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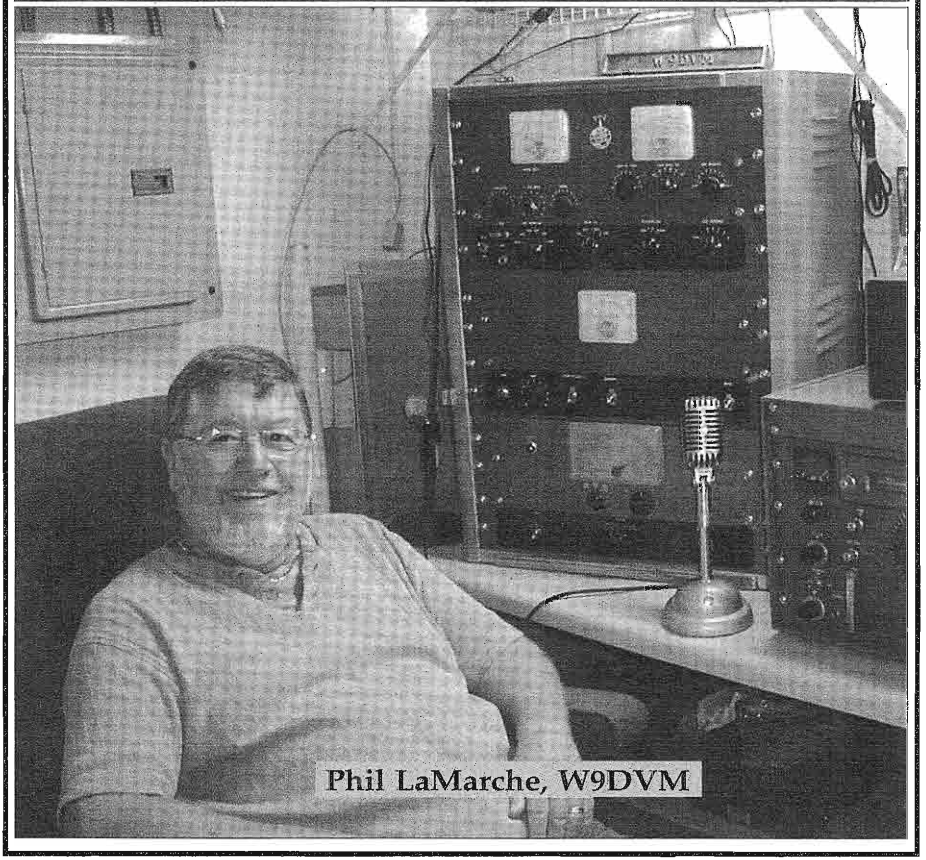
ELECTRIC RADIO

celebrating a bygone era

Number 176 January 2004



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ELECTRIC RADIO

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

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

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

Editor's Comments

Winter 2004 Classic Exchange

The Classic Exchange "CX" CW/Phone event is planned to take place from 1400Z Feb 8 to 0800Z Feb 9. Frequencies (MC) are: **CW**-1.810, 3.545, 7.045, 14.045, 21.135, 28.180; **AM**-1.890, 3.880, 7.290, 14.280, 21.380, 29.000; **SSB**-3.870, 7.280, 14.270, 21.370, 28.490. Exchange: Name, RST, QTH, and type of transmitter and receiver. You can work the same stations again with different equipment. Your score is determined by the age of your equipment. Send logs and questions or comments to WQ8U@arrl.net or J.D. "Mac" MacAulay, WQ8U, 6235 Wooden Shoe Ln, Centerville, OH 45459-1557. This is always a fun event everyone looks forward to operating in.

BPL Update

The Federal Emergency Management Agency (FEMA), which is now part of the Department of Homeland Security, has filed comments in opposition to BPL. Here are some partial FEMA comments from ET Docket No 03-104:

"IV. SUMMARY

The HF spectrum is a unique resource for survivable, long-distance fixed and transportable communications that are independant of fragile infrastructure. Other communications media cannot meet FEMA's requirements for disaster response and other mission-critical communications. Other users of the HF spectrum are similarly affected by the proposal, and only HF radio can meet their needs as well. Implementation of BPL under the present or relaxed emission restrictions would make HF radio unuseable, depriving our nation of an invaluable and irreplaceable public safety resource. The purported benefits of BPL in terms of expanded services in certain telecommunications sectors do not appear to outweigh the benefit to the overall public of HF radio capability as presently used by Government, broadcasting, and public safety users."

I will have more on BPL in a future issue of ER. 73, Ray, NØDMS

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Cover: Phil LaMarche (W9DVM) operates his great looking Globe King 500 and National HRO-Sixty station from Palm Harbor, Florida. A classic Shure microphone makes the installation complete.

Thinking Back

by Bob Shrader, W6BNB
11911 Barnett Valley Road
Sebastopol, CA 95452

When I think back on "radio" things I can go back some 80 odd years. Well, maybe they were all not all odd, but I digress.

In 1922, when my father and mother went back east with the Oakland California Realtors Glee Club to sing the praises of our great city Oakland, they farmed me out to "Aunt Mabel". They also bought me a little 4" x 2" x 1" wooden-boxed crystal detector receiver and earphones to keep me out of her hair. The little radio is titled B. M&T Co, and "BEAVER, Trade Mark, BABY GRAND". On its Bakelite top surface it also sports an antenna, a ground and two earphone screw down connectors, two tiny 10-contact rotary switches, the crystal in its holder, and of course the cat whisker to make contact with the crystal and its rotatable control. The single bunch-wound multiturn internal coil is tapped every single turn for the first 10 turns. In series with these are taps every 10 turns on the coil for the next 100 turns. The ground is connected to the rotor of the single-turn taps switch and the rotor of the 10-turns per switch contact goes to the remainder of the coil and to a small condenser (capacitor?), the other end of which goes back to ground. The antenna connection is made on the coil somewhere. The crystal diode is in series with the earphones and is across the condenser. With this little set I could pick up a dozen or so different broadcast stations in the San Francisco Bay Area. I still have it sitting up on the top shelf in my ham radio shack. It works quite well if it is hooked up to an antenna and ground and if used with its high-impedance earphones.

I am sure Aunt Mabel would have had a heart attack if she had seen me, at 9 years of age, up on the top of her 3-story home stringing my 100' roll of copper wire over to a tree for my antenna. My ground connection was to an indoor water pipe.

When the folks came home I moved my antenna to our house and began building my own variations on crystal set circuits. I did a lot of experimenting with antennas and grounds. Have you ever used the metal springs of your bed for an antenna? It does work, although a long ground lead to the bathroom probably helps a lot. There was the requirement of keeping the room quiet enough so that the broadcast program from one of the stronger local stations could be heard all the way across the room using an old high-impedance horn type, "Dicto-Grand Radio Loud Speaker". That same old horn speaker is on the shelf right under the Baby Grand and still works when they are connected together!

During the middle and later 20s there were times when I tried to learn the Morse code by sound and also with long, 2-handed signal flags with the Boy Scouts.

In the late 20s I found that my friend two houses down the street wanted to learn the radio code too. We found that if we connected an antenna wire to one side of our code practice buzzer's coil and a ground wire from a plumbing pipe to the other end, radio signals could be radiated from one house to the other and be picked up on our crystal radio sets! We had invented

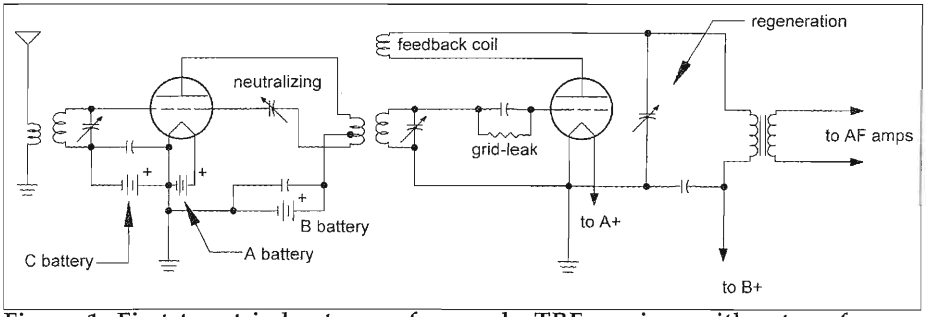

Figure 1: First two triode stages of an early TRF receiver with a transformer or inductively coupled antenna circuit.

some kind of radio transmitters - so we thought. They were just low power spark-gap transmitters.

Then came the triode vacuum tube (VT) days! Boy, could one of those things as an audio frequency (AF) amplifier make crystal detector signals LOUD! Now all kinds of local stations could be heard with my crystal radios all around the room from the loud speaker. It wasn't necessary to shuuush everybody in the room to hear the program being picked up, either.

Then triode VT detectors were tried. If a C battery biased the control grid of a triode tube just to the point of plate current cutoff, nice loud broadcast station signals could be produced. Then it was found that a high-resistance resistor in parallel with a small capacitor in series with the grid circuit could produce "grid-leak" bias. Next came the use of a regenerative or feedback coil from the plate or output circuit to the control grid or input circuit. If the regenerative energy was adequate and in the correct phase, the detector circuit went into self-oscillation, generating RF energy at its tuned circuit frequency. Now a whistle "heterodyne" or "beat tone" could be heard when tuning across unmodulated signals. Right at the verge of oscillation these detectors became extremely sensitive for broadcast signals. This resulted in a lot of all-night DX listening for stations back in the mid-west and even a few on the east coast.

When ship radio signals were tuned in they would be sending in code, but they were going too fast for me. In high school I joined the amateur radio club and practiced with the more advanced members to get my code speed up to the required 10 words per minute. Eventually came that great day when I went over to the Department of Commerce in San Francisco (later to become the Federal Communications Commission) and took the test for a Class B Amateur Radio License - and passed it! As soon as the required one-year had elapsed I went over again for my Class A Amateur License, the highest-grade amateur license there was at that time.

After graduating from high school in December of 1931, I enrolled in the Oakland Central Trade School's Radio Communication Class. After a couple of months I passed the Radiotelegraph Second Class Commercial License. Then, in the depths of the great depression I had to try to get a job as a radio operator to use my license! Not an easy task, as I found out.

During the many hours of spare time I experimented with many VT radio receivers. There were many types of radio frequency (RF) detectors, followed by audio frequency (AF) amplifiers that really whooped up the received signals. One standard receiver used a tuned RF amplifier feeding a detector (often a "regenerative" type)

plus one or more AF amplifiers, making up a "TRF radio". The circuits used were something like those shown in **Figure 1**. A, B, and C batteries powered these receivers. The A battery heated the filaments, the B was for the plate voltages of all tubes, and the C batteries produced the grid bias voltage for the amplifiers stages. To adequately drive loud speakers to high volume at least two transformer-coupled or later, resistance-coupled, AF amplifier stages were needed. Paralleling two tubes, or operating them in push-pull could further beef up the output stage, or with four tubes they could be operated in push-pull-parallel. Lots of different kinds of audio transformers were needed for all of these experiments. It was often necessary to tear down old iron-core transformers and rewind them for the various filament voltages that might be needed and also for the high voltages needed in VT amplifier power supplies. Such transformers could have been purchased, of course, but who had that kind of money in those days?

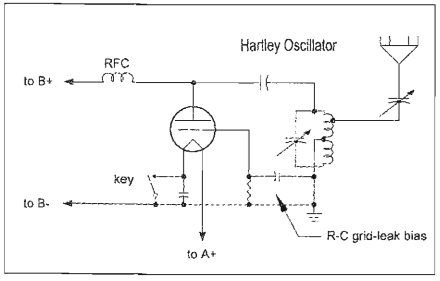

Figure 2: Hartley oscillator CW transmitter with a direct-coupled antenna.

My own experimental transmitters started out as simple single oscillator circuits, like the Hartley, the tuned-plate-tuned-grid (TPTG), the Colpitts, the crystal, etc. An example of one possible telegraph key operated, continuous-strength output wave, or "CW" circuit is shown in **Figure 2**. The RF choke, or RFC coil passed battery DC but stopped any RF AC. To produce

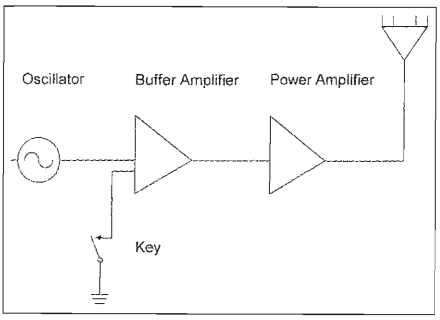

Figure 3: Block diagram of a 3-stage oscillator, buffer, and power amplifier MOPA CW transmitter.

more stable power output, one or more tuned RF power amplifiers had to be added. Early triode VT type RF amplifiers had to use neutralizing circuits to prevent them from breaking into oscillation. Such a circuit is shown in **Figure 1**. When tetrode and pentode tubes came into being they needed no neutralization, which made circuit tuning and operating much simpler. A "block diagram" of one possible 3-stage CW type Master-Oscillator-Power-Amplifier, or MOPA transmitter circuit is shown in **Figure 3**. Buffer stage keying was usually desirable to prevent transmission of key clicks and chirps.

Up to the mid '30s the transmission of voice and music was accomplished only by using "Amplitude Modulation" or AM circuits. A beginners first AM experimental circuit was usually to "loop" modulate the antenna or tuned circuit of perhaps a simple oscillator using a carbon-granule microphone, as in **Figure 4**. Those carbon-button telephone type microphones (I wonder where we got them?) had metal diaphragms which, when pushed in and pulled out by sound waves, alternately compressed and decompressed their internal carbon granules to alternately produce lower and higher resistance values. This was increasing and decreasing loop current and power dissipation in the microphone, which would subtract variable amounts from the to-

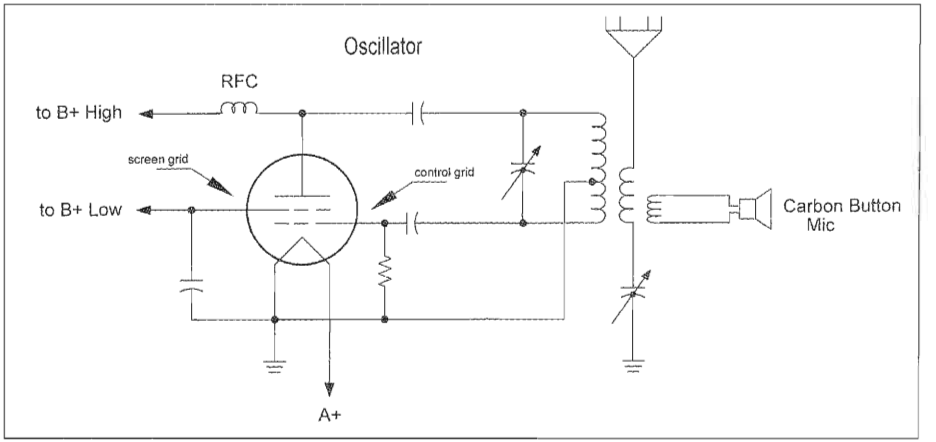

Figure 4: Loop modulator in the antenna circuit of a tetrode tube Hartley oscillator transmitter.

tal RF power transmitted by the antenna, resulting in an up and down, or modulated radiated power. We later found out that it was probably producing more frequency modulation (FM) than AM, but who cares, it produced a modulation that could be detected by those old receivers.

More practical methods of producing AM were to vary the different voltages applied to the vacuum tubes, resulting in varying strength RF output signals. One idea was to vary the vacuum tube's plate voltage. This was usually done in one of two ways, by adding audio frequency AC in series with an RF amplifier's plate voltage with either an AF "modulation transformer", **Figure 5**, or by using an iron-core AF choke coil of several henrys in series with the plate circuit, as in **Figure 6,** known as Heising plate circuit modulation. In **Figure 5**, if the plate supply voltage was 1000 V DC and the AF AC added in series with the power supply voltage peaked at 1000 V, the

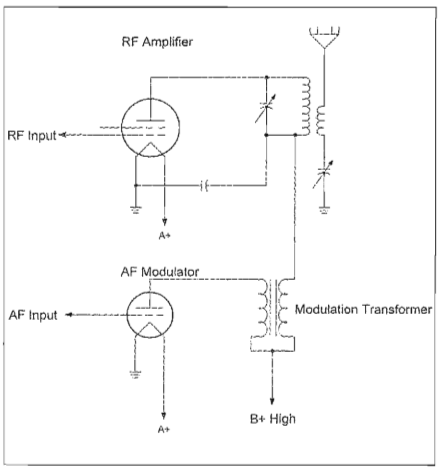

Figure 5: Transformer type plate modulation circuit.

