, you are likely to short out any contacts adjacent the spreaders and hard metal spreaders can deform phenolic or shatter ceramic wafers.

Below: Parts mounted to the tube and crystal sockets are installed first, as is any other wiring running close to the chassis. The bandswitch is inserted later, providing you left enough room, and wired to upper components already mounted on the chassis. This will result in a clean layout, easy for installing parts and alignment, along with an "intentional look" provides a completed project suitable for showing.



accompanied with the most noise. A suggested alternative approach is to adjust the mixer both for LO injection and output tank tuning, for the least noise or best signal to noise ratio. The easiest way to do this is to offer an input signal from your generator, quite likely the least signal it will output. Tune it in on your receiver, and adjust the mixer for the best S/N ratio. Your ear will probably tell you all you need to know, but instruments are completely acceptable and will be discussed at another time. If you would like to play and learn, you could use screen-grid injection of the LO into the mixer. In this case, bypass the cathode resistor of the mixer, remove the screen bypass cap, reduce the screen dropping resistor, and couple from the LO to the screen. You may need to joggle a couple of these values, but you should notice the unit behaves in a different manner. Perhaps your particular situation is more suited to the alternate scheme.

By now, you should be tuning in the WARC bands on your vintage receiver. It is sort of neat, and you did it yourself!

[1] See ER #199, December 2005, Part 1 of this article, p. 12, for a discussion of Handbook of Electronic Tables and Formulas, by Howard W. Sams Publishing Company, many editions 1962 to about 1989. Not currently in print according to the current "Sams" publisher:
Sams Technical Publishing, LLC
9850 E. 30th St.
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Many on-line book dealers have this book in used condition, such as at www.bookfinder.com. Also check local used technical book dealers.

Gear Stuff-The Basic Oscilloscope

Think of your scope as a visual voltmeter. You can not only measure the voltage, but you can "see" what it looks like. The response of a scope is much faster and generally quite different than that of an analog meter.

Standard operation of a scope is based on the vertical axis measuring voltage, and the horizontal axis measuring time. For this brief discussion, we'll consider a typical 8X10 centimeter display. Each vertical centimeter equals the voltage selected by the input attenuator. Selecting 1V provides eight units of 1V each, so the maximum voltage which can be read is 8 volts. Scopes are different than analogue or even digital meters, as when displaying an AC signal, which of course includes RF, the display is in volts, peak to peak. A signal which registers 1-volt RMS on a meter will show as 2.8-volts peak-to-peak on a scope. The base line is typically centered vertically for AC measurements to show both positive and negative excursions of the waveform. If the circuit you are viewing contains DC, you would use AC coupling to block the DC component and allow you to view the waveform only. If you wish to measure a static voltage select DC coupling and read the voltage directly from the screen. DC is DC; there is no "peak", so readings are accurate to RMS levels. When both DC and AC are present, as in this converter at various locations when the tanks are installed and power is applied, you will want to select AC coupling. Selecting DC would deflect the trace to 150 volts due to voltage on the plate of the oscillator, and the waveform would be superimposed on top of it. It will be difficult to see a 10-volt signal on top of a 150-volt signal, especially since the 150 VDC pushes the trace to the top of the screen.

For typical measurements, the horizontal time base within the scope provides the sweep. The horizontal sweep determines how fast the trace moves across the screen. So, a sweep selection of 1 µs (microsecond) means per centimeter, or 1µs/cm. This means if you are looking at a 1-MHz signal, a complete cycle will perfectly fill a centimeter of display. If you wish to view the 10-MHz oscillator output, selecting 0.1 microsecond sweep will place one complete cycle every centimeter, as the period of a 10 MHz signal is .1 µs. That may be fine for measuring the voltage, but you will have 10 complete cycles across the screen and viewing detail in the waveform will be tough. By increasing the sweep speed, by a factor of 5, would give a sweep speed of 0.02 µs and offer only two complete cycles across the screen, much better for analyzing. Many scopes have a magnifier switch, usually a locking push button, which automatically multiplies the selected sweep by a factor of either 5 or 10, just for this reason.

Another thing you can do with a scope that you can't do with a meter is frequency measurement. Frequency measurements will not be to the cycle, pardon me, "Hertz," but they are close enough. If you have not built an oscillator, even a crystal oscillator such as the 4-MHz unit needed for 12 meters in this project, and had it fire at the second or fourth harmonic, you will! With a meter (using an RF probe) you will see the voltage and figure you are fine, but your circuit doesn't work, and you can't hear the oscillator in your receiver, even when you "tune around." The scope will tell you it's oscillating, and if you ask, "on what frequency it is running?" When you see it is at 8 MHz, you'll realize you made a mistake, and also why you didn't hear it; you didn't tune 4 MHz above your target frequency, did you? You can also see the wave shape; to be sure you have a clean, pure signal.

Another point to keep in mind is that the scope probe and input to the scope act as a capacitor and resistance in parallel with whatever you are measuring. To assure the most accurate measurement and least detrimental effects to the circuit under test, always use a X10 probe. Such probes offer loading factors ten times less than traditional X1 probes, but also are only 1/10 as sensitive. Some scopes will automatically change their range display when you connect an X10 probe. Others require you to remember this and multiply voltage readings by 10. An often overlooked item is using an aftermarket or Hamfest-found manufacturer "A" probe on a manufacturer "B" scope. This can cause many problems. The bandwidth of the probe must match the bandwidth of the scope, the impedances must match, some probes and scopes have grounding pins to automatically switch between X1 and X10 ranges, and some probes require power for internal preamplifiers. A scope should be the most sophisticated piece of test gear you have, and you need to be able to believe what it tells you. This is no place for "it oughta work".

ER

Using a BC-1306 on 75 Meters

By Bill Feldmann, N6PY
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After a picture of my ART-13 Vintage Field Day station was in Electric Radio last summer, I received an email from Bud Johnson (K9IDB) asking about my ARR-15 receiver shown with my ART-13. Bud had been a radio operator during WWII on Navy flying boats and had never seen this receiver used with an ART-13. After an email explaining that the ARR-15 went into service just after WWII, we exchanged more emails discussing subjects like military radios and even motorcycles. In one email, Bud mentioned he owned a BC-1306 that he didn't have time to get on the air, and wondered if I was interested in it. After a little research on the BC-1306, I sent a check to Bud for it. This opened the door to a very interesting part of vintage military radio, low-power AM field radios.

The BC-1306 was the radio used in the SCR-694 Army field radio system, put into production near the end of WWII, in 1944. It was designed and produced by the Crosley Corporation to replace the SCR-284 field radio system used throughout most of WWII. It covered the same frequencies, 3.8 Mc to 6.5 Mc, had about the same power output of 25 watts on CW and 8 watts on AM, but was much smaller and lighter than its predecessor. This system was designed to provide reliable phone communications over a range of 15 miles and on CW to 30 miles using a simple whip antenna. But, I've found it can cover far greater ranges.

The BC-1306 is not a transceiver but it's a separate transmitter and receiver packaged in the same case. It was designed to be very easy to operate and service under field conditions. The transmitter is in the upper part of the case with the receiver below it as shown on my BC-1306 in **Figure 1**. The receiver's VFO is calibrated in megacycles, while the trans-

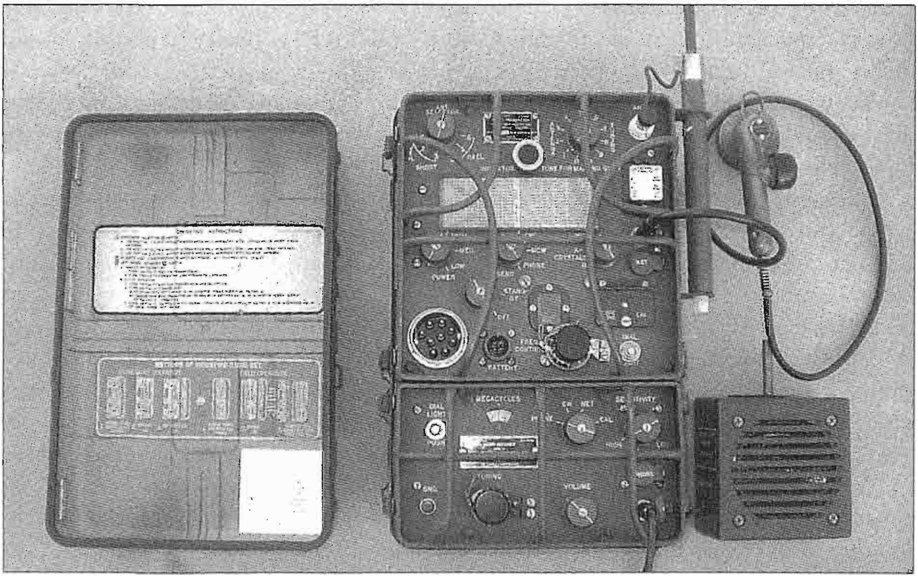


Figure 1: Front of the BC-1306 with the case open. The transmitter is on the top and the receiver is below.

mitter VFO uses a logging scale with a frequency table on its front panel. The receiver's "net" mode can be used to tune the transmitter to the same frequency as the receiver. The transmitter and receiver can be easily unplugged from connectors and removed from the case as shown in **Figure 2**. By removing the tuning knob, three screws from the transmitter's front panel and four screws from its chassis, the tuning capacitor assembly can be easily removed for access to transmitter components.

The receiver front panel contains a VFO tuning knob, mode switch, RF/IF sensitivity switch, and a volume control. A switch on the back of the receiver selects either of two phone jacks with 4000 or 250 ohm impedances. The audio output is less than 1/10 watt but sufficient to drive headphones or a small 250 to 500-ohm speaker. The transmitter's front panel has a main power receptacle for power input from external power sources, battery receptacle to power only the receiver, VFO tuning knob with logging dial, off/send switch, mode switch, MO or crystal switch, and a RF power-level switch. The top of this panel has an antenna selector switch to match the SCR-694 antennas, an antenna tuning knob, a neon bulb RF tuning indicator light, and the antenna terminal. There are also CW key and microphone jacks, along with hinged covers over receptacles for two oscillator crystals and the CW sidetone volume control.