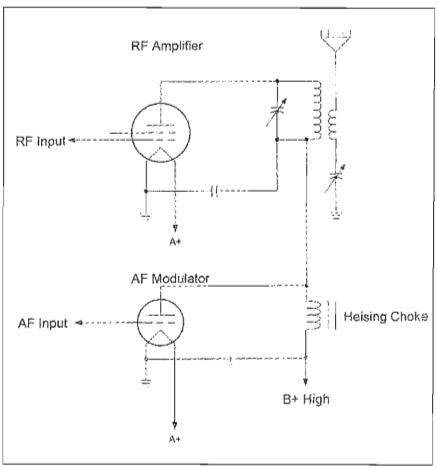

Figure 6: Heising choke coil plate modulation circuit.

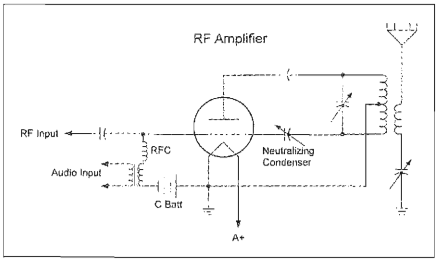

Figure 7: Control grid modulation of a triode RF amplifier.

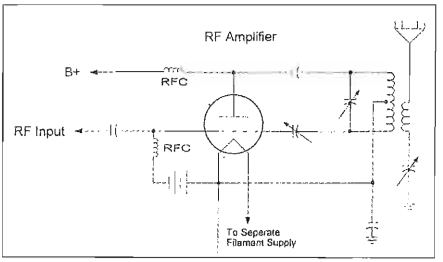

Figure 8: Series type AM circuit.

actual voltages being applied to the plate would be varying from 2000 V to 0 V at the AF rate. In the case of the "Heising" modulation choke circuit in **Figure 6**, when the AF amplifier's plate current was increasing or decreasing though the AF modulator choke coil it induced an AF AC voltage across its turns which, being in series with the power supply voltage, varied the RF tube's plate voltage. As the AF amplifier tube's plate current varied so did the RF tube's plate voltage, producing an AM RF output.

The plate current of a VT also varies with any grid bias voltage variation in the grid circuit of a tube. So, a modulating transformer between the control grid bias voltage supply and the grid produced a varying power output from the RF amplifier. Such a circuit is shown in **Figure 7**. While the power output might also have been changed by changing the temperature of the filament or cathode of tubes, such a change would be very slow and could not follow audio voltage variations, so there were never any filament AM circuits. But when tetrode and pentode tubes were used, their "screen" and "suppressor" grid voltages also controlled the plate current, so AF applied to them through an audio transformer, as with control grid modulation, produced AM.

If an AF triode amplifier was connected in series with an RF amplifier's filament to plate circuit, as shown in **Figure 8**, "series type amplitude modulation" resulted.

If a transmitter had an oscillator, a buffer first amplifier and a final power amplifier, the buffer stage could be amplitude modulated. Any varying RF drive to the power amplifier's grid circuit made its RF output vary. However, modulating the power amplifier this way produced only about 30% final amplifier efficiency, whereas plate modulation of the final amplifier operated at about 60% efficiency of the power input. With plate modulation, an RF plate power input of 1000 W required 500 W of audio power to produce 100% modulation. That is a lot of audio power! With grid and screen grid modulation only a couple of watts of audio power were needed. There was no "best" circuit to produce AM.

In the early days, amateur radio operators built essentially all of their transmitters, receivers, power supplies and antennas. Many smaller radio parts could be purchased at Woolworth's 5 & 10 cent stores, but the amateur himself manufactured many. There was no going to a store to buy an amateur receiver or transmitter. There were no such things as transceivers, single-sideband (SSB), or frequency modulation (FM) equipment. These did not show up to any great extent until the 1940s and 1950s. SSB was so complicated that only a few amateurs built such transmitters. But it wasn't long before such rigs were manufactured by radio companies and amateurs began buying ready-made equipment rather than building it. Much of the "building"

today is merely putting together kits of parts that are purchased from some manufacturer.

Getting back to trying to find a radio operators job--among other trials, I contacted the Dollar Steamship Line radio people, but there were no jobs available in 1932 and into 1933. The man in charge of radio operator hiring (Mr. Pelmulder) suggested that I go out to their code station once a week and practice copying code on their typewriters. After about six months of this 3-hour each way travel from Oakland to San Francisco by ferryboat, then way down the coast to the radio station for a couple of hours, one Tuesday I was advised that there was an assistant radio operator's job leaving pier 44 in San Francisco at 4 PM on Thursday. What a rush to come up with the required blue, white and khaki uniforms in time to get on board on time! But I was on watch as we sailed out the Golden Gate on our way to Honolulu and around the world! I was handed a message for coast station KPH to advise that the SS President Harrison was on its way out of San Francisco bound for Honolulu. Unfortunately when I turned on the transmitter and called KPH on 600 meters wavelength (500 kc, or if you prefer, kHz), it was right smack in the middle of the 3-minute Silence Period that is set aside 15 and 45 minutes after every hour of every day when all stations must listen for distress or emergency traffic on 500 kc. Oops! I was told by KPH to "QRX SP" meaning stop sending during the SP. What a start for a beginning operator after only half an hour on watch!

In those days the Dollar Line used 1 KW self-excited Gammatron triode tube oscillator transmitters, using high voltage 500-cycle (hertz?) AC as the plate voltage. It produced an over modulated broad AM RF signal that was used on both the 500 kc distress frequency and any of the adjacent "working" frequencies. Our antenna was a single wire that ran from the transmit-receive antenna relay up to the main mast and then to the foremast, a length of about 300 feet. It was also used on all of the six high frequency ship-to-ship and ship-to-shore bands. These transmitters always drifted a couple of kilocycles (kilohertz?) after a few minutes of operating. The operator had to try to keep one hand on the receiver tuning dial and of course two hands on the typewriter, or "mill" at the same time. It was quite a feat. Actually, because of the distorted AM, CW ("MCW") put out by the transmitters their signals could be heard across about 5 kc of a receiver's dial. So the drifting was not as much a problem as it would be with today's narrow-band receivers and unmodulated transmitter code signals. Essentially all code copying was done with typewriters. Pencils or pens were only used for keeping notes and log entries.

We also had a 2-kW "quenched-gap" spark type transmitter for use on 500 kc and adjacent frequencies. Spark transmitters put out a very broad signal; it was hard to miss a call to you when it was made with a spark transmitter. It used the same 500-cycle (hertz?) AC "alternator" (generator) that was rotated by the same 110-V dc motor used to power the VT transmitter. This gear was located in an enclosure outside of the radio station room.

There were two receivers. One was an "IP 501a" regenerative detector with a 2-stage AF amplifier working into earphones, or usually a loudspeaker. It was kept tuned on 500 kc to listen for distress or emergency traffic, or any calls for our ship. It was connected to the transmit-receive antenna relay. With nothing happening, the antenna was connected through the relay to the monitor receivers. If the operator closed a transmitter key it also closed the circuit to the relay, which switched the antenna to the desired transmitter.

When the key was opened the antenna went back to the receivers. This allowed, "break-in keying", meaning that you could hear the other station if it wanted to stop you while you were sending. This was very handy when sending and receiving messages. Many ships did not have such capabilities in those early days. Mounted on the front panel of the IP 501a was a little crystal detector. It could be switched in and used as an emergency receiver if the batteries in the receiver ever went dead. Luckily ours never did!

The other receiver was a tuned-RF stage into a regenerative detector followed by two AF amplifier stages. Since it was used for almost all message handling and weather reports only headphones were used with it. It could be tuned to all of the HF bands as well as the medium frequency (300 to 3000 kc) or MF, 500 kc frequencies. It was also connected for break-in keying. On some ships there was also a separate shortwave antenna, but many ships used only the one longwire. Both of the transmitters and both of the receivers had their own antenna tuning or peaking circuits built into them.

There was also a big set of 110 volt emergency batteries (54 cells to check!) that had to be kept charged at all times. All ships in the early days used only DC power — no AC. If the ship's 110-V DC power was ever interrupted, as in a disaster, the radio batteries could be switched to operate the radio station for hopefully whatever time was required to handle its emergency traffic.

Because the Dollar Line ships always carried two or three radio officers, they did not have to have an "Auto Alarm receiver" aboard. An AA receiver was tuned to only 500 kc. It was turned on when the single operator on the ship went off duty. When sending an SOS a radio operator is supposed to send one minute of A-second dashes spaced by I-second intervals before sending the distress traffic at 18 words per minute. When the AA equipment hears three such dashes it rings bells in the radio shack, in the radio operator's room and on the bridge. When I was on a little single operator ship with an AA receiver when sailing down to Panama, at first I was constantly answering false alarms. It seems that distant and local lightning crashes often will produce a series 00.5 to 4.5 second and 0.5 to 1.5 seconds of near silence, for which AA circuits are timed. I soon found that by reducing the RF amplifier gain on the receiver, weak distant noises would not set off the AA circuits and sleep was possible. The little rust bucket I was on had a top speed of 8 knots and would never have covered any long distance in a reasonable time. If the ship in distress was close enough for it to be within our travel distance range even with the reduced receiver gain its signals would have been strong enough to set off the AA properly.

When I had to send my only SOS the SS President Hoover was being bombed by aircraft and I just didn't want to linger around for 60 long seconds before letting it be known that we were under attack. We had already been hit a couple of times. Luckily we were close to Shanghai, which had excellent radio operators at XSG, the Dollar Line station there. They had no trouble reading my 25 WPM SOS transmission.

After six trips around the world and a dozen or so to the Far East, plus some shorter Honolulu and Panama trips I jumped ship and became a deputy sheriff for Alameda County in their radio communication division. There I used code as well as voice communications in the 911 type work we did at that time. In one case all of the operators were also involved in building and installing our 15-W AM mobile transmitters and their 30-mc (MHz?) antennas. Since the base station was on 1658 kc, it was only necessary to tweak the broad-

cast receiver in the squad cars from their highest broadcast band frequency, usually about 1550 kc, to our base station frequency.

In mid-1941 I had picked up a 2-afternoons a week, 2-hour radio teaching job for merchant marine cadets on Treasure Island. After Pearl Harbor I volunteered as a USCGR officer and was assigned to teach radio full time to cadets at the U.S Merchant Marine Academy at Kings Point LI. NY. After the war it was back to being a deputy sheriff again, but I soon moved into another teaching job, this time at my old Oakland Central Trade School, later to become Laney College. While there, in 1958, I wrote a 900-page text to cover my day and night radio courses, "Electronic Communication", now in its 6th edition. Its first edition was the last text I know of to delve into the theory of both spark and arc transmitters. Several other books followed, all in the radio, electrical and electronics fields, until I wrote a Fire Fighting textbook in the late 90s. But, that is another story.

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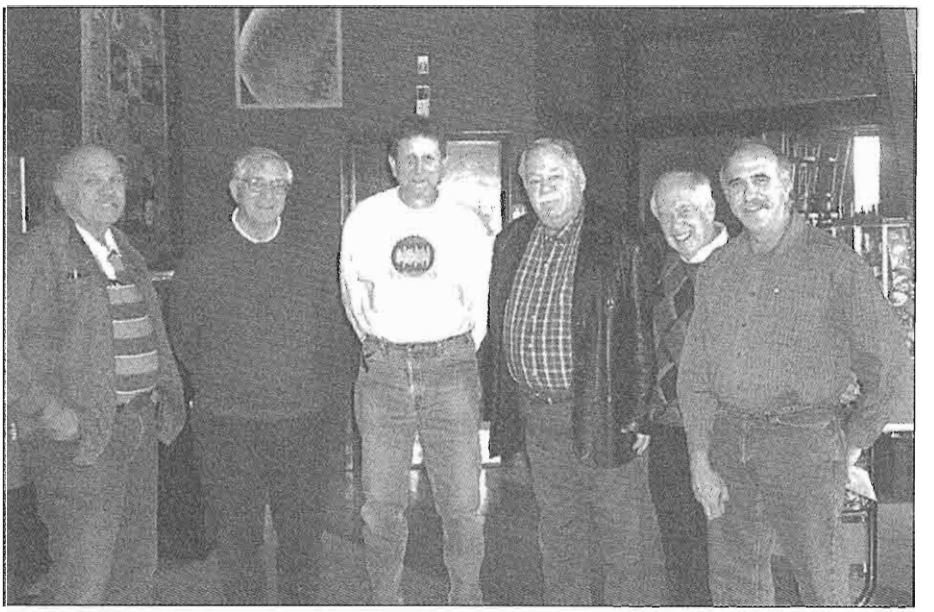

In the greater Phoenix, Arizona area an active group of AM'ers have a 2-meter vintage AM net each Tuesday night at 1730 hours MST on 145.450 MC. Several of the 2 meter AM-ers got together on Monday, December 29th, 2003 for a luncheon. From left to right are shown Max (K7CAX), Larry (KO6SM), Tom (NE7X), Warren (K7SA), Ernie (W7CCC), and Dave (N7RK). (Photo courtesy of NE7X.)

The HSR-2: Homebrew Superhet Receiver 2 Part 1

by Brett Gazdzinski, N2DTS
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I wanted a complete home brew station, and since I have various homebrew transmitters, only a receiver was needed. At first, I thought I would build something simple that worked just well enough to be able to copy AM under good conditions, just so I could say I had a homebrew station. But I wanted something a little better than the regen receiver type of radio, maybe a simple superhetrodyne. I did loads of research, looked in Bill Orr and all my old ARRL handbooks for simple receivers. All the circuits had some sort of problem, complex tapped coils, hard to get parts, poor designs, etc. I also looked at the diagrams for things like my Gonset G76, the Scott model SLR-M I have, the Hallicrafters SX-17, and the R-390.

I decided to base the receiver on the Scott SLRM, since it works very well, has good fidelity, uses 8 pin tubes and a 455Khz IF. I ran into problems though, as the Scott was built to reduce emissions out the antenna, with loads of shielding and an RF amp with tuned circuits. Some changes would be needed.

I accumulated parts, and started con-

The homebrew superhet at N2DTS is in the center of this photo, with the audio distribution equipment to the right. A Behringer speech processor is above the HBS-2, and to the far left are an R-390A and the trusty SX-17.

struction with the basic layout with tuned circuits on the antenna input and RF amp output, a separate local oscillator and mixer, two stages of IF amplification, hifi detector, S-meter circuit, AGC circuit, and power supply.

Since it was to be experimental, I used octal sockets for everything, the antenna coils, the local oscillator coils, and the IF transformers. This allowed much experimentation without drastic changes. So the receiver started out with plug in coils to change bands.

I laid out all the parts, leaving room between things to allow for experimentation, and mounted the basic parts.

I tried various circuits for the local oscillator, using coils wound on ceramic forms, B&W coil stock, and slug tuned ceramic coil forms. This step would have been very difficult without the aid of a very nice spectrum analyzer I have through work. It allowed me to look at the frequency output, harmonics, hash, drift, frequency range, amplitude, all at the same time.

At first, I went with plug in coils in the local oscillator, used the RF amp, using the spectrum analyzer to peak things and check gain. The RF amp seemed to work well, the mixer was easy, then into a filter. I planed on using a mechanical filter, but they are expensive, and a little tricky to put in the circuit. I found a company on the web, Kiwi, who makes various filters, and went with one that has an op amp input, three bandwidth filters of slightly different center frequencies and an op amp output, and runs off 10 to 30 volts DC. There is no loss through the filter, and its quite similar in results to a mechanical filter. I used a 5.5kc model. It mounts on Velcro, and has pig tail shielded wires to hook up to the IF system. This filter is easy to add to any receiver using 455 KHz as an IF, and really works fantastic, and only costs $50.00.

I copied the IF system out of the Scott, and used a hifi detector from one of the AM web pages. It took some experimentation to get the AGC takeoff and IF gain control systems working well, then I added the S-meter circuit I stole out of the Bill Orr handbook that uses a 6SN7.

Taking the receiver for a test drive revealed some problems. Startup drift was excessive, muting the receiver seemed impossible, the RF amp caused all sorts of problems, and the IF amps were unstable. A lot of these problems were due to the excessive space between tubes and the IF cans, etc. As a test, I hooked the antenna up to the mixer input and bypassed the RF amp, and had very good results, so I removed the RF amp completely, and went with two tuned circuits then into the mixer. Some experimentation with the antenna link on the input coil boosted gain quite a bit. I ordered a selection of NPO caps, and did weeks of experimentation on the local oscillator stability, changing components, design, putting the coil in a metal can to shield it, and got the stability much better, but still had startup drift for the first 5 minutes.

Careful shielding and reducing the gain of the IF eliminated the odd oscillations I got at times, and the receiver was working quite well. I did not like the tuning dials I had, marking the frequency was hard with the drift, and I have a real problem marking the frequency so it looks nice on the dial. I needed something better, and found the almost all digital electronics digital frequency readouts, basically a frequency counter with a selectable frequency offset. You program the thing to offset the IF frequency, in my case, 455Khz lower, and all you need to do is get the pickup close to the local oscillator tube, and the display reads the exact receive frequency down to 1000 Hz. I used their backlit display, which looks nice, and a real accurate frequency

readout is very nice to have. These units will work with ANY receiver, and cost about $100.00

The performance of the receiver was astounding! With the transmitting antenna I used, sensitivity was very good, fidelity was great. I use a Marantz amp on all the receivers in the shack, into a big three-way speaker, and the homebrew sounds the best because of the low distortion fi fi detector, I guess. The biggest surprise is the noise level. Since the tube count is low, and the mixer design is a quiet one, the receiver is incredibly quiet. One mixer tube, two IF amps, a detector, and that is it! Its MUCH quieter than anything else I have, or have ever had. Forget the modern rigs, the IC chips just can not run quiet, and there are so many of them in modern rigs that the noise and distortion in any modern rig I ever used is way high. Comparison to my very well working R-390A was dramatic, I could CLEARLY hear signals that were well under the hash level of the R-390A, the signals were unreadable on the R-390A, but very good comfortable copy on the homebrew receiver. When using the transmit antenna sensitivity is great, signals that don't move the S-meter can be copied, strong signals will drive the S-meter up to 50db over S9, with no sign of overloading. With a poor antenna, weak signals might be hard to copy, but I have not tried it that much. I have been unable to detect any problems with birdies, images, or other odd behavior.

After the results I got out of the homebrew, the plan changed from something I could use sometimes, just to have a complete home brew station, to the receiver of choice. This caused problems. I had the receiver mounted in a rack cabinet, and had to run around back to change the plug in coils, a real pain over time. So out came the receiver, and a new front panel and band switching was added, along with 160 meters. Tuning was changed to a system using TWO back to back vernier drives, the tuning range was changed to cover only part of the ham bands, giving very nice slow tuning range. A BFO was needed for zero beating AM signals, so I found and built a 455Khz crystal oscillator circuit, with a variable output level by way of a pot in the screen voltage. The level control is on the front panel. The BFO also allows me to copy CW and SSB quite well without a product detector. I can listen to the SSB guys complain about the guys running AM. The receiver moved into a cabinet on the operating desk, and was integrated in the shack with muting and antenna switching, and is the main receiver now, the others are almost never used.

The only problem the receiver has, and it does not bother me, is the startup drift. From a cold start, it drifts about 2kc over about 5 minutes, then is rock stable. This might be due to the choice of octal tubes, the actual tube used effects the drift quite a bit. Experimentation with NPO caps can reduce the drift, but it starts drifting the other way over longer periods of time, and I think it's better to have 5 minutes of drift and stop, rather than drift less but over longer periods of time.

I was quite surprised about how easy it was to build, and how much raw fun it was to design the thing, and do all the testing and development. You sure do learn a lot when you build something step by step, without any overall design to start with. Every system must be analyzed, built, tested, changed, other things tried, etc.

The end result looks a little rough inside, as it was changed quite a bit, deleting the RF amp, adding band switching, etc, but it still looks ok. Its been totally reliable and stable for about a year now, with quite a lot of use.

My next project is a superhet receiver using 7 and 9 pin tubes, using things I

learned from the first one: Start off with band switching, Forget the RF amp, it's not needed on the low bands at all. Do NOT leave a lot of space between things, but put the tube sockets and IF cans as close together as possible, along with the local oscillator parts and band switch. It will also include two filters, 4.5Kc, and 5.5Kc. The 5.5 was a great overall choice, but a 4.5 will help when things get crowded on the bands. Building a good receiver for AM reception is not as hard as most people think, and I encourage people to give it a try.

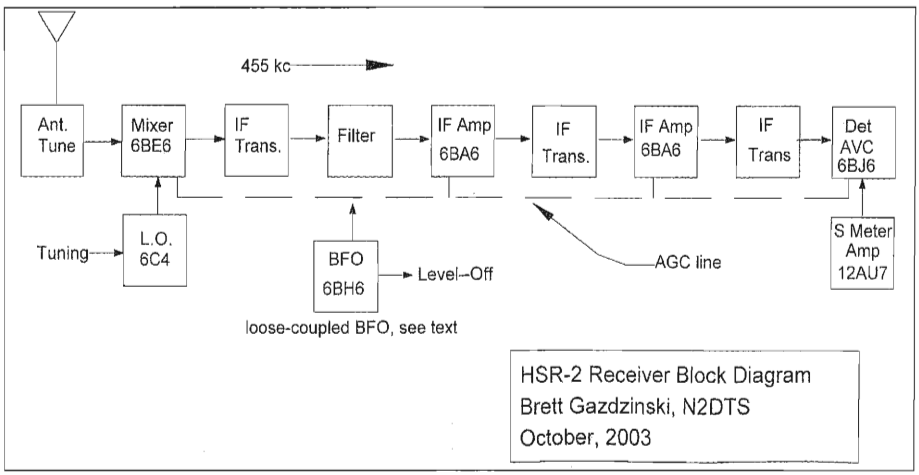
I have no formal electronics background, all I know I got out of books and by playing around, so if I can do it, almost anyone can. The older ARRL handbooks, around 1965, are full of very useful info on building receivers. Parts are not a limitation, although it may take some time to assemble all you need at a reasonable cost. Things like IF cans can be gotten out of old tube radios such as old table top AM radios . Other good sources of parts are Mouser Electronics, Antique Electronic Supply, Hamfests, and even Radio Shack.

You may find you can build something better than anything you can buy for almost any price, as YOU pick what is important. I only wanted part of 80 and 40 meter coverage, low noise, and hi fidelity, along with reasonable frequency resolution. Old tube receivers like the Scott SLR-M, SX-17, and the SX-28 can be quiet and have hi fidelity, but lack frequency resolution, good filters, and cover more bands than I need. Newer tube receivers like the R-390 series, the Collins 75-A series, the National NC300/303, Drake, and others have some good points,but lack fidelity, bandwidth choices, look ugly as stink, or have some other drawback. All new ham equipment seems to be very high in noise and distortion, and you may THINK some of that stuff sounds good, until you compare it to a good AM signal through an old tube hi fidelity receiver like the Scott SLR-M or the SX-17. Even with output from the detector into a good hi fidelity amp and speaker, there is no comparison between the new and old stuff on AM.

I integrate all the receivers into the Marantz amp, and I can jump between various receivers quickly, all tuned to the same signal, and the difference in audio is dramatic. I have tested many Kenwoods, Icoms, and others and they are all poor receivers for AM if you want fidelity.

[Next month, the circuit details--Ed.]

ER



The DX-60H

by Bruce E. Stock, AB7YD
Ab7yd@earthlink.net

No, Heath never made a DX-60H — but you can, and it is very simple. The "H" stands for Heising, and this article will show you how easy it is to beef-up the modulation in your DX-60. You just add a tube, a choke, and some small parts and you're ready to get on the air with a lot more punch.

As designed, the DX-60 was an excellent entry-level transmitter, with good looks, good parts quality and good performance on CW. However its controlled-carrier screen modulation always put it at a disadvantage when compared to plate-modulated transmitters such as the Ranger or Elmac AF-67/68. By adding Heising modulation to your DX-60, you can make it a much more potent AM performer.

The idea for this conversion came about when Steve, KF7EH, mentioned an article in a 1950's issue of CQ magazine, which described a form of high-efficiency Heising modulation. One of the reasons that Heising modulation fell out of favor was that it used a single-ended class A modulator tube, which has very low efficiency when compared to the class B or AB stages commonly found in push-pull high-level plate-modulators. However, by shifting the operating point of the Heising modulator tube in proportion to the amplitude of the audio signal, the power dissipated in the tube can be minimized considerably.

It occurred to me that a different way to get efficient Heising modulation would be to use the DX-60's controlled-carrier modulator to provide both audio drive and operating point shifting for the modulator tube. **Figure 1** shows

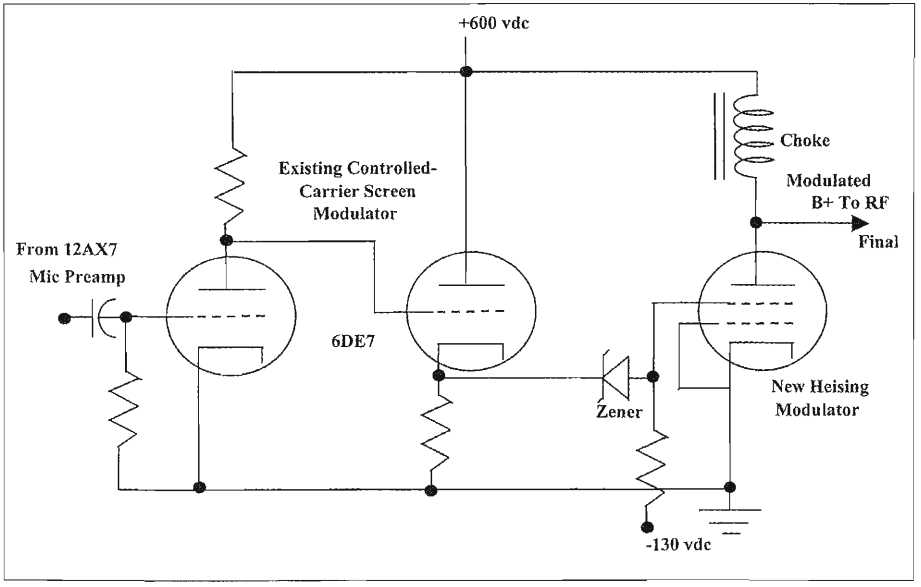


Figure 1: The basic concept of the DX-60H is a 6146 Heising modulator that is driven by the standard Heath controlled-carrier 6DE7 screen modulator.

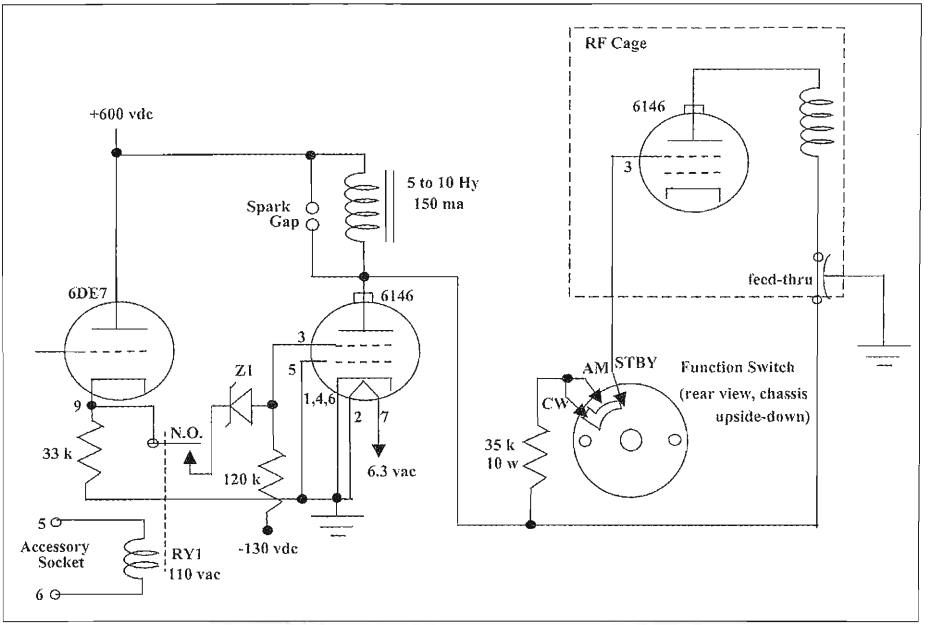


Figure 2: The complete schematic of the DX60H modification which also shows the new relay functions.

the basic concept. The 6DE7 is the standard Heath controlled-carrier screen modulator stage, and added to this is a new 6146 modulator tube with its control grid grounded and the audio signal applied to the screen grid.

To understand how this works, you need to know that the 6DE7 stage acts as an audio clamp circuit. At its output terminal, the most negative peaks of the audio signal are clamped to the top of a DC level. That means that the audio waveform only increases upward from the DC level, and never swings below it. The purpose of the Zener diode is to transfer the DC level downward, so that the screen of the new modulator tube is fed an audio input that only swings upward from a level a few volts below ground potential. The 6146 plate current is a reasonably linear function of the screen voltage over quite a large range, so it nicely amplifies the output of the 6DE7 and applies it to the choke. When you're not speaking, such as between words and sentences, the modulator screen voltage drops and its plate current idles at a low value. When you do speak, the modulator plate current goes up accordingly, reaching 200 ma on voice peaks. The result is a Class A stage that draws current like a Class B stage.

Figure 2 shows the complete schematic of the DX-60H modification. A relay has been added so that the new modulator will be enabled only when the Function Switch is in the transmit mode. It is a 110-vac SPDT relay and it is powered from the "Antenna Relay" contacts on the accessory socket on the rear apron. This relay also prevents audio feedback through the modulator when the Function Switch is in the "Tune" position and in addition it reduces the feed-through of switching transients.

Another necessary addition is a spark gap across the modulator choke to catch high voltage kick-back, which may sometimes occur when the DX-60H is switched from transmit to standby.

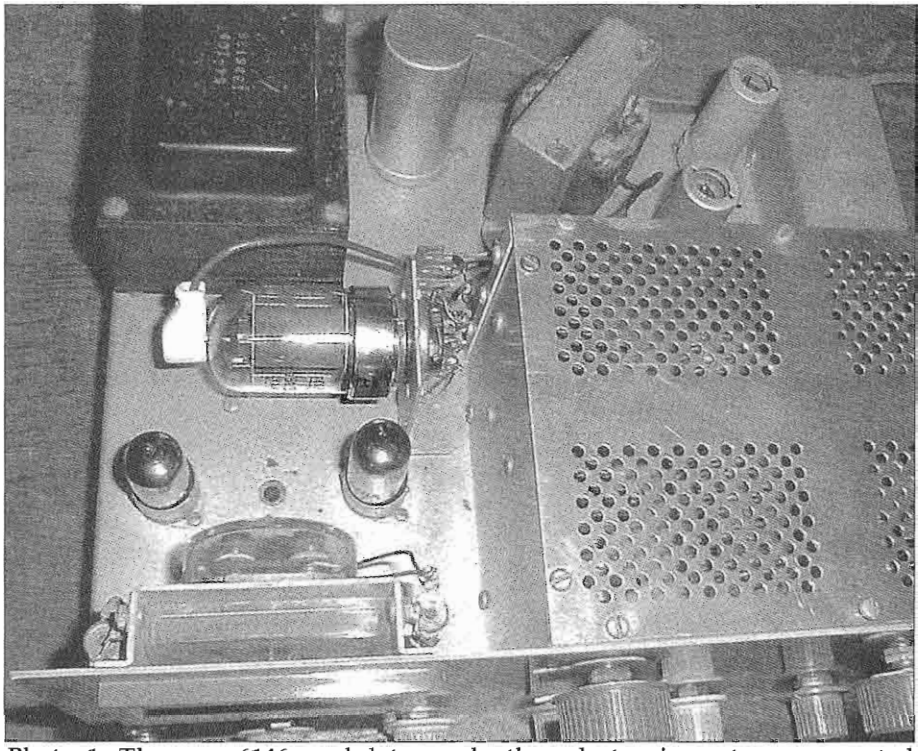


Photo 1: The new 6146 modulator and other electronic parts are mounted horizontally just in front of the power transformer.

Getting Started

The first thing to do is to make sure that the DX-60 you are going to modify is in good working order. Even if you've been successfully using it on the air for a long time, you should carefully clean up the components inside the RF cage. They are going to have to handle up to twice the peak voltage as before, so dust and spider webs that were OK at the old levels may arc over at the new higher levels.

Another thing to check is the accuracy of the meter shunts. Over time these can drift to the point where the meter readings are seriously in error. The safest way to verify shunts is to check them with the power off, by applying a known current through them and noting the DX-60's meter readings. I use a 0 to 24 vdc bench supply in series with a good ammeter (VOM, DVM, etc) and a series current-limiting resistor to supply the required current flow through the appropriate shunt. For the grid current checks, I use a 2 k series resistor, and I check the indicated reading at both 2 ma and 3 ma of actual current. For the plate current check, I use a 100 ohm series resistor and inject 100 ma of current. Either trim the shunts as necessary, or write down the corrected readings for use during tune up.

You should also have a good schematic for your DX-60 on hand. These can be downloaded without charge from Ken Grimm's Boatanchor Manual Archive at http://bama.sbc.edu.