The radio used the just-introduced miniature tubes with 1.5-VDC filaments, which were used in small portable radios after WWII. It's a six-tube, single conversion superheterodyne-design receiver consisting of a 1L4 RF amplifier, 1R5 mixer/oscillator, 1L4 first IF, 1R5 second IF, 1S5 detector-first audio-BFO, and a 3Q4 audio output amp. The detector cir-

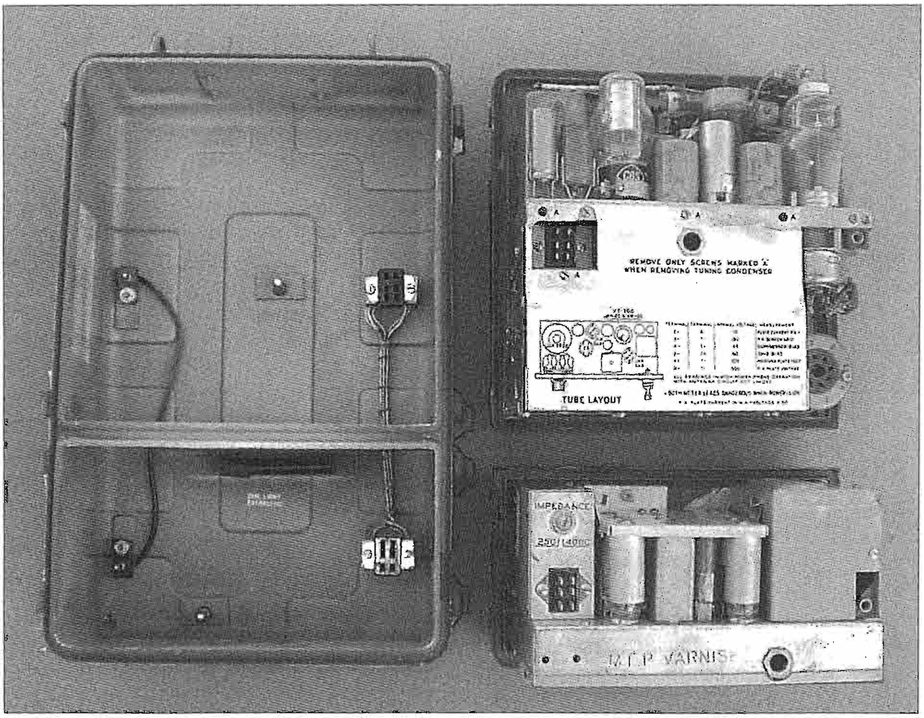


Figure 2: The transmitter and receiver units have been unplugged and removed from the case.

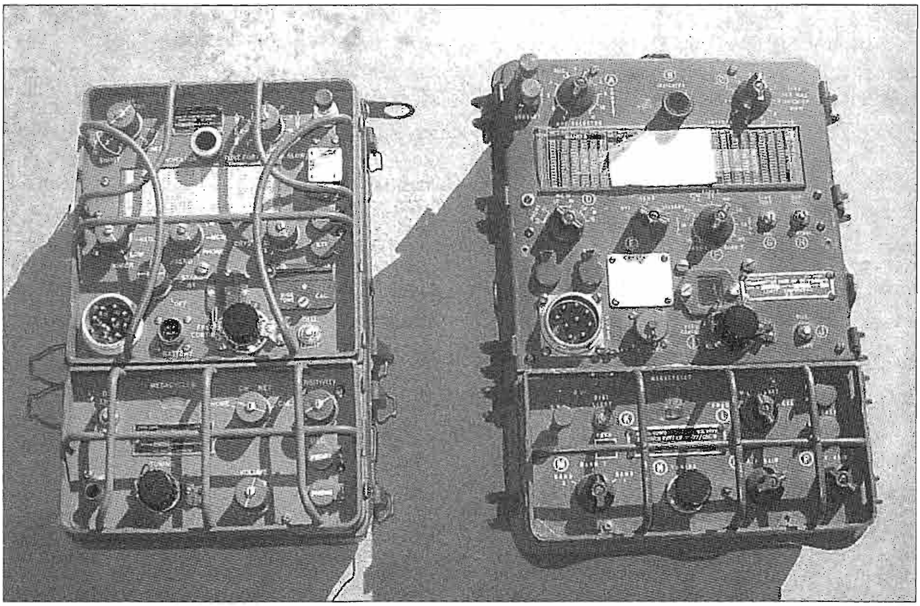


Figure 3: For comparison, a later GRC-9 is shown to the right of my BC-1306.

cuit also supplies negative AVC voltage to the grids of the RF and first IF tubes. RF/IF gain control is performed by a three-position sensitivity switch that varied the screen voltage of the RF and first IF tubes. Its crystal calibrator provides markers every 200 kc using the 1R5 second-IF tube to also generate the marker signals. For CW reception, it uses the first audio pentode section of the 1S5 as a BFO that oscillates at half the 455 kc IF frequency. This signal's second harmonic is then coupled to the grid of the second IF. This design is acceptable for copying CW but very poor for SSB reception.

The transmitter is a four-tube design using a 3A4 as a VFO operating at half the transmitter frequency. It's coupled to the grid of the 2E22 final amplifier through a tank circuit, gang tuned with the VFO for multiplication to the transmitter frequency. The final output network consists of a parallel-tuned tank circuit whose tuning cap is ganged to the VFO cap to tune the final tank circuit with the VFO. An antenna coil having a moveable iron core for antenna tuning follows the tank coil. A second coil follows this antenna coil that can be switch in sections for tuning the 15-foot whip antenna, supplied with the SCR-694 system, using the first three positions of the antenna selector switch. The last three positions of this switch disconnect the second coil and switch in different value capacitor for tuning a wire doublet antenna also supplied as part of SCR-694 system. A center tap on the tunable coil outputs antenna signals to the receiver through the keying relay contacts. This tap is also connected to a neon RF output lamp on the transmitter's front panel.

The transmitter has a second 3A4 tube used as an AM voice-modulation amp or as a sidetone oscillator when in the CW or MCW modes. In voice mode, its grid is connected to the mike jack through a mike transformer. Its plate is connected through a modulation transformer to the suppressor grid of the 2E22 final amp. When switching from CW to voice, this suppressor grid is disconnected from ground and to a network supplying negative 40-VDC bias to reduce the output power by about 1/3 for proper modulation. CW keying is accomplished by keying the T/R relay that controls power to the final amp and VFO tube's plate. In voice mode, both the VFO's and 6-volt transmitter's filament voltages are also keyed through the mike jack. The mike jack also receives power for a carbon mike from the 6-VDC filament supply. The transmitter's fourth tube is an OC3 that regulates 105 VDC for both transmitter and receiver VFOs.

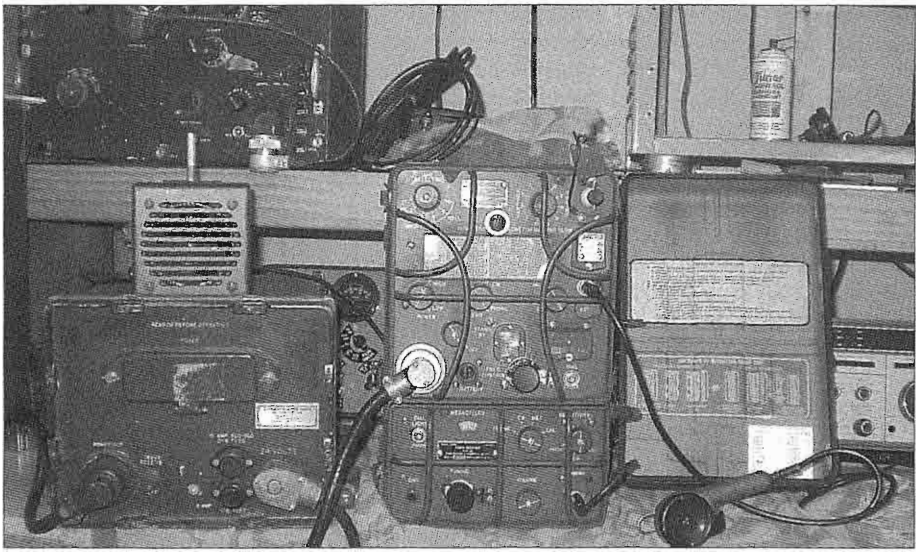
External 6-VDC, 1.5-VDC, 105-VDC, and 500-VDC power must be supplied to the BC-1306 from an external source such as the SCR-694 system's GN-58 hand cranked generator, or PE-237 vibrator supply through the transmitter's power connector. These supplies are getting hard to find, but fortunately it's still easy to obtain power supplies and cables for the GRC-9, which are fully compatible with the BC-1306. Battery 1.5-VDC and 90-VDC power for the receiver may also be supplied through a battery connector located on the transmitter's front panel.

Around the start of the Korean War, the design of the BC-1306 was improved to increase its frequency range to 2 Mc through 12.4 Mc using three bands, improve it's CW reception, but with an increase in weight and size. Its mechanical and electrical design remained similar. This became the GRC-9 radio shown in **Figure 3**, to the right of my BC-1306 for comparison. This increase in size was necessary to add a driver/multiplier tube between the transmitter's VFO and final, and a separate BFO tube in the receiver.

Using a BC-1306 on 75-meters is a snap due to its very user-friendly design. Start by unlatching and removing the cover, shown on the left in **Figure 1**, then secure the transmitter and receiver to the case using the cover latches. Connect a 4000 to 150-ohm headphone or speaker to one of the receiver's phone jacks and a RF ground to the ground terminal. The bumper of my truck worked fine for field use. Connect and power up a suitable power source to the transmitter's power connector. Attach a 15 to 50-foot wire or whip antenna to the transmitter's antenna terminal. If a coax-fed antenna is used, connect the coax shield to the ground terminal and its center conductor to the antenna terminal with a 100-pf cap in series.

Place the transmitter's off/send switch in standby, place the receiver mode switch in phone, the sensitivity switch in high, and the volume around half its range, and tune the VFO between 3.8 Mc and 4 Mc. After a few seconds, noise should be heard in the headphones or speaker. Initially tune the antenna by placing the transmitter's antenna selector switch in positions 1 to 3 for antennas less than 20 feet, and 4 to 6 for a longer antenna. Adjust the antenna tune knob for maximum audio noise. If the audio is weak, unlatch the receiver from the case by pulling on its panel guard to remove it, then check that the setting of the audio impedance switch on the back of the receiver is set for your headphones or speaker. I found 250 ohms works fine for my 500-ohm speaker. Check the receiver's VFO calibration by placing its mode switch in cal and tuning to the 200-kc markers. I find it's best to select the lowest selectivity switch setting for a half-range setting of the volume control to reduce receiver noise and prevent overload, especially in CW. Don't expect good copy of SSB stations, the BFO injection is very low and this radio was never designed for SSB reception. But, I've found a properly operating BC-1306 receiver is very sensitive and excellent for AM or CW reception, even on a short 16-foot antenna.