The DX-60H is going to make a lot bigger demands on the power supply than the DX-60 did, so if your DX-60 hasn't been used in some time, check out the electrolytics and replace them

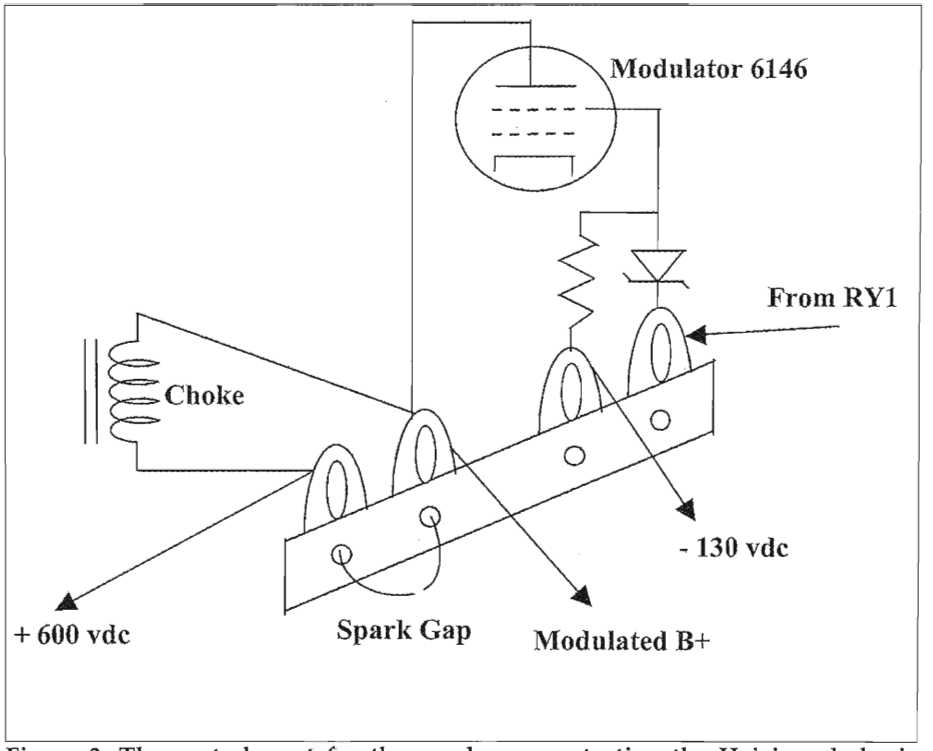


Figure 3: The parts layout for the spark gap protecting the Heising choke is shown here and is described further in the text.

if you have any doubt about their condition.

Also, there should be no leakage in the .005 coupling capacitor going from the 12AX7 to the 6DE7. It is best to replace it with a Mylar or other good film capacitor. Otherwise, verify that the original has greater than 100 megohms of leakage.

The changes to be described here should also work for a DX-60A or a DX-60B. Unfortunately, on the DX-60A, Heath removed some of the main power supply filtering that was in the DX-60 version. They thought better of this and put it back in when the DX-60B came out. You should first upgrade your DX-60A power supply before starting the Heising modifications.

Construction Notes

As described in this article, the DX-60H is an ***AM-Only*** transmitter. This keeps the modifications as simple and straightforward as possible.

You can begin your project by removing that power-wasting 30k center-tapped bleeder resistor, and replace it with a pair of 100k 2-watt resistors, just as Heath did in the DX-60B. Solder one across each of the power supply output filter capacitors. Removing the original bleeder resistor also clears plenty of room to mount the new modulator choke. The hole through which the old resistor's leads went will now be the access hole for wiring to the new parts installed above chassis.

Photo 1 shows how the new parts are mounted. The 6146 modulator tube socket is mounted on an L-shaped piece of aluminum scrap. It is installed using an existing chassis screw. I installed a 4-lug terminal strip next to the 6146 socket for easy connection of wires

and parts. The layout of this terminal strip and the included spark gap is shown in **Figure 3**.

The spark gap was fabricated by taking a 1-inch length of solid wire and bending it into a horseshoe shape, then soldering it into the eyelets of the two lugs to which the choke is to be attached. Snip through the top of the arch to make the gap, and bend the ends together to set the gap to 1/32 of an inch.

Since the Zener value will likely require some adjustment, you should orient the modulator tube socket so that the screen grid pin is near the top, so as to have easy access. You can pick up the –130 vdc pull-down bias for the modulator at the negative end of the dual 20 mfd capacitor (C37/C38) in the bias supply.

The modulator choke should 5 to 10 Henrys, with a current capacity of at least 150 ma, and a DC resistance of under 200 ohms. The first choke I used was rated at 9 Henrys, but only 110 ma. It worked OK, but on occasional voice peaks it would saturate and send an unpleasant mechanical jolt through the chassis, so I replaced it with one that had a higher current rating.

Remove all existing components and one wire from the three terminals of the Function Switch terminals shown in **Figure 2**.

RY1 is mounted on a shop-made L-bracket, and secured by an existing screw in available space under the chassis.

The original wires carrying the screen and plate voltages to the RF final are bundled into the main wiring harness. Since they will now be carrying high level modulated voltages, they should not be used. Disconnect them at both ends, then insulate and fold back both ends of the two wires. Rewire according to the schematic, using well-insulated wire and route the new wiring away from existing circuitry.

Be sure to wire the new 35 k screen resistor between the Function Switch and the modulated B+, rather than between the switch and the final tube. This gives added protection to that irreplaceable Function Switch.

Solder a jumper wire across the key jack to prevent anyone from accidentally trying to use the DX-60H on CW.

If your DX-60 does not have a fuse, add a 4-Ampere fuse in the AC line. When you are finished installing everything, double check all your wiring against the schematic. The value of the new Zener will be determined in the next section.

Checkout

With the modulator 6146 removed, you should be able to power up and check your work. Tune up the transmitter to 100 ma of plate current into a dummy load. You should hear RY1 pull in when you switch to AM mode, and you should be getting around 40 to 50 watts of output power on the low bands.

Here is a tip: With the original screen modulator configuration, the Heath tune-up procedure recommended getting the first dip of the plate current in the AM position (which limited the plate current), and then to switch to CW mode to complete the tune up. With the new circuit you will peg the plate current meter when you switch to the AM mode, until you find the dip (exactly as happens on Ranger and Elmac transmitters). But you can avoid this if after setting the grid current in Tune mode, you immediately switch the meter to the Plate position and tune the final for a dip while staying in the Tune position. There will be only 10 ma or so of plate current indicated, so you have to watch very carefully for the dip, but it is there. Then switch to the AM position and finish loading up to 100 ma of plate current and 2.5 ma of grid current.

With the DX-60 transmitting into a

dummy load, measure the voltage at pin 9 of the 6DE7. This should be approximately 120 to 130 vdc. On my DX-60 it was 125 volts. We want to drop that voltage down to between -5 and –12 volts at the modulator screen. You will probably have to put 2 or 3 Zeners in series to get close enough to the value that you need. I used two 60-volt Zeners, plus one 15-volt one to make a 135-volt drop, giving me –10 vdc at the 6146 modulator screen. Higher than -5 volts will raise the resting dissipation of the modulator, and lower than –12 volts will tend to clip the audio peaks. I used 5 watt Zeners because I had them, but with the intermittent current drain at this location, 1 watt Zeners up to a 60-volt rating can be used. After you install the new Zeners, verify that the voltage at the modulator screen is within the specified range under transmit conditions.

You are now ready to put in the modulator tube, attach a microphone and begin final checkout. Start with the microphone gain pot at minimum gain (fully clockwise, as viewed from the top), and use a scope to monitor your RF modulation envelope. Switch to AM mode and increase the mic gain until your negative modulation peaks reach the baseline. If you don't have a scope, you can get some idea by watching the power output on a wattmeter. At full modulation, there will be a minor upward twitch of the output power on modulation peaks. You are now ready to button it up and put it on the air.

Concluding Thoughts

The efficient Heising modulator described in this article is just a new twist on an old idea that can be traced back to at least 1935. If you want more information on bias-shift Heising modulators, see the articles in CQ magazine for April 1954, p.33, and October 1953, p.37. These articles illustrate the use of bias-shift Heising modulators on both small and very large transmitters.

Heising modulation only achieves 80 to 85% modulation before distortion begins to rise rapidly, however you can go up to about 90% without audible distortion. Conventional wisdom dictates that you can achieve 100% modulation by reducing the plate voltage to the RF final with a series resistor in parallel with an audio bypass capacitor. However it seems wrong to me to reduce the carrier level to match the available sideband power, since this will not increase the level of demodulated audio at the receiver, and it does reduce the quieting effect of the additional carrier power at the receiver. I think the better solution is to leave things just as they are.

There are some limitations on the DX-60H that you should keep in mind. The DX-60 specifications state that there are 2 amperes of 6.3 vac available for accessories. We've used up 1.25 amperes of that by adding our new 6146, so be careful about the filament drain of whatever VFO you plug into the accessory socket.

Secondly, the power supply of the DX-60 was not intended for continuous carrier operation at these power levels. In addition to that load, we are adding an intermittent but potent modulator drain that brings the total HV current up to over 200 ma on peaks. The bottom line is to be aware of these new strains and don't abuse things further by loading up beyond 100 ma or by making extra-long transmissions without adequate rest in between. Use common sense and it all works fine.

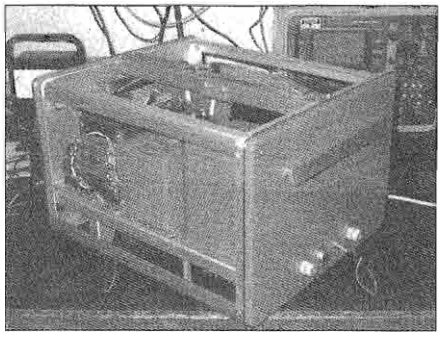
That is all there is to it. Get your DX-60H on the air and I guarantee that you will be talking to a lot of folks who won't believe you're only running a DX-60.

ER

ART-13 Additions and Corrections

by John Svoboda, W6MIT
2261 Peaceful Garden Way
Rescue, CA 95672

In ER #175, December 2003, my ART-13 schematic contained errors that were not in my original power supply schematic. The correct schematic is shown in **Figure 2**. The corrections include the missing line between the HV relay poles, correct grounding symbols, and the removal of a line between U-7, pin 2 and the HV rectifier. The meter ground is a sense wire ground carrying only meter current. As shown in ER #175, the plate meter would be destroyed. There were also some part number errors.



W6MIT's ART-13 power supply is built into an old Tektronix case.

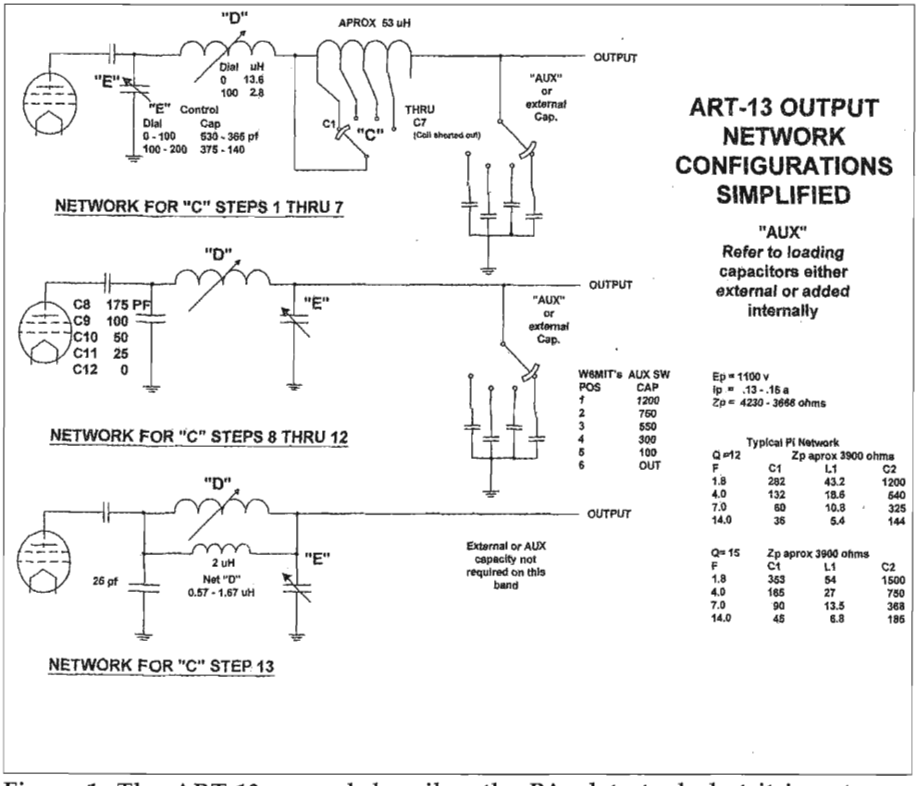


Figure 1: The ART-13 manual describes the PA plate tank, but it is not very clear. Here, I have redrawn and simplified the output network.

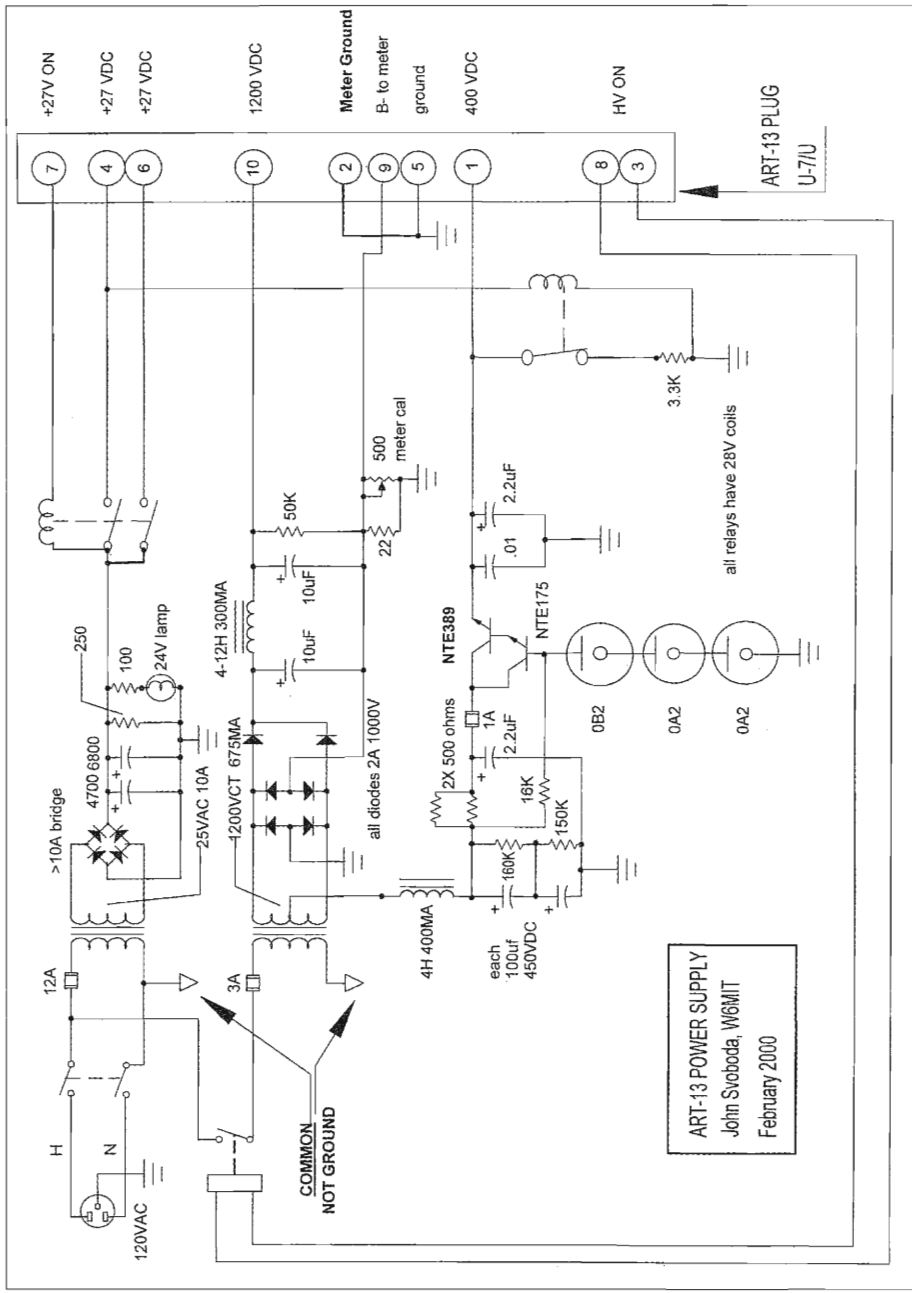
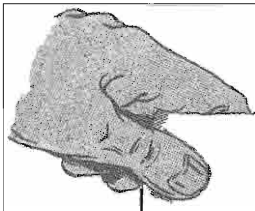


Figure 2: This is the correct schematic that should replace the W6MIT ART-13 power supply schematic on page 28 of December 2003 ER.