Plug a T-17 or equivalent carbon mike into the mike jack or a CW key into the key jack. Place the power switch in high, mode switch in phone, crystal switch in MO to use the VFO, and the off/send switch in send. If you're using a dynamotor supply, you should now hear the dynamotor start to run. If your antenna is less than 20 feet long, place the antenna selector in short positions 1 to 3. Use reel positions 4 to 6 if you're using a longer antenna. Set the transmitter's VFO using the front-panel logging table. To work a station you are receiving, first use the



Testing the BC-1306 on 75 meters with a 28-volt, DY-88 dynamotor supply. The little BC-1306 is a great AM radio and I've had lots of fun working QRP DX with it, up to the Canadian border and Boulder, Colorado on 75 meters late at night using my 150-foot doublet antenna fed with homebrew ladder line.

receiver's CW mode to zero beat the station, then place the net mode to zero beat your receiver using the transmitter's VFO tuning knob. Press the CW key or mike switch and adjust the antenna-tuning knob to obtain the brightest indicator light. If the light doesn't light or is very dim, try a different selector position. If the light is very dim or you are in bright sunlight, rotate the light's lens for best viewing. If the indicator is very dim, use a higher power output setting by putting the mode switch in CW. If the indicator light is equal in brightness in more than one selector position, use the antenna selector switch position that results in the antenna tuning knob setting closest to midrange for maximum efficiency. When tuning for voice, I found it's best to first use a power setting for a dim indicator so that while talking into the mike I can see it brighten as a check for RF modulation, and then switch to the higher power. For maximum antenna RF output using an antenna less than 20 feet long, only use the selector short positions, even if the indicator is brighter in a reel position. Failure of the indicator to light indicates an antenna or transmitter problem and you'll need to do some troubleshooting. Last, pick the desired mode and RF power output using the radio's mode and power selector switches. For CW, lift the sidetone cover and adjust the sidetone output for a comfortable level, but turn it down in voice mode to prevent speaker feedback.

When my BC-1306 arrived I was pleasantly surprised, the radio looked like it just came for the factory with hardly any signs of wear. It also showed no signs of repair or modification, usually found today in surplus WWII radios. Testing of the tubes indicated they were all like new. My first problem was finding a power source, since PE-237 vibrator power supplies are getting hard to find. I called Fair Radio and found they were long sold out of PE-237's but they supplied me a DY-105B 24-VDC dynamotor supply with cables for a GRC-9 radio, but it worked fine for a BC-1306. But as a collector, I'm still looking for a restorable PE-237 supply for my radio. I also ordered a copy of the SCR-694-C manual from W7FG Vintage Manuals at www.w7fg.com.

Dennis (W7QHO) gave me a hand firing up my radio because I've never operated a BC-1306, only operated a similar GRC-9 a year before, and had never worked on one. When we connected it to the DY-105B dynamotor, powered by two 12-VDC auto batteries in series, the receiver immediately came to life. We then connected it to a 50-ohm dummy load and a power meter through a 100-pf cap and attempted to tune the transmitter. The neon indicator was very dim and the power meter indicated only a few watts of output on CW. When the transmitter's VFO was initially tuned using the net mode it was right on the receiver's frequency, but not during transmit as I found out when listening on my 75A-3 receiver. There were also a lot of spurious emissions around its carrier. At that point I decided to study the manual sections on its theory of operation and repair.

The manual's recommended way to start checking the transmitter's performance is by measuring voltages at a meter socket on the back of the transmitter. I then built a cable assembly, described in the manual, to run either the transmitter or receiver out of the case. By checking meter socket voltages, I found very low final-amp grid bias, indicating low or no grid drive from the VFO, but the VFO appeared to work fine during netting. A study of the schematic showed that during netting, only the screen grid and not the plate of the VFO tube was powered. I then removed the capacitor assembly from the transmitter to gain access to the VFO circuit components.

The first thing I checked was the VFO's plate choke using an ohmmeter, and found out that it was open. This explained the lack of final grid drive. The spurious emissions from the transmitter were because the final amp is designed to self oscillate with no drive for its protection against excessive plate current, according to the manual. I found a choke among my spare parts that looked the same as the bad one and even had the same DC resistance as listed in the manual. After replacing the bad choke and reinstalling the capacitor assembly the transmitter came to life. Nearly 25 watts out on CW and it looked good on my scope with full modulation using a T-17 carbon mike on voice mode. The scope showed just very slight clipping at nearly 100% modulation, but it was right on frequency and sounded great on my 75A-3 receiver.

I next decided to check the tube voltages in both the receiver and transmitter, and found some were off a fair amount. Looking at the parts list in the manual, I found many dry paper caps, which in the past I have found to be very prone to leakage. However, in my receiver, I found disk ceramic caps in place of the paper ones listed in the manual. It also appeared the receiver was originally built with them. Its serial number was much higher than the transmitter's number, leading me to believe my receiver was built at a later date than the transmitter and had been changed during its Army service. Crosley must have switched to the better caps on late-production units. I also found the mixer tube's grid was connected to the AVC line, even though the manual schematic and the schematic on the inside of the case showed it at ground, further indicating it was a late-production receiver.

I replaced all the paper caps in the transmitter with modern axial film or disk ceramic ones. I also checked the resistors in both the transmitter and receiver. I found many of the high-value carbon ones were high in value where many low-value ones were low in value. I replaced any resistor more than 15% out of spec, and then rechecked tube and circuit voltages. They were now very close to spec. I also found and replaced a leaking paper-oil cap in the receive sensitivity circuit that was causing the receiver to go dead with low sensitivity. Usually, these paper-oil caps are more reliable than the dry paper ones so I hadn't replaced them. Additionally, my transmitter's dial light bulb was open, and I replaced it with a 2-volt, T-49 bulb available in the Mouser catalog.

After alignment of both the receiver and transmitter, I decided to see if anyone could hear my little 8-watt AM signal on 75 meters, so I tried it on the Saturday night Military Radio Collector's Net. I was pleasantly surprised! I was heard way up in northern California, 400 miles away. I was using a carbon T-17 mike that seemed to work fine, but I had Brian (NI6Q) record my signal with the carbon mike and then with a T-17 mike that I had installed a small Radio Shack condenser element in. When he played back my transmissions, the carbon mike sounded fine but the condenser mike was much better having more highs with less distortion, perfect for a low-power transmitter. A week later, I tried the BC-1306 in a big AM round table on 3870 kc. There, I worked Steve (KL7OF) up in Washington near the Canadian border. I then tried dropping to low power, 3 watts, and Steve still heard me, but I had dropped to between Q3 and Q4 copy at his station. Not bad for only 3 watts of AM on 75-meters. But, I wasn't using the SCR-694 antennas, I was using my home station's efficient 150-foot doublet antenna, center fed with 600-ohm ladder line and a Johnson Matchbox. I found the receiver has excellent sensitivity along with very good AVC on strong AM signals. Its 5-kc narrow bandwidth is perfect for copying small military or QRP radios that have lots of midrange and highs in their audio. But, stations with stronger lows and fewer highs can be harder to copy; they are more easily copied by tuning a little off frequency to receive more of one sideband to get more audio highs.

I don't have the SCR-694 antennas intended for my radio, but I wanted to simulate its field use. I fabricated a 16-foot whip antenna using 4-foot sections of military mast material and a PVC insulated base to fit the antenna mounting brackets on the right side of my BC-1306's case, shown in **Figure 1**. With the radio grounded to the bed of my truck, it did a great job during the military collector's field day at San Pedro, CA, this fall. But, one night on 75 meters, I worked a station 300 miles north of my QTH using this simulated SCR-694 system whip antenna. I found with the 16-foot whip that the radio would transmit over its whole bandwidth using the antenna selector switch reel positions 1 to 3. It would also appear to tune the whip better in the reel 4 through 6 positions, with a brighter neon bulb, than in the whip positions. But, using a field strength meter, I found there was much more RF output in the whip positions, even with the dimmer bulb indication. So, the manual is right, only load antennas less 20 feet in positions 1 to 3. I also found that in reel positions 4 though 6, it's necessary to have a 100-pf capacitor in series with the antenna terminal to load near 50-ohm low reactive antenna. This is because the output circuit was designed to load the capacitive reactance of the short SCR-694 doublet antenna in the reel antenna switch positions.

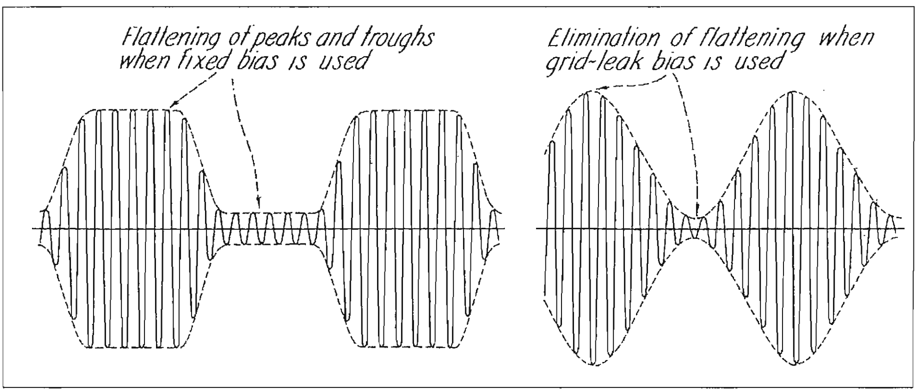
The BC-1306 will not tune into the CW end of 80 meters or up to 40 meters like the later GRC-9. Also it's a pain to work a SSB station because of its weak BFO injection that causes audio distortion. On CW it isn't as bad, but often the tone of the received signal is distorted. I did improve SSB/CW reception some by decreasing the 100-pf cap, item 13-2, on the output of the oscillator to 20 pf. However, increasing the 3-pf BFO output cap resulted in IF circuit oscillation, so I didn't change it. In the GRC-9 the addition of a sensitivity control pot in place of the switch and a better BFO circuit was a large improvement.

But even with the SSB and CW reception problem this radio is a lot of fun to operate on 75-meter AM because of its ease of use and setup, the receiver's excellent AM sensitivity and selectivity, good transmitter audio, small size, and it's also a nice piece of WWII military radio history. ***ER***

Linear Plate Modulation for Class C Triode RF Amplifiers, Part 2

By Bob Stout, WB9ECK
stout@wpr.org

Normally, grid-leak bias is used along with an RF driver stage having a high internal resistance. With grid-leak bias, the bias increases with an increase in grid current. The grid current goes up during negative-going modulation troughs (zero DC plate voltage). *Grid-leak bias tends to increase rather than decrease as the plate-supply potential decreases.* It does increase linearity at the negative troughs by further cutting off the tube when the plate-supply potential is at zero and further reducing plate current. This reduces flattening of the troughs in the modulation envelope. *On the positive peaks of modulation the grid current, and therefore the grid bias, will decrease.* This helps raise the plate current on modulating peaks, preventing flat topping. This is shown in exaggerated form in **Figure 10**, below. The grid leak owing to the variations in grid current automatically reduces the bias at the peaks and increases it at the troughs. This eliminates the flattening effects shown in **Figure 10** caused by the use of fixed grid bias. An RF driver stage having a high internal resistance is also in the same direction. If high grid current is drawn at the troughs of the cycle then the internal voltage drop in the exciter is high and less RF excitation is available for the grid of the final tube. The RF output of the final stage is reduced and the troughs rounded out just the same as if the bias increases. During positive going peaks the grid current decreases so that more drive is available at the grid of the final. This raises the RF voltage and prevents flattening of the outward peaks. **Figure 10** illustrates the benefits of having a high internal driver resistance as well. This combination of the two has a tendency to offset each other. An example of this is during negative troughs the grid current rise is partially counteracted both by the internal driver resistance and the increased bias voltage drop in the grid leak. The combined effect may be greater than that of either alone, but is not as great as if both were independently varied. This discussion seems to indicate that both the bias as well as the RF drive should vary in the same direc-



This is "Figure 10" from the textbook "Advanced Electronic Engineering Technology," page 13, Capitol Radio Engineering Institute (CREI) published in 1961.

tion as the final plate modulation.

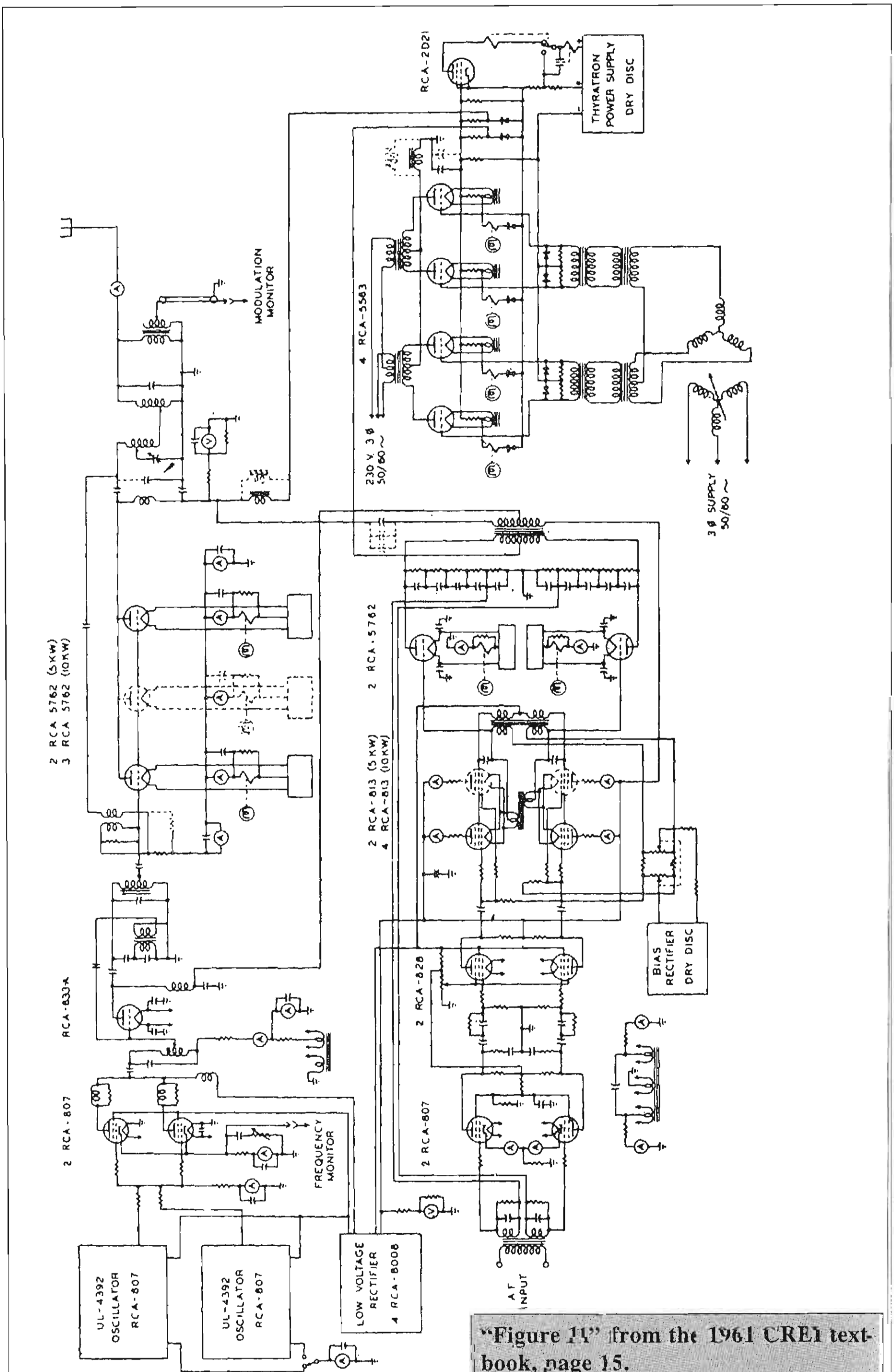
When the plate of a single grid tube operating in the Class-C region, using grid-leak bias, is modulated 100 percent, the DC plate voltage will swing back and forth between zero and twice the DC power supply voltage during the modulation cycle. During the positive half of the cycle the more positive plate element of the tube will rob the control grid element of electrons, lowering the DC grid current. Just the opposite occurs during the negative half of the cycle when the DC plate voltage goes to zero. This indicates that the *negative grid bias voltage should increase, or else the RF excitation should decrease during positive going modulation peaks.* This is where modulating the exciter stage comes into play. Modulating the excitation gives you a way of turning the drive to the final stage up and down as well as controlling the negative grid bias when a grid-leak resistor is used.

The resistance that the RF tube presents to the modulator stage is not constant over the modulation cycle. The angle of flow should remain constant at all times. We can accomplish this by modulating the excitation since all of the negative grid-leak bias is developed from the drive and the voltage drop across the grid-leak resistor. Without RF grid drive there will be no negative grid bias. By modulating the drive the same polarity as the final (in step) we can increase (or decrease) the amount of negative grid-bias and drive as required. If the angle of flow in the final remains constant, the ratio of RF current to the d-c component will be constant regardless of what part of the modulation cycle is occurring or throughout the modulation cycle. Both will be directly proportional to the DC power supply voltage plus that of the output of the modulator tubes. The RF current and voltage will be directly proportional to the modulating voltage. Also the ratio of the instantaneous DC component to the instantaneous plate-supply potential will remain constant.

This translates to the RF final stage presenting a constant resistive load to the modulator stage greatly reducing the *distortion* generated by the modulator stage itself. The modulator stage can be considered as an audio driver stage, the same as the preceding RF stage to the final is considered an RF driver stage. The requirement for constancy of angle of flow results in the need for modulating the driver excitation voltage and the bias as previously stated.

Earlier, we were discussing the *negative* grid *bias voltage varying in the opposite manner to the RF drive* and final modulation. What is the benefit of this mode of operation? The answer is in the constancy of the resistive load that the RF final PA stage presents to the modulator stage. The class of operation (A, B, or in this case, Class C) is established by the *amount of negative grid bias* on the tube with respect to the amount of plate voltage. Let's say at the peaks of the outward going modulation, the excitation increases, but the negative bias decreases. Then the angle of flow increases, the DC component tends to rise faster than the a-c (RF) component, because it is a different kind of function of the angle of flow. This means that at 100 percent positive peak modulation, the resistance the RF final presents to the modulator would instantaneously go lower than it is at no modulation or dead carrier. Likewise, at 100 percent negative going modulation troughs, the resistance presented to the modulator by the RF final would instantaneously go higher than at carrier conditions. The resistance, or load that the RF final presents to the Class-B modulator, floats around along with the modulation envelope. The modulator does not like this *variable load.*

It appears then desirable *to modulate the bias 180 degrees out of phase* (grid becomes more negative) *and the excitation in phase* (excitation becomes more positive) *with the plate modulation* (becoming more positive), for proper opera-



"Figure 11" from the 1961 CREI text-book, page 15.

tion. Another beneficial effect is the elimination of hot spots on the plates of the modulator tubes owing to electron beam focusing at the modulation peaks and excessive grid dissipation during modulation troughs. They glow more evenly. My 833A modulator tubes have a nice, even, silver-dollar size orange glow on their plates now.

By modulating the excitation or driver stage, we now have a variable source of drive rather than a fixed one. This modulation is independent of grid current, and can be used to make the grid-leak bias vary in the desired manner if it is of a high enough amplitude to do so. For example, at the positive peaks of modulation, the drive voltage is increased to a peak value also. It can be made high enough to draw more grid current instead of less at carrier condition, as would be the case if the amplitude were fixed. This means that the *negative grid bias can increase instead of decrease at 100 percent* positive going modulation. Likewise, at 100 percent negative going modulation, the drive will go down and the grid-leak bias will go down, rather than increasing, lowering grid current and grid dissipation during this instantaneous period when there is no DC plate voltage on the RF final. This will hold the *class of operation* somewhat steady.

Whether or not the driver modulation is of high enough amplitude to produce this effect to the necessary degree or not, it does tend to *reverse the phase* of the grid-leak bias variation. If it isn't of sufficient amplitude to do this, it will still eliminate flattening of the peaks of modulation, but not stopping the RF final from changing its resistive load that it presents to the modulator over the course of the modulation cycle.

Since the modulator tubes have appreciable internal resistance, the variable load resistance will produce variations in the output voltage just as occurs in a Class AB2 push-pull audio stage when the driver resistance is greater than zero. The solution is *inverse feedback*.

The distortions in the output signal owing to variations in the load resistance have no proportional relation to the waveform of the input audio signal. Inverse feedback will reduce the output voltage distortions and minimize the effects of the RF tube load variations. Inverse feedback is employed because it is an easy way of dealing with minor changes in the resistive load that the RF final presents to the modulator tubes. I see it as icing on the cake.

"**Figure 11**" is a simplified schematic of the RCA BTA-5G 5-kW broadcast transmitter. The broken lines indicate modification for 10 kW. The 833A RF driver stage is plate modulated, generally around 50 percent or so, but not more than 80 percent. I've found that you get into trouble fast once you exceed approximately 80 percent modulation on the excitation. This will hold the resistive load the RF final presents to the Class B modulator *constant*.

This is a lot of fun to play around with. There are many different ways of modulating your driver stage. Experiment and use what works for you.

This information can be found in greater detail still in the 1961 edition of the Capitol Radio Engineering Institute's Advanced Electronic Engineering Technology manual, Section 2, Under *Modulation*, pages 12 through 18.