Mailbag

To:
Electric Radio
PO Box 242
Bailey, CO
80421

Dear ER,

I share the concern expressed in letters reacting to the overly pessimistic view of ham radio's future by ER's contributing writer Bruce Vaughan, NR5Q. I am glad that I delayed sending you my own response to his gloomy article, now in light of the eloquent rejoinders published from two of your correspondents, Walt/KJ4KV and Chris/KAQ2IQB.

I had enjoyed, up until his skeptical article, Bruce's series of wonderful storytelling and interweaving of radio experimentation, repair, and aspects of technological and listenership heritage we amateurs have in common with early broadcasting. But Bruce is way off the mark to suggest the demise of our hobby is imminent. Indeed, we are in a prime position to help bolster post-911 efforts at fortifying the nation's emergency communications infrastructure. To fill that position will create our strongest set of credentials in the years to come. The federal grant money being given to the ARRL to help train emergency operators is concrete evidence we are taking solid steps to participate in that fortification.

My own view is that having a vibrant hobbyist-oriented philosophy during times of non-emergency communications will guarantee we can offer a critical mass of operators who will step forward and volunteer a competent system of communicating when a crisis takes place. There is no need to fret over the nature of today's operator, as long as each person has a sincere interest in moving ahead the amateur service in some sort of agreeably positive manner.

It is not unreasonable to consider as part of future licensing requirements the occasional participation in mandatory "emergency drills" for which credit can be given to operators as part of earning our continued use of the bands. Such a license standard would avoid the divisive debate over how to link license testing to the unquestionable need for quality operators, and would move the point to the more relevant topic of how to show our value to the world at large. A demonstrated participation in a well-structured drill would weed out disinterested or unmotivated candidates for a ham license, new or renewed. If that results in a smaller amateur population, so be it. Those remaining are more likely to be available and counted on to serve the public good during a communications emergency.

Within our specialty, members of the AM Community play an important role, since the majority of us have substantial skills at troubleshooting and establishing communications links with the most basic of electronic components. To have received very favorable public comments earlier this year from FCC enforcement counsel Riley Hollingsworth, K4ZDH, speaks volumes about how our skills and merit

are viewed within government. It is our duty to make sure we continue to give reason for such an affirmative impression.

As for nurturing the next generation of radio operators, I hope the Defense Department will consider increasing its focus on practical training courses that will give technicians in the military a more versatile, hands-on knowledge of circuitry. Such education may stimulate an avocational interest in communications and radio to expand beyond today's approach of substituting modules with only a minimum of real knowledge. The result of enhanced instruction along these lines by the armed forces may yield an investment in amateur radio that can be repaid during national communications emergencies.

I am greatly troubled that the ARRL is, in many aspects, a moribund little non-profit group whose influence has lost significance in the eyes of regulators and the amateur community as a whole. Changing such an organization from within is difficult because of years of accumulated inertia and misguided attempts to protect the institution. Today as never before, individuals who can step around the League and successfully promote the amateur service can enjoy nearly equal stature alongside the ARRL, by taking advantage of our ability to directly communicate with politicians, regulators and telecommunications authorities at the federal, state and local levels. By having demonstrated our leadership, the League will be forced to follow or risk losing even more of its incumbent franchise to "represent" ham radio.

We have many among us who are closely associated with military communications officials thanks to interest in vintage military radios. We also have several national bodies, including Electric Radio, that can serve as progressive avenues to represent "ham radio" by taking advantage of the enthusiastic, dedicated interest of members of the AM Community. I stand ready to help leverage that interest to foster growth and improve the public image of the amateur service, and prove wrong Bruce Vaughan's contention the hobby is about to fade away.

Paul Courson, WA3VJB

Dear ER

Incredible timing!! I am refering to the article by Hal Guretzky, K6DPZ, 'The Seven Dollar Wonder'. My beloved NC-303 lost it's original audio output transformer just a few days before I received this issue. Low and behold, this article appears.

In this area we have three Radio Shack stores. At the closest one, they did not have any. At the second store, they had one and I bought it; I left one on the rack. Instead of $7, they now go for $2.50, as they are closing these out. I called my friend, Jeff W7ID, to let him know I found one; he said I had better get another as the price was less than mentioned in the article and just in case another vintage receiver (or other item in the shack) loses it's audio transformer. So I went back and they were out. I checked the Radio Shack web site and they no longer list these 70 volt 10 watt line transformers (catalog part # 32-1031B; however, they did the day before I bought the first one). I visited the last one locally; I asked the clerk if they had any; he did not know what I was talking about—so I browsed around the store and found two—bought them both. Then I advised Jeff, W7ID, to buy some—he finally found some but had to travel to several stores in the Boise, Idaho area to do so.

Word to the wise—better see if any of your local stores still carry these. It worked just great in my NC-303. Now, I need to try to fix the 'missing' sidetone in my Hallicrafters TO Keyer...should work fine. Thanks ER and thanks to Hal, K6DPZ and to W7ID who had to remind me about the article. How did you all know? Thanks for the Christmas present.

Best 73, Larry Knapp, KC8JX

ER

A Visit to Purchase Radio Supply

by Glenn Bowman, KC8WUL
2355 Textile Rd.
Saline, MI 48176
gbowman12@comcast.net

As I drive down the tree lined streets of southern Ann Arbor, I'm immediately overtaken by the sounds of modern collegiate life as I cruise down East Hoover Ave. A coordinated trumpet blast or the rhythmic cadence of the drum corps follows my slow meanderings as I pass the University of Michigan practice stadium and approach Wolverine Stadium located further up the hill. Purchase Radio Supply, being unassumingly housed in the residential section of this college town, causes me to pass right by their parking lot, so I circle the block and try again. Passing over the railroad tracks of the Conrail system, I find the home of Purchase Radio Supply. Nestled between the rail tracks and Wolverine stadium, this Mecca for the radio enthusiast has been a source of parts, services, amateur radio knowledge and general electronic based information for over 73 years.

"We moved to this location back in 1957," says Dan McCollough, WB8UXO, Vice President and General Manager of the store. " We were originally located downtown when we were paired with the camera business. Purchase Radio was founded in 1930 by Roy Purchase who was a firm believer in the strength of American products. Many radio hobbyists were also involved with photography and we served both interests. We added the camera shop in 1940. In fact, roll film was in such short supply during WWII that word sort of went out when we received our monthly shipments. Sometimes, when we opened for business, there would be twenty-five or thirty folks lined up outside our door. We eventually sold the camera side of things in 1954 and moved our radio shop here a few years later. Our current location started out as a local rooming house for the university and later on was home to a small manufacturing facility."

"We had a lot of fun with this bus," says John Ransom. " We used to take it to Hamfests and DX contests. It was fully electrified and was a functioning emergency communications unit for Civil Defense work."

As I step through the screen door that's directly opposite the practice field, I find that I have entered an 'old hardware store' for vintage radios and supplies. While Dan and his brother Paul are busy helping customers at the sales counter, my eyes are immediately drawn to the top shelves that run around the room. Here I find old radios from the prominent American manufacturers of the thirties to the sixties. There's a Chelsea Super Five, a Grebe Synchrophase, an Atwater Kent, and a locally manufactured, battery powered, Arbor Phone Model 27. I also see newer radio models from Zenith, GE, RCA, Realistic, Westinghouse and Admiral. There are also many ceramic and glass insulators along with a few spring-supported mics and a studio mic sporting the call sign of local AM radio station, WWJ.

Along with the old radios and electrical artifacts there are also several examples of past events and remnants from their past newspaper articles, now yellowed with time, that document part of their history and involvement with amateur and broadcast radio, are displayed on a central pillar in the store. One of these local stories is dated July 22, 1948 and is titled 'Roy Purchase of Purchase Radio and Camera Shop sets up ham radio phone contacts between local residents and relatives overseas.' Another article dated February 22,1962 states that 'Two local hams tape every word of Col. John Glenn's three-orbit flight'

"Roy Purchase, my father-in-law, got involved with radio at a very early age and became W8RP," says Dan. "Roy was working with spark gap transmissions back before ARRL was formed. Roy came to Ann Arbor in 1926 to study music. His major instruments were the cello and piano, but he played clarinet in the pit band at the old Majestic theater."

"There were many local radio clubs back then," adds Dan. "It took awhile, but things really started jumping when ARRL was formed. In fact, a few of the

Roy Purchase, the store's founder, is shown to the left with a customer during 1959. The drawers contained literature about radios, test equipment, sales flyers, and owner's manuals.

local amateurs drove to the first ARRL convention in Chicago back in 1921. It took them two days to get there going over back roads. Heck, all roads were back roads then, no interstates or super highways. We hired a few other individuals to help with the store, including our administrative manager, John Ransom." Dan adds that Roy was doing local radio repairs and helped to set up the first two-way radio systems for the local police and fire departments. John joined Roy in the business in 1944, but left in 1950 for a three-year stint in the Air Force. For 37 years, John served as President and General Manager of Purchase Camera. He returned to Pur-

If we could step back in time to September 25, 1964 and pay a visit to Purchase Radio, this is what the main display area would look like. Is that my Hallicrafters SX-122 and matching speaker I see on the top shelf? Notice also the sales posters and test equipment shown in the photo. Some of the new

chase Radio in 1990. I had the opportunity to talk briefly with John. His love for both amateur radio and the business go back to the early beginnings of the company. John noted that 'back in the early days' we had this bus that we had converted over to a mobile amateur radio emergency and Civil Defense station. "It was fully electrified," says John, "and we used to take this to ham fests and field day events, and also use it for DX work and contesting. It was great fun. On the weekends I liked to head on up to Grayling, Michigan. I had a get-away cabin up there and got a kick out of running QRP-CW. There was very little electrical interference in the area. I used a Ten- Tec Argonaut to pull in some great contacts back then, but that was 35 years ago and I've sold the cabin and the radio!" John still manages the administrative side of the business and his call sign is W8PAM.

Other shelves located throughout the store contain more radios, various parts, and pieces of older test equipment. Magazine racks hold the latest electronic periodicals including CQ, QST, Popular Science, Popular Communications, Electric Radio and Monitoring Times. They also carry many of the ARRL series of license manuals and how-to books. The racks containing

radios are still in their original factory plastic wrapping. "We were a licensed dealer for Collins, Hammarlund, Hallicrafters, and many others," says Dan McCollough, the current Vice President and General Manager.

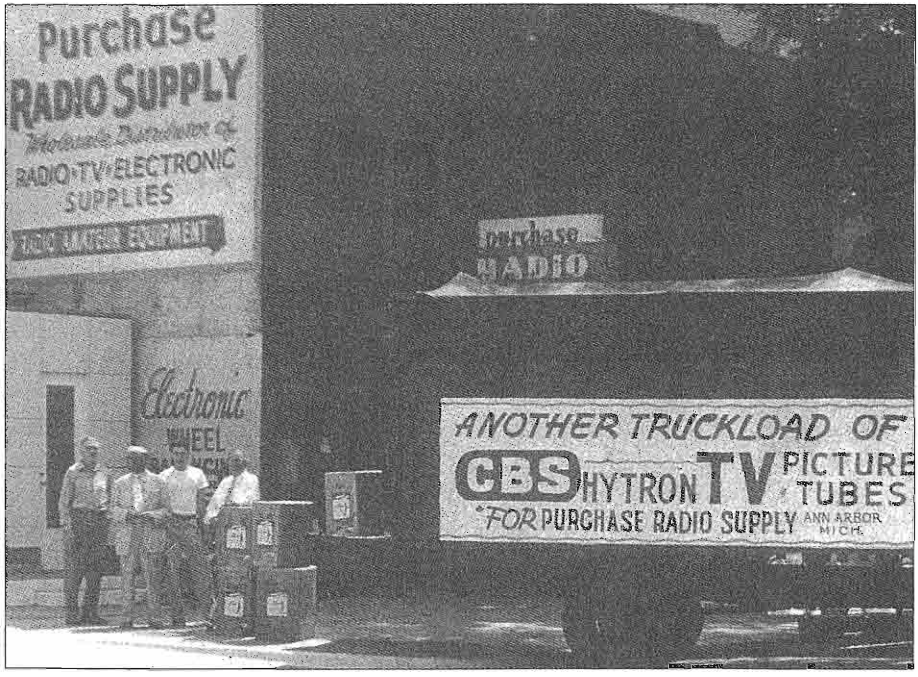
parts are loaded with packaged resisters, diodes, transistors, switches, relays, meters and panel lights, along with all the needed tools of the trade including soldering irons and electrical connectors in all shapes and sizes. Other shelves hold oscilloscopes, amateur transmitters, receivers and power supplies, along with signal generators, tube testers and meters of all types and varieties. Coiled antenna sets and radio kits reside above the equipment shelves. There are also several boxes filled with various electronic parts, salvaged from older radios and test equipment. I took a personal interest in a Drake T-4XC/R-4A transmitter/receiver combo with the available matching speaker and power supply, and a 'Variac' that must have tipped the scales at thirty pounds. There are also old CB's and late model pieces of stereo equipment. On an earlier visit to the store I happened to see a mid-70's Marantz stereo set. Hmm, it seems to have vanished. Need a replacement antenna or batteries for your portable radio or cell phone? You'll find those parts here along with modern computer cords and networking peripherals.

Business seemed relatively busy but I managed to ask Dan about their customer base. "Our main business is elec-

tronic parts, and while we have several steady customers, there seems to be a different request coming in nearly every day. The University of Michigan is one of our main customers. We supply their various research departments with electronic components for their equipment and various parts for repairs. Many local businesses call on us for electronic parts and we also support many school and science fair projects. There are many radio amateurs here that count on us for replacement vintage parts and we even supply the Mayo Clinic with electronic tubes and small control motors. In fact, there was a missionary doctor who used to come in here and take replacement tubes for his trips to Africa. If you're interested in tubes, we've got tubes!"

Dan returned to the sales counter and took me though the main parts area. Packed floor to ceiling like nuts, bolt and nails in a hardware store, were tubes of all kinds and large capacitors neatly arranged by part number. I saw radio and TV tubes and all the other associated electronic parts. Asking about old tubes, I was shown the following part numbers that Dan mentioned came from around 1935: 104, 316, 11, 80, 5894, G7 -807 and many 6F6-800's that were never opened and were still in the original boxes. "We also have several old telegraph keys that appear to have come from the railroad era and many old light bulbs and head sets. We even supply the University of Michigan with certain props for some of their performances. Come on upstairs to our attic and I'll show you more!"

The trip up to the 'attic' was certainly an educational experience. When I turned the corner going into the main attic space, I saw more and more tubes. I would safely estimate their numbers into the thousands. "We have our



A truckload of TV picture tubes has just been delivered to the original store on Church St., in Ann Arbor, Michigan. This photo was probably taken in the summer of 1954, and the truck was loaded with roughly 50-60 tubes of all sizes.

sources," said Dan. "We sometimes have the opportunity to buy up the stock from other stores that may have sold electronic parts as a sideline. In fact, we once hired a couple of college kids to try and catalog our stock up here," says Dan. "But, after a couple of days, they suffered 'burn out' and called it quits." In a side room I found about thirty TV deflection yokes made by Thordarson and Merit, in various sizes.

Back out in the main attic area, are more tubes, more radios, stacks of advertisement memorabilia, and copies of CQ and OST running almost from floor to ceiling. While cruising through this area, I happened to randomly pick up a copy of QST dated in 1929. Dan mentioned that back then you couldn't return the unsold copies of magazines, so they just sent them up to the attic for storage. 'We occasionally get requests for magazines for a certain date, like a birthday month or anniversary month," say Dan, "and we get a real kick in finding these and sending them along." I could easily have spent the remainder of the day in the 'attic', but my 'coffee and donut' alarm was starting to go off so we headed back downstairs.

The business offices are located just off to the side of the main sales floor. That's where I got the chance to meet Nancy Rushton. She handles the accounting and correspondence side of the business, and is many times the voice you'll hear on the phone if you call in an order. "I keep the boss informed about what's going on" says Nancy, "and keep 'the guys' out of trouble." Dan added that we have several other part time employees helping out who have retired from other jobs. These folks include: Nate Rosenthal N8WNB, Clarence Swanson KA8PAX, Bill Oliver K6CAP, and Richard Allport N8AB, who also collects vintage radios and telegraph keys. What a great place to work if your hobby includes any facet of amateur or vintage radio.

It's also in the business office where the historical photos from the past are displayed. Many photographs show the early days of the business and capture the happenings of an earlier time. When was the last time you saw a delivery truck pull up, with 50-60 TV picture tubes, from American manufacturers? The pride in the faces of the people waiting on this delivery is certainly thought provoking. Pride in the business, the manufacturers, and the customer base. Roy Purchase put his heart and soul into the business, but after Roy's passing in 1987, his daughter Ola Jeanne McCollough (Dan's wife) took over as President of the establishment. Ola Jeanne had been working in the store part time and now divides her time between Purchase Radio and her other business interests...running 'First Glass Kennels' and the breeding and showing of highly rated 'Show Dogs'.