In the older (1950s and early 1960s) West Coast handbooks, the writers also comment on this topic under "Distortion in the Modulated Stage. " Check the book's index.

{Editor's note: Part 1 of this article appeared in ER #194, July 2005, p. 39]

ER

Ham Radio's Twins

The McMurdo Silver 701T and 802R

By Harold Smith, W4PWQ
1435 Bush St.
Pensacola, FL 32534

When I received my ham license, W4PQW, in 1948, I was so excited and anxious to get on the air I could not move fast enough. I owned an old National HRO receiver but no transmitter. A lot of local Hams advised me to get a military surplus ARC-5. Best way to go, right? I finally located an ARC-5, 40-meter version, built a power supply, and fired her off on 40 CW.

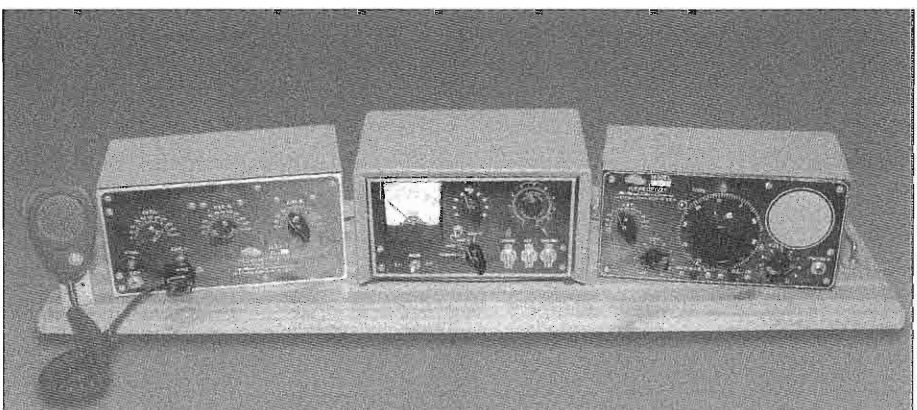
Once I got her on the air, all signal reports came back something like 5-9-6C. I found that I had "chirp" in the worst degree. After working on it for a couple of weeks, I cleared up most of the "chirp," *then* I had "key clicks." I was exasperated to say the least.

At the time, a new radio supply dealer opened up locally that sold Ham gear. My plan was to save up some cash and buy a transmitter. After working nights and weekends part time with an electrical contractor, I was able to save about $50.00, just enough to buy a factory-built transmitter. I already had a good power supply. When I got to the store, they only had two models in stock. A Millen Exciter model 90800 at about $40.00 and a McMurdo Silver Model 701. The Millen Exciter was CW only and the McMurdo Silver Model 701 would do CW and AM. It was $36.95. I chose the McMurdo Silver and including coils and tubes at about $10.00, for $50.00 I was up and running. At this point, I was on the air working mostly 10-meter phone.

I used the McMurdo Silver for a couple of years and eventually traded it for an ART-13 Collins HF transmitter. There would be no 10 meters for awhile, but I was going strong on 75, 40, and 20-meter phone. With the HRO receiver and ART-13, I was "big time."

For the next 57 years I worked all bands with all sorts of equipment.

A few years ago I became interested in radio twins, or matching transmitters and receivers. I now have 10 or 12 complete sets of twins. I recalled the early years that McMurdo Silver had the first



The McMurdo Silver "twins," Model 701T transmitter on the left, and the Model 802R receiver on the right. In the center is my power supply. (Photo by Joe Veras, K9OCO)

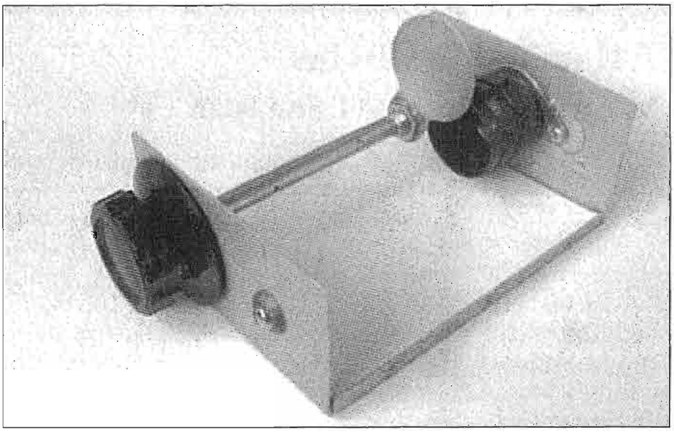


Figure 1: A model of the tuning system used in the McMurdo Silver Model 802 receiver.

set of twins that I had ever seen. I set out to get a pair, 701 transmitter and 802 receiver. The transmitter came easily; the receiver took several years of searching. The only receiver that I could locate was a "basket case" to say the least. It must have been rescued from a landfill. I restored both pieces and built a matching power supply. I use them quite often on 75-meter phone. The transmitter uses a 6AQ5 oscillator, 807 PA, a pair of 6AQ5s in the modulator, and a carbon microphone. It is crystal controlled and has plug-in coils. The transmitter runs about 20 watts output.

The model 802 receiver has plug-in coils for 80 through 6 meters, a built-in speaker, 5 tubes, and it requires an external power supply. Tube lineup is: 1st RF 6BA6, regenerative IF 6BA6, detector/ noise limiter 6J6, 1st audio and BFO 6J6, audio output 6AQ5. The IF frequency is 735 kHz. The IF coils are not enclosed in cans as they normally are. They are wound on 1/2" coil forms with a special air-variable capacitor mounted on top of the coil. (McMurdo Silver sold these variable caps. I believe he held the patent on them.) The IF coils are spaced about 1/2" apart and seem to couple all okay.

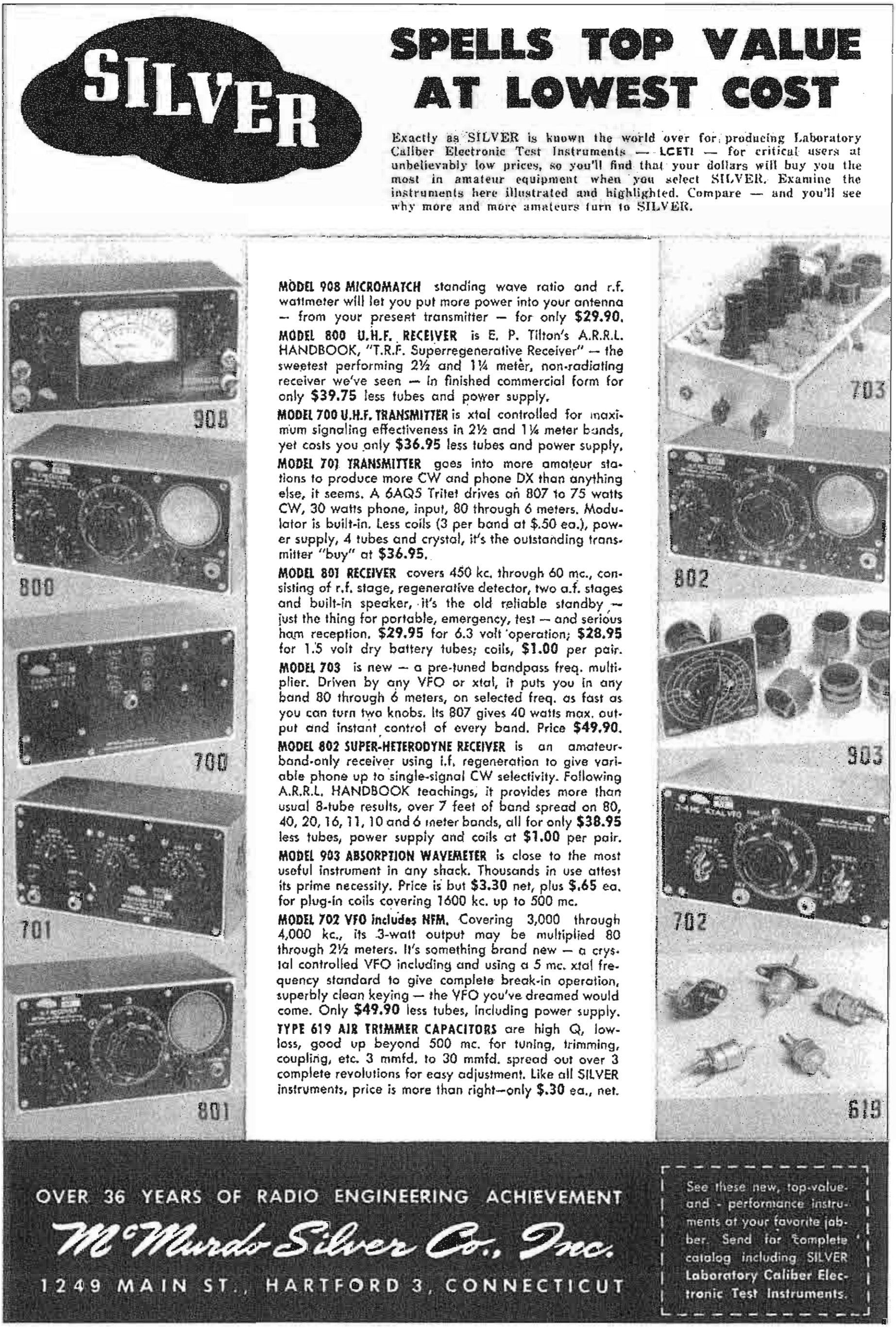
The most interesting thing about this receiver is the tuning method. The RF and oscillator tuning is done with a copper disc about the size of a silver dollar. The disc is mounted on a 1/4" shaft that runs out through the front panel and has the tuning knob attached. Rotate the knob, and it rotates the disc back and forth across the end of the plug-in coils. The tuning is so smooth and simple. A regenerative IF is used to increase selectivity and gain. It is quite effective, see the model of the design in **Figure 1**.

Mr. McMurdo Silver was obviously a sharp, active engineer. Early in his career, he developed several high-class receivers that competed with the best of the time. During World War II, I believe he developed and worked in wartime production of radio equipment. After the war, he recognized the need for a practical, affordable line of Ham equipment and a complete line of electronic test equipment. In a 3-year period he produced about 10 different Ham transmitters, receivers, watt meters, oscillators, wave meters, etc. He developed test equipment to cover everything a radio service shop would need, such as signal generator, VTVM, signal tracer, R/C bridge and others.

Almost everything he produced used the same size cabinet, 5 1/2"x 5"x 10" inches. They were painted a silver/gray color with black panels using raised lettering. They were quite attractive for the time. It all performed very well and were affordable.

Mr. Silver passed on to his reward in 1949. I wish I could have known him. I am glad to show some of his work and to be able to enjoy it.

ER



A typical McMurdo Silver advertisment from the post-WWII period shows some of the product line. This ad is from the November 1947 issue of CQ Magazine.

February 2006 Classic Exchange "CX"

By J.D. "Mac" McAuley, WQ8U

The CX is a no-pressure contest celebrating the older commercial and homebrew equipment that was the pride and joy of ham shacks many decades ago. The object of the Classic Exchange is to encourage restoration, operation and enjoyment of this older "Classic" equipment. However, you need not operate a Classic rig to participate in the CX.

YOU MAY USE ANY RIG in the contest although new gear is a distinct scoring disadvantage. You can still work the "great ones" with modern equipment.

WHEN - WHERE - WHAT

Saturday February 11, 2006, from 1400 UTC to 0800 UTC on February 12, 2006. (9 A.M. Eastern Time on Saturday to 3 A.M. Eastern Time on Sunday) AM and SSB only AND Sunday February 12, 2006 from 1400 UTC to 0800 UTC on February 13, 2006. (9 A.M. Eastern Time on Sunday to 3 A.M. Eastern Time on Monday) AM, SSB, and CW. On CW, send "CQ CX," on phone, call "CQ Classic Exchange."

SUGGESTED FREQUENCIES

CW:	1.810	3.545	7.045	14.045	21.135	28.050	50.100	144.10
AM:	1.890	3.880	7.290	14.286	21.420	29.000	50.300	144.200
SSB:	1.885	3.870	7.280	14.270	21.370	28.390	50.125	144.250

Exchange your name, RST, QTH (state US, province for Canada, country for DX), receiver and transmitter manufacturer/model (homebrew send final amp tube or transistor type) and other interesting conversation. The same station may be worked with different equipment combinations on each band and in each mode. Nonparticipating stations may be worked for credit.

SCORING

Calculate your score for each mode (AM, SSB, CW) and total these scores for your overall CX score. **For each mode**: Multiply total number of **complete QSOs** (all bands) by your **CX multiplier**. **Complete QSO** requires successful exchange of name, QTH, RST, type of transmitter and type of receiver. **CX multiplier**: Total age in years old of all receivers and transmitters you used in that mode. Each receiver and transmitter must be used in a minimum of three complete QSOs to be counted in the multiplier. If the equipment is homebrew, count it as a minimum of 25 years old unless actual construction date or date of its construction article (in the case of a "reproduction") is older. Transceivers score a separate receivers and transmitters of equal age.

Certificates and appropriate memorabilia are awarded every now and then for the highest score, the longest DX, exotic equipment, noteworthy signals, best excuses and other unusual achievements.

Send logs, scores, comments, anecdotes, pictures, etc. to J.D. "Mac" MacAulay, WQ8U, at WQ8U@arrl.net or by mail to:

WQ8U
104 W. Queen St.
Hillsborough, NC 27278

The CX Newsletter and announcement of the next CX will be posted on http://qsl.asti.com/CX

ER

2006 AWA AM QSO Party

By Gary Carter, WA4IAM

If you didn't participate in the first annual AWA AM QSO Party held in February of 2005 you really missed out on a fantastic on-air event and a whole lot of fun! Many an old timer was overheard saying that they had not heard that many amateur stations running AM on the air at the same time since the 1950s. Plenty of stations using their solid state rigs joined in the fun, many of which commented that they had never even pressed the AM mode button on their rigs before and attempted an AM QSO until they heard all the AM activity on the bands that weekend. For vintage ham radio equipment fans there were tube transmitters galore of almost every manufacturer and type imaginable participating in the event. One of the highlights of the event was Ed Gable (K2MP) and Dave Payne (KA2J) firing up James Millen's personal transmitter located at the AWA Museum annex using the AWA club callsign W2AN. They weren't the only ones putting a club station on for the event. Paul Courson (WA3VJB) put the club station of the Radio History Society in Bowie, MD, on the air using the callsign W3R and was heard throughout the country with a tremendous signal.

Well gang, it's time to fire up those AM rigs again! Everyone is welcome to participate, as this is the one on-air event sponsored by the AWA that is open to members and non-members alike. We've simplified the rules this year to make joining in on the QSO Party even easier, and we've bumped up the points for contacts on 20 meters to boost QSO Party activity on that band. We've maintained the 24-hour format of last year's event as that seemed to be to the liking of all the participants. We've also added a new feature: extra points for a contact with two designated "flagship" stations. So without further ado, here's the rules for the upcoming AWA AM QSO Party for 2006:

Dates and Times: The QSO Party starts at 7PM EST (00:00 UTC) on Saturday, February 18th and ends at 7pm EST (00:00 UTC) on Sunday, February 19th.

Objective: To promote and encourage the use of AM as a mode of operation in ham radio, and to have fun!

Frequencies: 3.835-3.890 MHz, 7.280-7.295 MHz and 14.275-14.295 MHz. It was decided not to include 160 meters as not all vintage AM transmitters have this band available.

Exchange: Name and state or province (or country if you're outside of North America). That's it! Of course we encourage participants to talk about the transmitters and receivers they're using, antennas, microphones, etc. Take your time and enjoy showing off that station of yours!

Scoring and Classifications: For stations running 100 watts or less carrier OUTPUT each contact counts 2 points. For stations running over 100 watts carrier output each contact counts 1 point. All contacts made on 20 meters, no matter the power class, count 5 points. You may contact each station once per band. See extra points for flagship station contacts below.

Flagship Stations: Listen for the many AWA Flagship Stations. If you are lucky enough to contact one, your first QSO with them counts as a 10 point contact, but if you happen to contact them again on other bands then all subsequent QSOs with them are the standard point count for your particular power category. If you're fortunate enough to pull off a "grand slam" by making contact with both flagship stations that will give you an extra 20 points!

Logs: Send your summary sheets, postmarked no later than March 15th, to: Gary Carter, WA4IAM, 1405 Sherwood Drive, Reidsville, NC, 27320-5224.

Results: The results for the AM QSO Party will be published in the AWA Journal. They will also be published in Electric Radio and also online at Amfone.net.

ER

VINTAGE NETS

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

BFO CW Net: Tuesdays, 7PM local ET, 3693 kc. QSX WY3D in Southern NJ. Vintage gear welcome!

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

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

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

Colorado Morning Net: Informal AMers on 3875 kc daily @ 6:00 to 6:15 AM, MT. QSX KØOJ

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Texoma Trader's Net: Sat. morning 8:00AM CT 3890 kc, AM & vintage equip. swap net.

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

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

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

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

CLASSIFIEDS

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

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Deadline for the February 2006 issue: Saturday, January 28

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

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

FOR SALE: Collins 75S-3, excellent with optional CW filter, $600; KWM-2, VCG with PM-2 and 136B-2 noise blanker installed, $700; 75S-1/32S-1/312B-3 package (75S-1 has Waters Rejection Tuning installed), $1100. Gary, WA9MZU,209-286-0931 (CA) or ghal@ix.netcom.com

FOR SALE: Two 36" wire parabolic ants w/downconverters, pwr sply, for UHF exper. $200 ea + shpg. Old ham band Geleso receiver M.O. Hank 570-654-2347

FOR SALE: Panasonic RS761S reel-to-reel tape recorder, great condition, $35. B&K 2050 RF generator $45. Leader 27A audio generator $35. B&K 1822,175 MHz frequency counter $35. Hallicrafters S120 short wave radio, good condition, works $25. B&K 2833 true RMS bench multimeter, $30. B&K 878A LCR meter, new in box $65. Johnny Umphress, 1415 Moore Terrace, Arlington, TX 76010, 817-915-4706.

FOR SALE: SBE-33 inverter: 12VDC to 110VAC. NOS $75. TS-1019 radar test set. $125. Gary 952-496-3794. K7ADF@aol.com

FOR SALE: Crank-wind-up Instructograph code machine with one paper tape. Make offer. Gary, KØCX, kzerocx@rapidcity.net 605-343-6739 evenings

FOR SALE: Viking Invader 2000 $1100 or trade. Heathkit SB300/SB400 twins $350 or trade. You ship. Ken Sands, K8TFD, 734-453-7658, ken.sands@juno.com

FOR SALE: DENTRON Clipperton-L amplifier w/10m mod, $600 B/O w/manual, meet or pick up. HEATHKITS: EK-2 receiver & EK-1 meter, $150.00 w/ manuals. HW-12A 75m Mono-Bander w/ HP-23, mike & spkr, $100. Both items+shipping CONUS. Steve Davis KD2NX, 71 Oak Street, Keansburg, N.J. 07734, 732-495-8275, kd2nx66@yahoo.com

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FOR SALE: Hallicrafters HA-1 "T-O Keyer", $85; Lafayette HA-350A, hambands receiver, $125. Both with manuals. Richard Prester, 131 Ridge Road, West Milford, NJ 07480. 973-728-2454. rprester@warwick.net

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FOR SALE: Heathkit TV alignment generator TS1. Sencore PS163 oscilloscope. Hallicrafters rcvr S95. Make offers. Hank, 570-654-2347

FOR SALE: Heathkit Warrior HA-10 amplifier in great condition $300 Bob, W1RMB. 508-222-5553

FOR SALE: Military whip antennas, radio receiving set AN/GRR5 $150. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777, 989-595-6483

FOR SALE: Johnson Viking Invader 2000 + power supply, $750. Prefer pick up. Richard Cohen, 813-962-2460

FOR SALE: BC645A, RT19/ARC4 BC625A, Galaxy 5, DX60B, HG10B, 6 meter transcvr. **WANTED:** Hammarlund receiver and power supply dust covers. Bill Coolahan, 1450 Miami Drive NE, Cedar Rapids, IA 52402. 1-319-393-8075

FOR SALE: Part of 30-year Collins collection including 30K-1, A-line and S-line items, etc. Call or email for details. **WANTED:** Westinghouse "MX" meters, 7.5VCT 5A filament transformer. Gary, WA9MZU, 209-286-0931 (CA) or ghal@ix.netcom.com

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FOR SALE: Complete QST 1915 to now, $6000, shipping negotiable. K8CCV, 330-427-2303

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

TUBES FOR SALE: Radio club stock reduction. Tubes from 2A3 to 5692. SASE for price list. E.F. Hayes, WØJFN, 3109 N. Douglas Ave, Loveland CO 80538

FOR SALE/TRADE: QSTs, various issues and condition 1928 to 1976; total about 300lbs. Sale or Trade. Newell Smith VE7AEC@rac.ca 250-629-3435

FOR SALE: QSTs from 1930s into 1980s, SASE for contents pages. State subjects, months, years. One dollar up plus postage. Charles Graham, W1HFI, 4 Fieldwood Dr, Bedfore Hills, NY 10507 914-666-4253

FOR SALE: Globe Champion, VG, $300. Palomar Skipper 300 linear $120. Radio Shack Pro-2006 scanner, manual, $300. Ron, MI, 517-374-1107

FOR SALE: Superior signal tracer, M-CA1-11 in wood box w/probes $35. Lafayette FM communication rcvr CH 30 to 50 M-HB 75 $50. Weston Selective Analyzer M-665 (navy type CV-22193(M-CE12)) $25. Bernie Samek, 113 Old Palmer RD. Brimfield, MA. 01010 413-245-7174, bernies@samnet.net

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

FOR SALE: QSTs 1923 to 1993 complete, best offer. Rudy, W2ZIA, 3411 Home Rd., Alden NY, 14004 716-937-9279.