My revelry into the past was interrupted when Nancy mentioned that we've come 'kicking and screaming' into the modern age. "You can call us at 734-688-8696, but 'check out our web site' at www.purchaseradio.com," says Nancy. "We've recently updated our web site and even have driving directions and website specials. We're the cure for antiseptic radio."

The Wolverine marching band was starting to crank up and I was reminded by the fact that "We're closed during Michigan home games," so it was time to head out. I have been a steady customer at Purchase Radio Supply for the past several years but never knew of their history in this community. They have been an advertiser in Electric Radio for several years now and support not only the vintage radio crowd but also help supply many local business with electronic parts and services. For the 'cure for antiseptic radio', I suggested that you visit their web site, call them with your next vintage radio need, or better yet, plan on stopping in during your next visit to the Wolverine state.

ER

The RAC Digital Dial for your Old Boatanchor

by Jeff Covelli WA8SAJ
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The thought of installing a new digital anything on an old boatanchor might make some folks might say, "What is going on here?" I first saw this neat little gadget at the Dayton Hamfest about 10 years ago. Lee Richey (WA3FIY) was showing some QRP gear and one of them happened to have a "Digital-Dial" installed to read the frequency of the rig. I asked him where he had gotten the dial, and he replied "I make them." Wow, I was really interested now. As we talked, he brought out a Model A-2W, which is the factory wired version of the Digital-Dial. I set out to install it into a Drake TR-4CW, and it worked great, so I thought maybe I could install it in some of my other old rigs I had laying around, such as the Hammarlund SP-600JX-17, Swan 700-CX, Hallicrafters SX-115, and finally the Drake R-4B. I will talk about the Drake R-4B, since it was the easiest to install and the lightest one to move on the bench for this article.

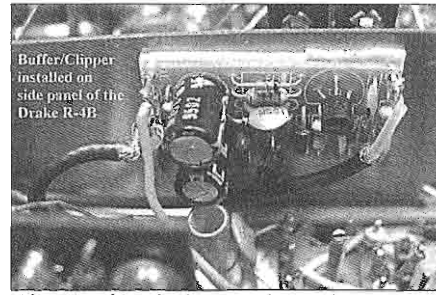
Description

The Digital-Dial is a general frequency counter that works to around 50 MHz. The six-digit readout for the frequency is bright red LED's, and they sure look nice against the blue dials on the Drake gear! Plus, it has the capabilities of a direct readout display with an IF offset. Now, with that in mind, it

The RAC Digital Dial is small enough to sit on top of my Drake R-4B

also has five memories that can be programmed to have the readout count forward or backward, depending on how the mixer stages in your equipment work. You can have the readout accurate to 100 Hz, plus the LED's will blank "off" when not moving frequency to save on current draw. When you change frequency again, the LED's come back on. There is a built-in feature for adding up to 16 different memories vs. the 5 that come with the unit, but you have to make the changes yourself. Most folks only need the five common Ham bands, so that works well with the stock unit. The readout does not jitter like most frequency counters, but has an "anti-jitter" code built into the RAC C-5 chip. The C-5 chip has the crystal time base, counter logic, drivers, and memory control to do the counting, not bad compared to just a few years ago when you would need a pile of chips to do that. The Digital-Dial needs from 75 mv to 1 volt of drive at 50 ohms to make it count, and the voltage should be free of mixer products, or else the counter display will jump around.

The unit is nice and small, measuring 2H x 4.5W x 3.75D in a very attractive aluminum cabinet. I use RG-174 50-ohm coax coming out of the rig to feed the counter input, and it works great. Most rigs have enough drive to make it work well. For the rigs that have low drive, RAC makes a buffer/clipper (BK-174), which I recommend. The buffer/clipper is used to keep the Digital-Dial from pulling down the RF drive from the circuit it is counting. On some of the rigs there is so much drive so that the dial has no trouble at all counting, and the circuit is not affected. The power supply voltage required to operate the dial is between 9 and 13 volts DC @ 100ma. The buffer/clipper only needs 6.3 VAC from a filament string or about 8 volts DC, and it has a rectifier built-in for AC. The small

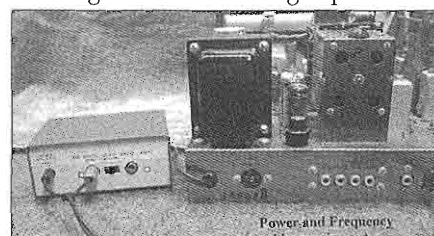


The buffer/clipper board mounts neatly inside the R-4B on a side panel, and may be attached with removable double-sided tape.

board measures 0.75 by 1.5 inches, and can fit almost anywhere. I have used the filament string for my voltage tap-off to feed a half-wave diode rectifier and filter. I can then supply DC voltage to the Digital-Dial using RG-174 coax, and the DC output cable and the output cable for the counter come out the back of the radio.

Installation

The Digital-Dial and the buffer/clipper come with all the connectors for power, and a couple of RCA phono plugs for the RF. I started installing the buffer/clipper first by trying to locate a spot on the bottom side of the chassis in the R-4B that would not impede any future work like alignments, etc. There was a spot near V-3, a 12BE6, in between the IF cans and on the side-panel not far from the injection point. This is where the frequency input goes. I used good old "double-sticky" tape, which works great for mounting. I picked off



The two cables that carry DC power and RF come out the rear of the R-4B.

the 6.3-volt filament for the buffer/clipper from V-2 (6HS6), not far away. The buffer/clipper has a rectifier and filter installed already, so there is no need to supply DC to it. I used RG-174 (50-ohm) coax cable to tap off the "frequency-injection" jack; this is the pre-mixer output for the R-4B, more on this later. The buffer/clipper now has a high impedance input, so it will not pull the injection level down and passes along the frequency to the Digital-Dial. It also maintains a constant level for the output, as the input varies. The output cable is also RG-174 (50-ohm) coax and I run it and the 12-volt DC out an open hole on the rear of the R-4B. The cables are fastened together with tie wraps for about 3 feet, just the right length to feed the Digital-Dial.

The Digital-Dial counts whatever it is given, but the feature that sets it apart is that it can offset the count by whatever IF frequency is, up to 77 MHz. In the case of the Drake R-4B with the pre-mixer output, (VFO and heterodyne crystal) are already mixed, and now the output has all the mixing done except for the carrier oscillator (5645 kHz). Most of the time in this case the carrier oscillator is within about 100 Hz, so the count won't be off that much and as you change bands, and the counter will follow along without having to change the pre-set on the Digital-Dial for each band. Note: this is not the case for all radios, just the pre-mixer type. For all of the other type radios, you will have to push the memory button for each new band to set up the correct pre-set for that band. There are five band pre-sets built in and if you want you can go up to sixteen memories using the method described in the manual. There is a little tuning of the trimmer pot inside to set up the correct level for the dial to count, and once that is done you are ready to enjoy direct readout, without having to "squint" at that old dial. It kind of takes away the fun of tuning the old dials like in the old days, but it's nice to have both working for you, as we are getting older and have trouble reading the old boatanchor dials.

I have used the Digital-Dial on my Hammarlund SP-600 and it really worked great, since I only had to change two memories for the whole tuning range on the SP-600. Using the Digital Dial with some of the other rigs like the Collins S-Line could be a problem with only five available memories because the Collins uses 200 kHz segments. You would run out of memories unless you opt for using sixteen as described in the manual. I have used the Digital-Dials for over ten years now and no problems have occurred during all the operating I do, plus all the times the gear is running while I'm working on the bench.

The price for the A-2W (factory wired) Digital-Dial is around $110, and the kit version is $80. The buffer/clipper BK-174 (factory wired) is around $15 and $10 in kit form. So, you can have a real nice digital display for your old boatanchor for a song and a little labor and have fun doing it. RAC not only makes these products, but a whole array of others. You can call them at 814-437-5355 or try their web page at: www.radioadv.com and their e-mail is: lee@radioadv.com.

So you can now have a different way of looking at your boatanchor radio with the Digital-Dial sitting on top of it. Have fun!

73' Jeff Covelli/WA8SAJ

On the bottom of the page opposite is the Drake R-4B receiver block diagram showing where the buffer/amp and Digital-Dial are installed. The Buffer/Amp is used on the R-4B to prevent the injection level from dropping.

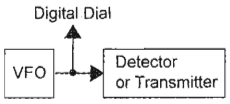


Figure 1

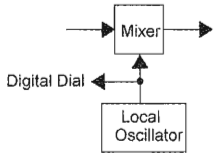


Figure 2

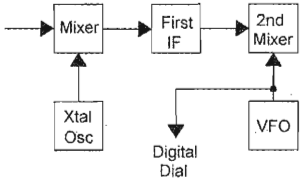


Figure 3

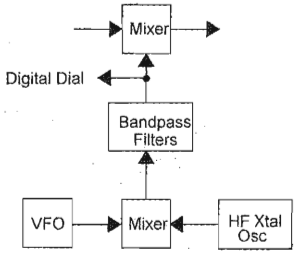


Figure 4

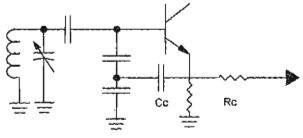


Figure 5

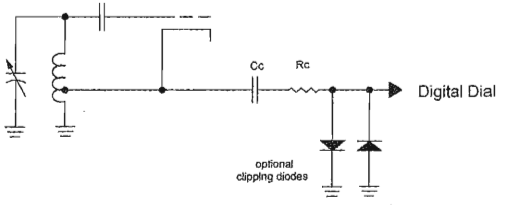
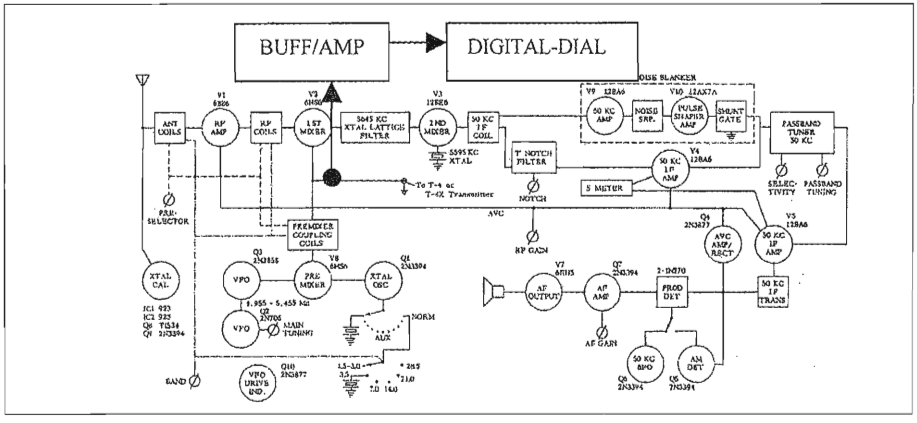
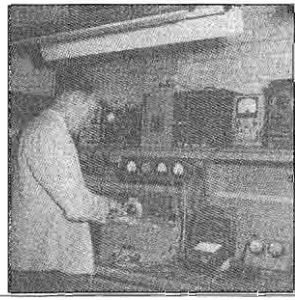


Figure 6

The above block diagrams show the different configurations of radios that the Digital-Dial can work with. Note: The Drake R-4B uses the pre-mixer type of Figure 4, which handles counting much easier and has less error.



The Restoration Corner



Sticking Johnson VFO Problem Solved
by Dennis Olmstead, WB9EMD
2605 Arbor Way
Montrose, CO 81401

Somehow I thought my Johnson Ranger would run forever. After all, it's something like 40 years old and is still running great.

Recently the VFO dial seemed to stick a little when the frequency was changed. I believe all Johnson VFO dials and mechanical systems work about the same, so many of you may have, or will experience, the same problem.

The small glitch then became a big one, when it would not turn past a certain point. I remember how difficult it is to get inside the VFO and hoped the problem was "outside" the box. Off came the back and a look behind the front panel revealed all of the connections looked OK, but the dial still was stuck.

The next possible fix, and the one I should have made first, was to attack the problem from the front. It's easy to get the VFO dial off. Remove the driver and plate and VFO tune knobs. Remember the dial setting of the driver and plate as you take them off! You can then see two small nuts holding the dial to the front panel. It may also be that the front knobs don't come off easy, then you need to remove the connection on the shaft and take the knobs off.

When the dial came off the problem was evident. At each top corner of the dial there is a strip of double sided sticky rubber, which has the function of holding the dial glass to the frame. Over the years the glue on the rubber and the rubber itself degraded such that it "flowed down" and in doing so hit the end of the VFO dial pointer.

The fix involved getting a small roll of double sided tape from the hardware store. It may be necessary to double the tape in order to have it thick enough to do the job. The correct amount seems to be about the thickness of the dial. Remove the old tape and replace with new. Clean the dial but take care not to rub off the dial markings.

While you are at it, this is a good time to also replace the dial pilot lamps for the VFO. Most likely the old pilot lights are burned out or about to expire.

These bulbs can be replaced from the front or from the back by pulling the dial holder out. Since the dial is already off an exchange of pilot light only takes a minute. You may have to search some for the dial lamp. The Johnson manual shows a number #51 bulb that is a small round bayonet lamp. A number #47 is too long. I found that GE #130 bulbs work just great.

Replace the VFO dial; check if it runs free on the entire range. Next replace

the nuts; check dial play again. Replace the three knobs.

If the back of the box is still open perhaps it's a good time to dust things off a bit and if you are a tube test person do that. My way of repair remains "if it works don't mess with it", so I just dusted and put the back on.

You may also want to check VFO calibration. If it is OK leave it alone. If it needs work the trimmers on the VFO should set things right.

Your Ranger should be good for another 40 years.

Removing Dents in Radio Cabinets, Restoring Old Paper Cone Speakers, and a Screw Terminal to BNC Adapter

by Clark Hatch, WØBT
3310 NE Croco Road
Topeka, KS 66617

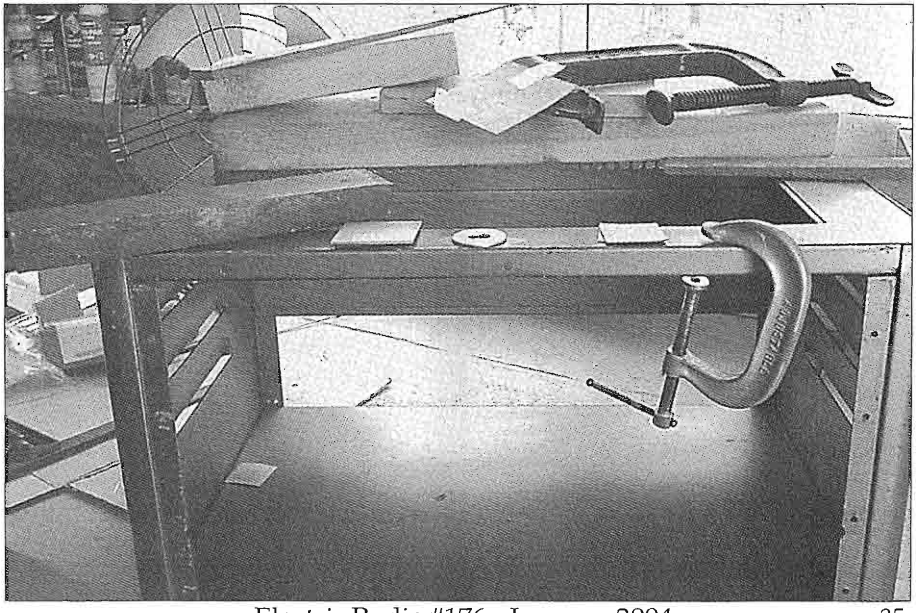
Removing Dents in Radio Cabinets

Below is a photo showing some of the tools I have used to straighten the bends and dents from a radio cabinet. The top front was bent down and had a dent in it. I placed the 2X6 board across the top and used shims for the proper spacing to bend it back into place with the large C clamp. Then I used the smaller C clamp and the heavy steel bar to push out the dents. The small round dents were pushed out by placing the big washer over the dent, then the heavy steel bar over the washer and next, used the small C clamp with a small piece of 1/16" printed circuit board as a pad under the screw side of the clamp, tightened the clamp and pushed out the small dents.

C clamps work much better than hammers or standing on it because you have precise control of the amount of force that is needed. Of course you can only use this method where the C clamp will fit, but I have used it on R-390As to straighten panels and chassis. A large crescent wrench works great for straightening bent over corners and angle lips.