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

FOR SALE: DRAKE TR-7/TR-7A/R-7/R-7A Service kit. Includes 13 Extender Boards and Digital Jumper Card. $63.85 includes postage. See http://pweb.amerion.com/~w7avk, Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net, 509-766-7277.

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

ALPHA AMP PARTS FOR SALE: 8877's, chassis, meters, pwr xfr, and more.Bob, WØYVA. Call or email; robert@isquare.com 703-450-7049.

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

FOR SALE: FT243 CRYSTALS: 3500, 3505, 3515, 3520, 3546, 3548, 3558, 3645, 3686, 3702, 3805, 3825, 3830, 3837, 3855, 3875, 3880, 3885, 3890, 3983, 5355, 5360, 7000, 7025, 7030, 7035, 7037, 7040, 7044, 7045, 7047, 7050, 7060, 7125, 7146, 8025, 8400, 10106, 10116, 10120, 12500, 14060, 14286kHz. See: http://www.af4k.com/crystals.htm_or call Brian, AF4K, at 407-323-4178

FOR SALE: ER back issues, complete years 1994, 95, 97, 98, 99, 2003 $20/yr, 1996 Jan-Nov, $15. Dave Sowers, K4SUE, 5197 Burnt Quarter Drive Vinton, VA 24179 d.sowers2@cox.net

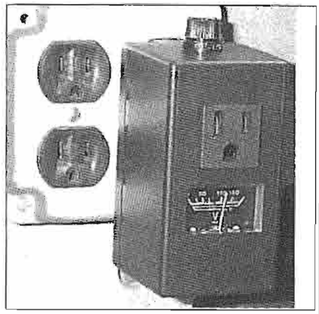
FOR SALE: Original Sams Photofact schematics and service information for vintage radios, $3 each ppd. Write, email or call for availability. Robert P. Morrison, 10238 117th Lane, Live Oak, FL 32060-6716. 386-362-1521 Email: rmorison@suwanneevalley.net

ZIM ELECTRONICS INRUSH CURRENT LIMITERS

Inrush Current Limiters are now available from the Electric Radio Store or on-line! These inrush limiters were reviewed in the September 2004 issue of Electric Radio and are available in three versions:

Model AB-1M (With Voltmeter) $34.95
NEW! Model AB-300M **300 watts (2.5 amps x 120 VAC) with meter $39.95**
Model AB-1 (With Pilot Light) $29.95
Shipping, each limiter $5.45
(4 or more limiters are shipped free for US orders. Overseas customers please ask for shipping quotes.)

The Inrush Limiter provides a gentle, slow startup for your valuable vintage radio equipment. They also reduce the line voltage closer to original design values due to the voltage drop across the limiter element. Both models come with a full money-back guarantee.



Model AB1-M

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HALLICRAFTERS SERVICE MANUALS: Ham, SWL, CB, Consumer, Military. Need your model number. Write or email. Ardco Electronics, PO Box 24, Palos Park IL, 60464, WA9GOB@aol.com, 708-361-9012 www.Ardcoelectronics.com

DRAKE INFO FOR SALE: Drake C-Line Service Information. Hi-Res Color photos of boards and chassis with parts identified. CD also includes Hi-Res scans of R-4C and T-4XC manuals, various version schematics and more. Garey Barrell, K4OAH@mindspring.com, 4126 Howell Ferry Rd, Duluth, GA 30096. 404-641-2717

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

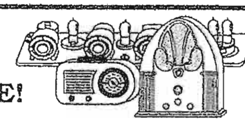
JOHNSON PARTS: EFJ replacement parts: Valiant tie bolts-4 for $18.50. Ranger tie bolts-3 for $17. 80-2CM mic connector (also for Heath/Collins/others) $10 All ppd. Contact Cal Eustaquio, N6KYR/8, 823 W. Shiawasee St, Lansing, MI 48915, catman351@yahoo.com

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

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

FOR SALE: QRP transmitter kits. Step-by-step instructions. Wood model, up to 5

FREE SAMPLE!



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watts 40/80M $15. "Tunatin" one watt 40M $10. You furnish crystal and power. Robert Larson, 1325 Ridgeway, Medford, OR 97504 W7LNG@arrl.net

FOR SALE: URM-25D signal generators, military 28VDC gas generators, AS-2851 antenna kits. Call, Lots more stuff! S. Daniels, 636-343-5263

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

FOR SALE: Obsolete Triplett parts. Send part number and description for possible quote. USA only. Also several tons of transformers, switches, other material that's Triplett surplus. Bigelow Electronics, POB 125, Bluffton, OH 45817-0125

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

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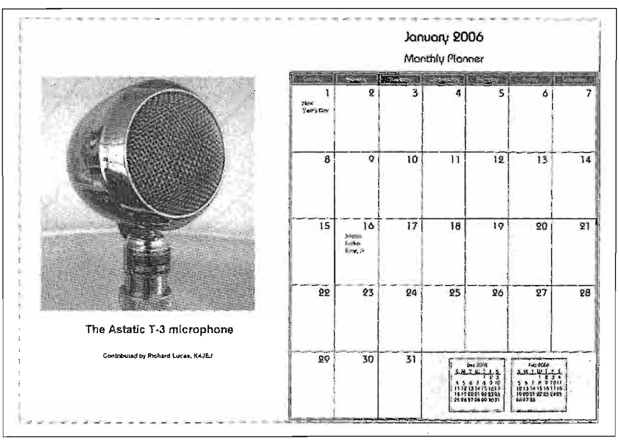
TUBES FOR SALE: Tested good globe 201A and 226 $14, 227 $10 and others. Slightly weak 226, 227, 245, 280 guaranteed to work in early radios ½ regular price. Write or e-mail: tubes@qwest.net for a new price list or see www.fathauer.com. George H. Fathauer & Assoc., 123 N. Centennial Way, Ste. 105, Mesa,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

FOR SALE: 160m FT243 CRYSTALS: 1885,1900,1915,1925,1930,1945,1970, 1977, 1985 kHz. See: http://www.af4k.com/crystals.htm or call Brian, AF4K, at 407-323-4178

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



The 2006 Electric Radio wall calendar is now available from the ER Bookstore.

$11.95 postpaid!

See page 63 for ordering information.

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

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

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

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

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

WANTED: Scott Special Communications receiver, EA4JL. Please call Kurt Keller, CT, 203-431-9740

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

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

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

ACCESSORIES FOR SALE: Spun Aluminum Knob Inlays for most Boatanchors. Collins Dial Drum Overlays. Dakaware Knobs. Charlie Talbott, 13192 Pinnacle Lane, Leesburg VA 20176-6146. 540-822-5643, k3ich@arrl.net

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

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

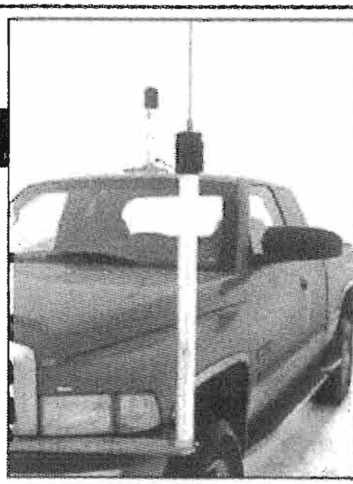
PARTS FOR SALE: Complete hardware set to connect Collins PM2 to KWM2 - $19.95 ppd. Warren Hall, KØZQD, POB 282, Ash Grove, MO 65604-0282.

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

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

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

WANTED: Gonset 3201 Power Sply/Modulator for the G77 Tx and either an R45/ARR7 or R595/ARR7AX. Working or repairable + good cosmetics preferred. Brian Cauthery, VE3DFC, Caledon, Ontario Canada. 519-927-5858



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

w4pnt@highspeedlink.net

WANTED: HP413A. URM-120 wattmeter, must be complete. Mil handbook #216 (coax cable and connectors). Dean Soderling, 6725 Portland, Richfield, MN 55423. 612-869-9264

WANTED: WWII IFF transponder BC-645 in complete, unmodified condition with all tubes. Ted Bracco, WØNZW, braccot@hotmail.com A.C. 217-857-6404 Ext 306.

WANTED: Meter cover and cabinet top for Heathkit DX-60B. Rich Baldwin, KD6VK, richard@wizard.com 919-767-9572

WANTED: WWII unmodified TBY man pack transceiver. Bob, K6GKU, txbobsplace@yahoo.com

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WANTED: New or repainted amp control panel overlay for Johnson Desk KW amplifier. Pete, WØEWQ, pcpatton@comcast.net 651-337-0482

WANTED: Service for my Hallicrafters transmitters. Will deliver/pickup within 4 hours drive of Savannah, GA. Bob, W4WTO, 912-663-4311. armco1@bellsouth.net

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WANTED: Copy of operating manual for RCA BW-66F modulation monitor. Jeremy Punsalan, KH7CN, 1509 Komohana St. Hilo, HI 96720, 808-640-1145, punsalan@hawaii.edu

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WANTED: Pulsating videoraser by Sonar Radio, Model # VP-2001 or equivalent. Contact Bob, K2MYS, at vtsprods@bellatlantic.net or 1-877-891-1002.