Restoring Old Paper Cone Speakers

I have used this method on a 4 inch broadcast radio and an 8 inch NC-300 speaker. I improved the sound on a 10 inch speaker, a National 50-TS. The 4

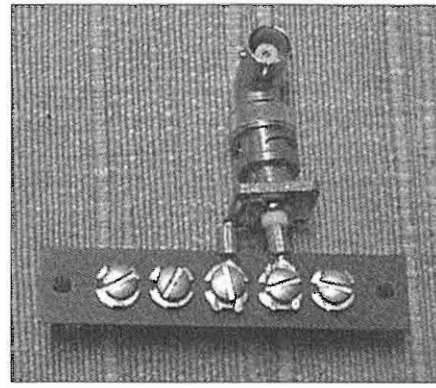


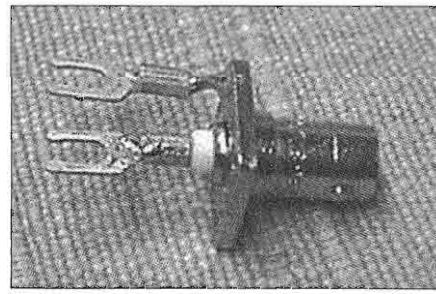
inch speaker had several splits in the cone along the outer edge of the cone. The 8 inch speaker sounded very distorted and lacked low frequency response. The 10 inch sounded pretty good but seemed to be lacking a little low frequency response. The paper in these old speakers seems to dry out, gets brittle and lacks flexibility. The fix is cheap, easy, quick and very effective. All it takes is a 1 ounce tube of Monkey Grip (TM) rubber cement, a tire repair product available at Tractor Supply, and other stores.

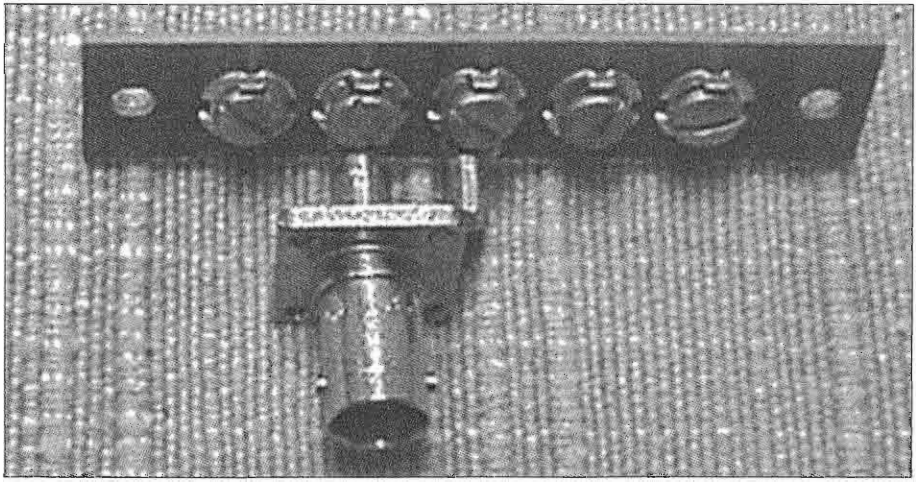
Start at the outer edge of the speaker and flow a copious amount of cement in the ripples of the cone. Flow it on evenly and use your finger tip to smooth it out and rub it in. Continue flowing and spreading the cement on the cone working toward the center. Do not get to close to the center with the cement to prevent it from seeping into the voice coil area. The wetting agent soaks into the paper, softens it, but the rubber makes it springy and flexible. Even the 4 inch speaker that had the torn places in it now sounds great and so does the 8 inch unit. There was also a noticeable improvement in the 10 inch unit.

Screw Terminal to BNC Adapter

Don't drill holes in a vintage cabinet if you want to use a coax connector on a radio having screw terminals only. Build one of these adapters instead! They also make alignments easier. The next 3 photos show my adapter.







A Broadcast Band Interference Filter

by Hal Guretzky, K6DPZ
Land Air Communications
95-15th St.
Richmond Hill, 11419

Many times an Amateur station is located close to high-power AM transmitters operating in the standard broadcast band. Many older receivers do not have sufficient preselection to reject these powerful signals, and lots of the new rigs have no filtering at all before the first mixer. If this is your situation, you are probably experiencing annoying interference. The bandpass filter shown shown below has been successfully used in these situation to eliminate the interference. It covers 1.6 to 30 MC with good rejection outside the bandpass.

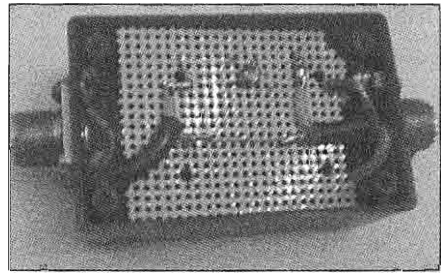
The inductors are stock J.W Miller coils, available from Digi-Key. The part numbers are:

2.7 uH	70F276A1
3.3 uH	70F336A1
4.7 uH	70F476A1
5.6 uH	70F566A1
15 uH	70F155A1

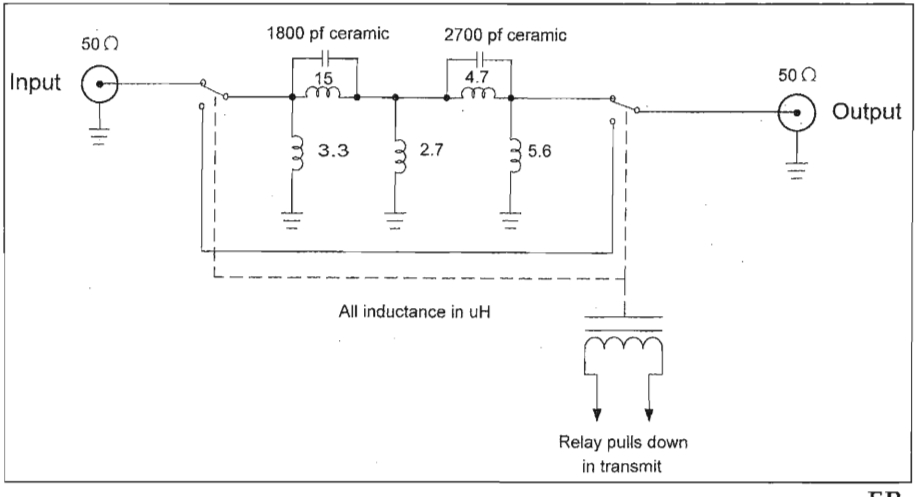
Similar coils are available from Coil Craft. The capacitors are commonly available for RF service.

The relay should be used when the filter is installed with a transceiver so that the electronics are bypassed when transmitting. The die-cast box is easily available from many sources.

I think you will be surprised at how well the filter works.



The filter is built with short leads and point-to-point wiring.



This is the complete schematic of the bandpass filter.

Installment 7

W. J. Halligan
Newspaper Reporter and the State of Radio 1923-1924, Part 3
Epilogue

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Full Outline of Part 3: The Broadcast Phenomenon

A. Radio Programs
B. Broadcasting Technology on the March
C. Vignettes Inspired by the Culture of Broadcasting
   1. Applause Cards
   2. General Vignettes
D. Epilogue
   1. The Initial Purpose of Broadcasting
   2. Bearing the Expenses of Programming
   3. Sources of Revenue
   4. Rebroadcasting as Precursor to a National Broadcasting System
   5. Transatlantic Tests
   6. WGI

Sources of Revenue.

The familiar principle of "survival of the fittest" governed economic progress in the broadcast industry. For example, the number in 1922 of authorized stations increased from 30 to about 600. The exact number of broadcast stations actually licensed by the end of 1922 is difficult to estimate. During the latter months of 1922 about as many licensed stations went off the air as came on the air. Indeed, during December, 1922, twenty stations relinquished their licenses, while between December 5, 1922, and January 13, 1923, sixteen stations were newly authorized ("Editor," 1923a, p.426). Whereas Bill Halligan cited eighteen different broadcast stations that were on the air in 1923, five of them, including WGI, were off the air and one had changed ownership and moved to a new location within four years (Keller, 1927).

Insufficient finances explains the horrific attrition rate. Morecroft, (1922, pp. 3-4), from his vantage as one of the first editors of Radio Broadcast, recognized immediately that serving such laudable goals as entertaining and educating would not produce revenue. He suggested, therefore, three options—each of which, he believed, would enhance the integrity of programming in the public interest: (1) establish endowments—why not endow a radio broadcast station as one might endow a library? It may prove to be the cheapest and most efficient way of delivering both amusement and teaching. (2) make contributions to a common fund to support a station—obtain voluntary subscriptions from those who benefit from listening. (3) acquire municipal support whereby a community provides finances in order to enrich its local culture. Whatever the merit of Morecroft's proposals, none saved early stations from the despair of bankruptcy.

RCA and the conglomerate that it represented controlled the fate of broadcasting during its early years. Members recognized several months into the broadcast era that the latter could not be sustained indefinitely if they ignored programming in favor of manufacturing receiving apparatus. First, they foresaw a time when households would become saturated with

receivers, which would lead profits from marketing sets and components to decline. Second, they recognized that the general public anticipated increasingly sophisticated programs. The awareness that they must widen their objectives led them to establish broadcast stations strategically located in populated areas, where, with their vast resources, they could afford to hire competent performers to present outstanding programs.

Secretary Hoover, Department of Commerce, a strong advocate of industry-government cooperation, zealously aligned broadcast channels to benefit well-capitalized, conglomerate stations, which could afford powerful transmitters and feature excellent programming. In May 1923, during the second of four radio conferences, the band between 550 and 1350 kilocycles was allocated for broadcasting. Power input to the transmitters of the nearly 600 licensed stations ranged from about five watts to 500. Obviously, the signal of a high-power station would obliterate that of a low-power station if the two were assigned the same frequency. To minimize the possibility, broadcast stations were re-licensed on the basis roughly of input power: Class A stations averaged 100 watts input. Class B stations utilized 500 watts input. [In mid-1923 nearly all of the Class B stations were equipped with 500-watt Western Electric transmitters, excepting WGY, Schenectady; KDKA, East Pittsburgh; WJAZ, Chicago; and a few other with 1,000 watt transmitters, see "Editor," 1923b.] Class C stations transmitted on the average with about ten watts.

Class A stations were assigned frequencies from 1000 kilocycles to 1350, and were separated by twenty kilocycles. Assignments inadvertently led many Class A stations in physical proximity to one another to be assigned the same frequency. Consequently, the interference problem could be severe for several stations of this class. Class B stations operated between 550 and 1,000 kilocycles, except for 833 kilocycles (360 meters). The country was divided into five zones for Class B stations. Ten channels in each zone were allotted to them. All would possess relatively clear channels on the grounds that they were capable of transmitting long distances at night. Excellent live programming was expected of Class B stations; indeed, none was permitted to play phonograph records over the air. The Class C stations were required to operate, as before, on 360 meters. On June 30, 1923, 572 stations were distributed as follows: Class A, 203; Class B, 42; and Class C, 327 ("Editor," 1923b). As Douglas (1987) points out, AT&T, General Electric, Westinghouse, etc. owned the powerful, well-financed Class B stations. The Class A and C stations belonged to universities, churches, labor unions, department stores, and local businesses. These stations obtained scant relief from Secretary Hoover's rulings.

Meanwhile, AT&T executives formulated plans to establish a broadcast station in New York City that would be not only self-supporting as it developed programs but would also make money. The Company created WEAF, August, 1922, which was intended to function as an "open-ended telephone" (Bergreen, 1980). The station would be open to members of the public, who, upon payment of a "toll," could broadcast a message to an "unsuspecting world" for ten minutes. The microphone then would be yielded to another customer. WEAF was in operation only a few days before it broadcast its first commercial advertisement, which pertained to selling apartment units. The station was paid $50.00 for the oration; the sponsor happily attributed a spike in sales to the presentation.

WEAF subsequently employed a salesman to promote its advertising scheme. Apparently, he was successful, for by 1923, WEAF showed a profit of $150,000. AT&T soon adapted its telephone toll concept to the advertising format that has become familiar to us today. From AT&T's point of view, advertising was a necessary source of revenue for sustaining WEAF programming. Thus, the Company executives declared defiantly that "`to do anything else than make a complete sales effort is to invite failure'" (Bergreen, 1980, p. 27) [see Halligan, B:3/20/24].

Idealists who believed that programming should be wholly free of extraneous interruptions regarded AT&T's campaign for advertising revenue as abhorrent and distasteful. Jackson (1922, p. 72), for example, decried the prospect of advertising by radio: "The very thought of such a thing growing to be a common practice is sufficient to give any true radio enthusiast the cold shakes." Furthermore, "can you picture to yourself the horror of sitting down to listen to a good song or two, or perhaps a newsy chat on the events of the day, and then being forced to listen to a broadcasting program that is nine tenths advertising matter? . . . If such a thing as broadcast advertising matter should become general—and it is no remote possibility—you'll have to listen to it or listen to nothing at all! And you didn't buy receiving apparatus to listen to nothing at all."

The danger signs were imminent. "Driblets of advertising, most of it indirect so far, are floating through the ether every day. You can't miss it: every little classic number has a slogan all its own, if it's only the mere mention of the name—and the street address, and the phone number—of the music house which arranged the programme." Jackson's (1922, pp. 75-76) observations led him to caution that "once the avalanche gets a good start, nothing short of an act of congress or a repetition of Noah's excitement will suffice to stop it." However, neither Secretary Hoover nor Congress took steps to impede the fast-encroaching impact of broadcast advertising.

Rebroadcasting as Precursor to a National Broadcasting System

The goal of operators of Class B broadcast stations was to offer the best possible programming to as large an audience as possible. From the perspective of programming, why should people in remote sections of the country be forced to listen to a mediocre offering from a local station while the finest singers in the world are broadcasting an opera from the Metropolitan Opera House in New York? From the point of view of the economics of broadcasting a program, it cost about the same to broadcast to a million listeners as to a thousand; moreover, revenue fees grow proportionally with increases in numbers of listeners. Broadcast engineers and entrepreneurs, therefore, felt from the beginning that, somehow, it was imperative to establish a national broadcasting network How, then, they wondered in 1922-1923 could it be done? The following two methods were given extensive consideration:

First, the early technology enabled AT&T to send speech over telephone wires almost any distance. A case in point is Bill Halligan's announcement [see Radio Programs, 9/12/23] that the Dempsey-Firpo fight returns would be broadcast on WNAC, a Boston station. He noted, too, as a consequence, that "crystal set fans" need not be depressed. He knew that had AT&T not agreed to wire the signal to WNAC, Boston BCLs who owned relatively insensitive crystal sets would be unlikely to pick up the broadcast from either New York or Schenectady.

It is noteworthy that had the AT&T engineers planned in 1923 to wire a

concert to WNAC, the effort would have been unsuccessful. Music relayed over telephone wires heretofore had been immersed in distortion (Morecroft, 1923a, p. 187). Refinements in technology leading to telephone transmissions of respectable fidelity occurred in the mid-1920s (Bergreen, 1980).

Second, radio engineers in 1923, knowing the limitations inherent in using telephone lines, divined that the best prospects for establishing a national broadcasting system would be to transmit programs by shortwave between stations. The station receiving the short-wave signal could then re-broadcast the program. For example, concerts were being relayed in 1923 from KDKA, East Pittsburg, to KDPM, Cleveland, WBZ, Springfield, MA, and KFKX, Hastings, NE, on 100 meters. KDKA transmitted its regular programs on 920 kilocycles and also on 3,200 kilocycles [see Halligan, B:3/20/24]. The 100 meter signal actuated the modulator of the subsidiary stations, which re-broadcast the signal, often on 360 meters. The technique of re-broadcasting required a very good receiving set at the subsidiary station. The receiver had to stay in tune for an indefinite period, which was nearly impossible given 1923 technology, to prevent the signal from slipping out of the receiver passband. The effects of ionospheric propagation patterns on shortwave transmissions also were still mysterious. Indeed, Rodgers (1923, p. 122), a strong proponent of rebroadcasting, insisted that "test have shown that daylight transmission is materially better than night transmission at a wavelength of 80 meters." Overall, nonetheless, circumstances for rebroadcasting seemed propitious. The probability of a national rebroadcasting system appeared to be only a few years away (Rodgers, 1923, p. 122).

Transatlantic Tests

Bill Halligan cited three independent efforts to span the ocean via broadcasting. He suggested, February 25, 1924, that European universities were planning to broadcast "instruction on power sufficient to transmit the lectures across the Atlantic." He reported, March 19, 1924, that the "almost world-wide broadcasting chain system of the United Kingdom was put to use in broadcasting a speech by the Prince of Wales." And in 1923, on March 13 and 14, he stated that WNAC, Boston, "will broadcast" live a transcontinental test of "instrumental and vocal numbers."