WANTED: Collins AC-3803 control interface kit. Icom UT34 tone board. Call Don, W4GIT collect at 352-475-3306. Retired00@alltel.net

WANTED: SX115, HT32B, HT33B and SP600JX21A. Also cabinet for 51J4 and SX73. Ward Rehkopf, 16173 Indian Valley St., Schoolcraft, MI 49087 269-679-3435. radiohound2@yahoo.com

WANTED: ITT-Mackay Marine 3010-C Receiver, late S/N, complete and in good or VG conditions, with original box and manual. The item has to be shipped to a friend in Ohio (not outside U.S.). Send your offer to Paolo Viappiani, Via Valle 7, 19124 La Spezia, Italy, or pviappiani@tin.it

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

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

WANTED: Schematic and info on a USN loop ALR 25, 10kc to 30 Mc, made by Electro-Metrics, NY. KB6BKN@Juno.com

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

WANTED: Tektronix **Type 570** curve tracer, any condition. Ron, AA2QQ, 718-824-6922

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

WANTED: Manual/schematic for Pearce-Simpson Marine Radio "Catalina". JR Linden, K7PUR, PO Box 4927, Cave Creek, AZ 85327 480-502-6396, jrlinden@usa.net

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

WANTED: CONAR Tuned Signal Tracer, mfg for National Radio Institute students. Also radio correspondence courses by National Radio Institute of Washington, DC. George Reese, 380 9th St., Tracy, MN 56175, 507-629-6091

WANTED: Heath SB104, SB102, SB301, SB303, HG108. Hallicrafters SR series transceiver 150-2000. BC348, T195, R392 and others. Jimmy Weaver, KB5WLB, 870-238-8328

WANTED: INTECH COM 6000 Service Manuals: COM3648, COM1000, COM1005 HF SSB Marine radio. Wes, K5APL,870-773-7424

k5apl@cableone.net

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

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

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

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

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

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

WANTED: Searching for RME CT-100 or

3R9 xmtrs and info about them. David Edsall, W1TDD, 156 Sunset Ave., Amherst, MA 01002. 413-549-0349, dedsall@crocker.com

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

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

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

WANTED: Collins 312A1 speaker, National SW5, Eldico R104 and T102, QSL cards from 1920's, 9CXX or W9CXX. Scott Freeberg, WA9WFA, 327 Wildwood Avenue, Saint Paul MN 55110. 651-653-2054 wa9wfa@qsl.net

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

WANTED: Bias and filament transformer from HT33 A or B amplifier. John, W8JKS, 740-998-4518

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

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

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

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

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

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

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

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

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

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

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

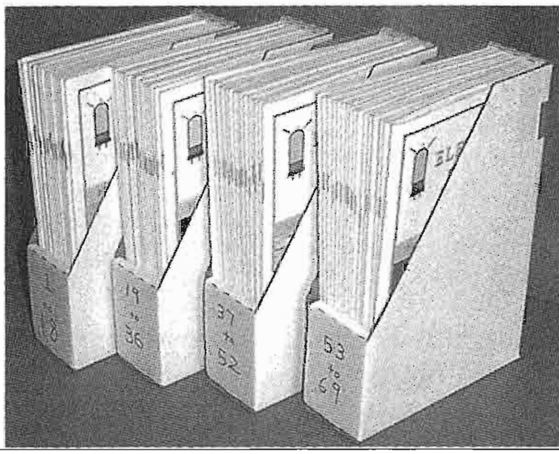
WANTED: SCR-602 components, BC-1083, BC-1084 displays, and APS-4 components. Carl Bloom, 714-639-1679

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

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

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

WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI 16 Carly Drive Highland NY 12528. 895-691-6247 WANTED: Circuit for the "Mitey-Mite" transmitter-receiver. Harold



Schaffner, W2GMX, 519 Perine St., Elmira, NY 14904.

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

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

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

WANTED: Tuning shaft adapters for command receivers. Amphenol 6-pin plug/jack inline connectors. Louis L. D'Antuono, WA2CBZ, 8802 Ridge Blvd., Brooklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

WANTED: KWS-1 RF section in any condition, or a complete KWS-1 for TLC restoration. Also HT33B, prefer operating unit; also seeking an HT20 and Rockwell Collins branded S-line gear. Gary, K2PVC, gschonwald@earthlink.net 917-359-8826.

WANTED: TOP DOLLAR PAID: for BC-610i Tuning Units & Coil Units. Also want xtals for AM portions of 75, 40, 20. Rick Brashear (K5IZ) rickbras@airmail.net 214-742-1800

TRADE: Multi-Elmac AF67 transmitter. PMR7 receiver, M1070 supply for a Eico 720 and 730 modulator. Bill, 701-772-6531, ke7kk@earthlink.net

NOTICE: Expert HRO-500 alignment done with modern test equipment (HP, TEK, etc.) 650-529-9180 www.nortrex.net or nortrex@bigplanet.com

Fairchild 1N4938 switching diodes: Packs of 20 for $11 each, postpaid from the Electric Radio Store! See page 63 for ordering information.

Electric Radio Coffee Mugs!

A new item in the Electric Radio Store is the 15-oz. ER mug. This is a nice white ceramic mug with the ER logo in 3 colors and a maroon-red handle and rim. This large mug is perfect for those long roundtable QSOs and holds a lot of coffee!

$13.99, including priority shipping within the US.

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720-924-0171

Or on-line: www.ermag.com

Electric Radio T-Shirts

The front displays the logo from the cover of ER (the tube logo, Electric Radio, and "celebrating a bygone era"). The back has "Real Radios Glow in the Dark" (used with the permission of Classic Radio). The T-shirts are 100% cotton and come in Small, Large, X-Large, XX-Large. The color is slightly lighter than the cover of ER. $15.50 delivered, $16.50 for XXL.

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Collins KWS-1, 32V series, and 75A series (A1 thru A-3): 43 pages, $15.00 plus $5.00 S&H

— BOOKS —

A. Atwater Kent, The Man, the Manufacturer and His Radios: This 108 page paperbound book describes Atwater Kent's biography, and his rise from a saleman and inventor of electrical equipment to become one of America's foremost radio manufacturers and a household name. There are historic photographs and diagrams on nearly every page, and color plates with vintage AK advertising, by Ralph Williams and John P. Wolkonowic. -- **$25.95 - 10% = $23.35**

A Pictorial History of Collins Amateur Radio Products: Jay Miller's (KK5IM) classic volume describes the amateur radio products produced by the Collins Radio Company. It has high-quality historic photographs on nearly every page, and the text is backed up by Miller's personal research. ---------- **$39.95 - 10% = $35.95**

A Family Affair, The R.L. Drake Story: The complete story of the R.L. Drake story, as told by John Loughmiller, KB9AT. 273 pages all about the history of the company, product descriptions, technical repair tips, and great shack photos make a must-have volume for Drake users and collectors. ---------- **29.95-10% = $26.95**

Arthur Collins, Radio Wizard: 394 pages by Ben Stearns tell Arthur Collins biography from his early years until retirement. Stearns is a professional journalist and was employed by Collins from 1962 to 1977. Many historic photographs and stories from former employees.
---------- **$18.95-10% = $17.05**

Collector's Guide to Antique Radios, by John Slusser. The 6th edition in 320 pages with hundreds of photos and descriptions of long-gone companies and products from 1920 to 1950.
----------**$24.70 - 10% = $22.45**

Communications Receivers, The Vacuum Tube Era: 1932-1981: This is the classic136 page volume that has much invaluable information about vintage receivers in one handy volume. By Raymond S. Moore, 4th edition ---------- **$19.95-10% = $17.95**

Crystal Clear: Crystal Sets, Crystal Detectors and Crystals: A 282 page guide to crystal sets and related equipment made in the US from 1920 to 1955, by Maurice Siever **$29.95 - 10% = $26.95**

NEW! Early Development of Radio in Canada: 154 pages of Canadian radio history by Robert Murray, excellent illustrations on nearly every page covering the early wireless days and the start of radio broadcasting and manufacturing! ---$26.95 - 10% = $24.25

Heathkit, A Guide to Amateur Radio Products: This is the new revised second edition including some 30 additional products, a tube chart, sales data, a separate ER article index, a completely new introduction, and a new section devoted to Heath's CB equipment. The book is 75 pages larger than the original. By Chuck Penson, WA7ZZW---$29.95-10% = $26.95

Heath Nostalgia: Written by Terry Perdue, K8TP, an ex-Heath employee, this 124-page book is a great history of Heath and the Heathkits that we all remember. ------- **$14.95-10% = $13.45**

SPECIAL DEAL! Heath Nostalgia *and* Heathkit, The Early Years CD both by Terry Perdue -- **$27.00**

Heathkit, The Early Years CD: By Terry Perdue, high quality scans of documentation from Heath publications, plus a voice recording of Gene Fiebich. ------------------**$18.95 - 10% = $17.05**

Hiram Percy Maxim: Published by Electric Radio, this is the complete biography of HPM, the famous founder of ARRL, by Alice Clink Schumacher, 216 pages. ----- **$19.95-10% = $17.95**

Miller's Collecting Science and Technology: 160 pages of high-quality color photographs from museum collections make this hardback volume an excellent introduction to this new collecting field. Written by Lindsay Sterling -- **$29.95-10% = $26.95**

The Collector's Vacuum Tube Handbook: This is a 205 page book that is full of unique, hard-to-find information on tube types that were released before 1934. Includes history and good photos. ---**$25.95-10% = $23.35**

Radio-Craft: 50 Years of Radio by Gernsback: This is a high-quality 656-page reprint of the March 1938 edition of Radio-Craft magazine and is about the first 50 years of radio, and contains hundreds of vintage advertisements. --------------------------------------- **$15.95-10% = $14.35**

Radios by Hallicrafters : High-Quality photos, descriptions, approximate values, and short histories of nearly everything made by Hallicrafters. By Chuck Dachis -- **$29.95-10% = $26.95**

Radio Tubes and Boxes of the 1920s by Fathauer: If you appreciate the rare and colorful vacuum tubes and advertising art from the early days of radio, then this great 104-page book will be very interesting and informative. -- **$26.95-10% = $24.95**

The All-American Five Radio: Although this book is about classic American 5-tube broadcast receivers, it also contains a wealth of accurate information on vacuum tube receivers, proper trouble-shooting, and alignment and is recommended for experienced repairmen and novices alike. 92 pages by Richard McWhorter --- **$21.95 - 10% = $19.75**

Transmitters, Exciters & Power Amplifiers : This is the companion volume to Moore's communication receiver book, by Raymond S. Moore, 144 pages. ------------- **$21.95-10% = $19.75**

Tube Lore: The best vacuum tube reference book in publication! All types of information is included, such as tube date code information and production history. 173 pages by Ludwell Sibley --**$16.95-10% = $15.25**

Tube Testers and Classic Electronic Test Gear:Written by Alan Douglas, a retired engineer, the book is packed full of valuable information about test equipment 166 pages. --**$29.95-10% = $23.35**

Understanding, Building, and Using Baluns: by Jerry Sevick, W2FMI. This is W2FMI's updated version of his classic book that gives detailed information about many commonly-used baluns in amateur radio. --- **$19.95 - 10% = $17.95**

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Zenith, The Glory Years, 1936 to 1945: 244 high-quality pages all about classic Zenith radios. Hundreds of high-quality color photos, and history from the Zenith company archives, never before available. If you like beautiful Zenith consoles, you will like this book! by Cones, Bryant, and Blakenship -- **$34.95 - 10% = $31.45**

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