Radio engineers in the early 1920s estimated extravagantly the distances that broadcast signals might travel. Their purview revealed the useful radio spectrum to be roughly 1,500 kilocycles wide. At the lower end of the spectrum, from 10 to 25 kilocycles, powerful alternator and arc transmitters spanned oceans routinely. At the upper end, from 1,500 to 3000 kilocycles (100 meters), interesting, but little understood, properties were beginning to emerge. The propagation of broadcast signals in the band from 550 to 1350 kilocycles had yet to be explored thoroughly. Radio engineers thus assumed naively that it was mainly either the power of the transmitter or the sensitivity of the receiving apparatus that limited the range of a broadcast signal.

Bill Halligan's speculation that North Americans might study at European Universities via broadcast radio never came to pass. The British Broadcasting Company (BBC) in 1923 lacked technical capabilities for operating a "world-wide broadcasting chain." On the other hand, the intent of WNAC management to conduct a transatlantic test was fully plausible, congruent with state-of-the-art assumptions, and a popular objective.

WNAC aimed to become the first

broadcast station in the nation to be heard in Europe. It would then be hailed as the first one to extend the potential of radio simultaneously to citizens of Europe and North America, and honors would be heaped upon it and its owners, the Shepard Department Stores of Boston. Consequently, on March 14, 1923, WNAC, operating with 100 watts, extended its evening broadcast schedule from 9:30pm until 3:00am in the morning. The signal was transmitted from 2:30am until 8:00am, London time. The time period was chosen so that the transmission would overlap during the night hours on both sides of the Atlantic. Nonetheless, no one in England reported hearing the WNAC signal.

Meanwhile, Mr. F. N. Doubleday, President of Doubleday-Page, after making a study of radio broadcasting in England, returned to New York, also in March, 1923. At a meeting shortly thereafter with the editors of his magazines he suggested that Arthur H. Lynch, senior editor of Radio Broadcast, arrange one-way transatlantic tests in which stations throughout the United States would broadcast programs to England. On the assumption that if one-way tests would stimulate both the progress of radio and international friendship, two-way tests would provide an even greater boost. Lynch enlisted the support, therefore, of Hugh S. Pocock, editor of Wireless World and Radio Review, London, in scheduling the tests.

The forthcoming transatlantic tests swiftly attained international publicity. For instance, the Associated Press, United Press, and International News Service, respectively, spread daily stories about them worldwide. The tests began November 25, 1923, and continued for three days. They covered a period of one-half hour, from 10:00pm to 10:30pm in New York (3:00am to 3:30am in England). Selected stations in the U. S. made broadcasts for ten to 15 minutes followed by ten to 15 minutes of broadcasts from all eight BBC stations. Newspaper exhortations urged non-participating broadcast stations in the United States to shut-down during the broadcasts from England, but many of them ignored the pleas. Maritime services, in contrast, obligingly held ship-to-shore commercial traffic during the half-hour period of the tests. Listeners on both sides of the Atlantic hunkered down with headphones to copy the signals.

Henry Ford spoke for a few moments from WWI (50 watts) Dearborn; other dignitaries spoke from such stations as WGY (1,000 watts) Schenectady, KSD (100 watts) St. Louis, KDKA (1,000 watts) East Pittsburg, WGI (100 watts) Medford, etc. Guglielmo Marconi was commended for staying awake until three o'clock in the morning in order to address American listeners over BBC stations.

A few American stations were heard in England barely above the noise level and a few BBC stations were heard in the United States deep in the noise. All the same, an editor in Radio Broadcast pronounced that "international broadcasting is now no longer an idle dream but a fact ("Editorial," 1924, p. 191). The editorial dampened its own euphoria considerably, however, by noting several technical difficulties that must be overcome before the owner of an average receiver, such as a modest crystal set, could listen to stations from across the Atlantic "at will." Broadcast transmitters must increase power markedly, wavelengths must be apportioned to overcome interference on the broadcast wavelengths, and most importantly, "direct broadcasting" must be superseded for international work by "some form of rebroadcasting."

Clearly apparent practical problems failed to deter the promoters of transatlantic tests. They were supremely confident that careful, elaborate planning

and precise execution would produce successful results. So, on November 24th and 30th, 1924, a second set of tests, planned methodically, were executed. The results of these tests replicated basically those from the 1923 tests (Lynch & Wing, 1925). Finally, a third testing period was organized for the fourth week of January, 1926. The Radio Manufacturers Association pledged thousands of dollars to publicize it. Powell Crosley was selected as Chairman of its steering committee. One goal of the committee proclaimed: "We believe that radio intelligently developed in the public interest is destined to become a potent auxiliary of international cooperation in bringing closer together broadcast listeners and wireless enthusiasts all over the world. Radio should perform valuable work in establishing common points of interest and in consolidating conscious world citizenship without which there can be no assurance of permanent peace between nations" (Wing, 1926a, p. 462).

Radio Broadcast offered listeners certificates of participation, suitable for framing, if they submitted a log of programs received. To aid them in identifying selections, the programs were listed in newspapers; however, to ensure the authenticity of listeners' reports, and to "throw off" zealous cheaters, one or two false selections, which would not be played were listed in each of the programs. A certificate would be denied any listener who submitted a false log. Unfortunately, reception both in North America and Europe proved again to be comparable to the results of 1923.

A report of the 1926 transatlantic tests concluded with this comment: "And so we write 'Finis' on the 1926 Tests. Better luck next time" (Wing, 1926b, p. 651)! Dreams of international broadcasting thereafter tumbled into oblivion; the three attempts showed convincingly that the broadcast band was unsuitable for reliable, effective radio telephony spanning the Atlantic. Moreover, as radio amateurs were beginning to demonstrate, the future of worldwide, direct broadcasting was in the shortwave regions of the frequency spectrum.

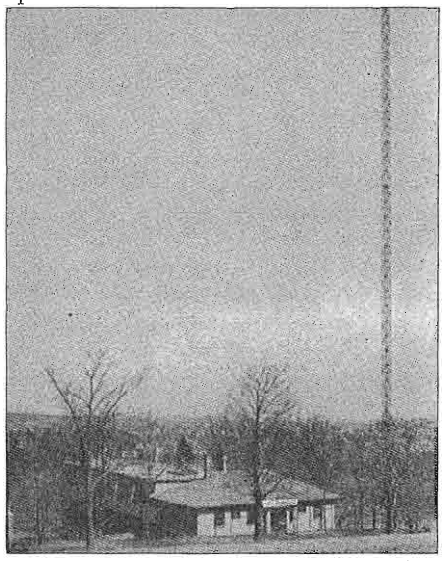

Figure 2: The first tower at WGI. This site is where the American Radio Research Company conducted experimental broadcasting in 1916. From Radio Broadcast, May, 1922, Vol. 1, p. 12.

WGI

The Hallicrafters Company celebrated its tenth anniversary in 1943—twenty years after Bill Halligan worked as a reporter for the Boston Telegram. On the occasion, Ray Durst, Halligan's partner, made the following remarks in tribute to Bill: "It is my good fortune to be close to Bill Halligan, my privilege to watch him work. I have seen him work under all kinds of pressure, but regardless of what he is up against he always comes out on top because his ideas are constructive and right" ("Oldtimers Give Dinner," 1943). I have documented elsewhere that staff members worked diligently for him, out of great respect. "Conditions overall were re-

warding, and they were proud to work for both Bill Halligan and Hallicrafters . . ." (Grinder, 2001, p. 38).

Bill Halligan's in-born, leadership skills were honed while interacting with friends and mentors long before he departed Boston for Chicago. Tobe Deutschmann, for example, with whom he established in 1925 the first "Radio Shack" store, is among the men who influenced him following his stint as a journalist (De Henseler, 1991).

A venerable aphorism holds the adolescent to be the father of the man. Who, then, might have been Bill Halligan's boyhood model as he aspired to attain social attributes and mature perspectives while becoming a radio operator in amateur, maritime, and naval services? Historical research may never provide consensus on the person's identity. Nonetheless, circumstantial evidence suggests that Harold J. Power, a neighborhood lad six years older than Bill Halligan may have been the most prominent individual who markedly affected his matriculation to adulthood.

Power, born July 19, 1892, was the singular force in 1915, at age 23, in launching "The American Radio and Research Corporation" (AMRAD) on The Tufts College campus. Subsequently, he established in 1916, an experimental amateur station, 1XE, and in 1921, procured the first federally licensed broadcast station in New England—WGI.

Power attended a public grammar school in Everett, MA, a Boston suburb on the north side of the Mystic River. Bill Halligan lived perhaps a mile from Power, on the south side of the river, near Bunker Hill and the naval station, NAD, at the Charlestown Shipyard. Wireless telegraphy was becoming in 1903 and 1904 viable on a commercial scale, and Power a charismatic, brilliant student, summoned up sufficient initiative to draw upon insights, scattered randomly throughout science magazines, to construct a simple spark-gap transmitter and a crude coherer receiver. Power tinkered diligently for a year and a half with the finicky coherer, until eventually, he managed to make out the call letters of NAD ("Reporter's statement," 1916).

"Jimmy" Power's tinkering attracted the attention of his teachers and members of the community. He was acclaimed a "radio wizard" while still in grammar school ("Reporter's statement," 1916); later, as a teenager, he was recognized as one of the more distinguished radio amateurs of Greater Boston (De Lue, 1950). Power's notoriety, knowledge, and operating skills led to accomplishments worthy of emulation. His traits spawned an informal, non-exclusionary cult of young, enthusiastic amateurs who saw in him a font of tutorial advice. To visit Power's modest station, which was in a small, tar-paper insulated room at the rear of his home, and then, to watch him send and receive signals, must have been awe-inspiring to youthful neighbors like Bill Halligan.

Power also modeled employment opportunities for younger acolytes. He showed them how acquisition of the skills of a radio telegrapher could qualify them for work in the maritime services. For example, during the summer of 1908, the De Forest Wireless Company employed Power at age 16 as a commercial radio operator. Next, he served on the steamship Harvard, of the Metropolitan Line, plying between Boston and New York. In 1909, the Marconi company, recognizing his talent, promoted him to radio operator aboard steamships traveling between Boston and Savannah, Georgia, and from New York to St. John's, Newfoundland. A few years later, Bill Halligan also worked for Marconi, traveling on the same steamship between Boston and Savannah (De Henseler, 1991).

Power enrolled in nearby Tufts Col-

lege as a freshman in the fall of 1910 at age 18. During his sophomore year, 1911, he co-founded the "Tufts College Wireless Society." He covered his tuition partially by teaching courses in radio technology at a nearby high school. Bill Halligan was 11 to 15 years old when Power attended Tufts. As a teenager, he probably visited the College Wireless Society and, perhaps, he even visited some of Power's classes.

Power earned a significant share of his tuition money by working each summer of his college years as a radio operator on yachts and steamships. The successive jobs that he obtained attest to the esteem adults held toward him. He spent the summer of 1911 aboard the "Nora" a private yacht of the late John Jacob Astor, who had lost his life when the Titanic sank; the summer of 1912 he served on the steamship, St. Louis, which visited English and French ports; the summer of 1913 he was aboard the "Corsair," which, fortuitously for the penurious Power, was the private yacht of J. P. Morgan. Power appears to have wholly convinced Morgan of the soundness of his ideas, in that Morgan advanced him $25,000 dollars start up money, and eventually, he may have invested as much as $800,000 in the potential of AMRAD (De Lue, 1950; Halper, 2001).

Power majored in electrical engineering at Tufts. During his senior year his attention turned to receiver development. Graduate courses for a year at Harvard following graduation enabled him to advance his theoretical understanding of receiver design. Power's self-assured, commanding acumen generated confidence among prospective benefactors. His former professors convinced the administration at Tufts to provide for him a building on the top of a hillside on its Medford campus, and importantly, J.P. Morgan provided funds to refurbish it into a sound and vibration proof AMRAD facility for research, manufacturing, and experimental amateur transmissions.

A 304-foot antenna tower was erected at the AMRAD building to boost the effectiveness of radio transmissions. It soon collapsed. However, the stability of a second tower was ensured when AMRAD elected to support it on four specially designed porcelain insulators, which, in turn, were imbedded in 15 tons of re-enforced concrete. The tower itself was held in position by 12 steel guy wires, one inch in diameter. The wires were secured at different heights and anchored at their bases in huge blocks of concrete. On at least two occasions, students risked their lives by climbing to the top of the tower in order to hang class flags.

AMRAD owed its existence to the proposition that radio listeners could be enticed to purchase ready-made receivers or components for building them. Power realized, four years prior to the first KDKA broadcast, that the general public would require more than an arcane series of dots and dashes before it would invest in receiving equipment. Therefore, on Saturday evening, March 18, 1916, Power played records for listeners over amateur station, 1XE. Perhaps he used the studio phonograph shown in the picture of WGI (see Installment 5). Power had devised for the occasion a special microphone the size of a megaphone. The broadcast was scheduled to coincide with a time when J. P. Morgan was off the coast of Cape Cod in the wireless room of the Philadelphia. He listened appreciatively with headphones clamped over his ears. The extraordinary moment reinforced his resolve to continue his financial backing of AMRAD.

Perhaps the 1XE transmission was the first continuous, full-evening entertainment broadcast in America. Two weeks later, a longer, continuous program was broadcast. Shortly thereafter, 1XE began broadcasting regularly every two weeks, and then, once a week.

In 1920 daily broadcasting began. In May, 1921, 1XE became WGI. At this time, WGI initiated both day and evening programming (De Lue, 1950).

Although 1XE began regular broadcasting before KDKA broadcast the national election returns on November 2, 1920, Westinghouse claimed appropriately that KDKA was the first station licensed explicitly as a broadcast station by the Department of Commerce to broadcast on a daily schedule on an assigned wavelength (360 meters). Power claimed later, however, that all early stations were issued licenses for broadcasting on 360 meters because he had shown via 1XE that the wavelength provided satisfactorily a clear channel among military and commercial radio telegraph stations (De Lue, 1950).

WGI was the first station in New England to initiate regular broadcasting, and for a time, it seemed, everybody listened to the station on an AMRAD crystal set. The station broadcast initially only few hours a day. Mostly classical piano music and extemporaneous announcer chit-chat was featured. Commercials were non-existent (see Installment 6, "Bearing expenses of programming"). Tuft students volunteered their musical skills. Even the AMRAD employees who kept 1XE and WGI operating during the evening hours received no extra pay (Halper, 2001).

WGI made radio history in spite of its insubstantial circumstances. Professors at Tufts pioneered in broadcasting college lectures; the station also offered timely weather and stock market reports, and it sponsored religious programs, dramatic presentations, and children's programming. Further, Boston Mayor James Michael Curley in 1921 broadcast a partisan political speech over WGI, which was probably the first such speech in the country.

Programming was beginning to attain quasi-professional status by May, 1921. WGI attracted live concerts and famous guests speakers, including Tuft's better know professors, opera singers, famous authors, notable economists (see Installment 5, "Radio Programs). When 1XE was the only station around, the "big names" in the greater Boston area sought the forthcoming publicity. Later, in 1922, as Halligan's vignettes indicate, E. Lewis Dunham, popularly known as "Uncle Eddie," began to tell stories and to entertain listeners, since he was an accomplished pianist, organ player, and impressionist. About the same time, Bob Emery, chief announcer and program manager, a self-proclaimed "Big Brother" to all the youngsters in the WGI listening audience, began to read them stories and to urge them to join the WGI "Big Brother's Club".

Sadly, in spite of its initial success, WGI failed because of the severity of encroaching competition and Power's surprising inept management of AMRAD (Halper, 2001). Stations with more powerful signals and equally good programming evolved in the Boston area. WNAC, owned by the prosperous Shepard Department stores, drew away a large proportion of WGI listeners. WBZ, although 100 miles away in Springfield, established a studio in a major Boston hotel, thus increasing its presence in the city. Competition for guests not only intensified, but performers increasingly demanded payment. Finally, "Big Brother" Bob Emery, the heart and soul of WGI, left for more lucrative employment at WEEI, the new station of the Edison Electric Illuminating Company.

Halper (2001) also observes that Power's marketing policies were haphazard. AMRAD failed to fill orders in a timely fashion. WGI's financial problems mounted in late 1923, and the station was off the air due to equipment problems several times. Few radio fans knew how serious the problems at AMRAD were becoming. Bill Halligan, however, could hardly have

been unaware of them. His vignettes reveal that he praised the programming of the station whenever he could. Power had been such a dominant icon in Boston amateur, manufacturing, and broadcasting circles that Halligan must have been both surprised and disappointed to see him falter.

At times during 1924 and 1925 Boston newspapers mentioned WGI's poor technical quality and on-going signal problems (Halper, 2001). In February 1925, the call letters of WGI changed inexplicably to WARC. The new identity did not stop its relentless downward spiral. Broadcast scheduling grew intermittent. The station started sharing 360 meters with a religious station; then, one day in April, 1925, WARC simply vanished without warning or explanation. Tufts was poised to take back its building. Creditors wanted their money; financial investors, including J. P. Morgan, had disappeared. Harold Power thus sold what was left of the resources of AMRAD to Powell Crosley, a distinguished manufacturer of broadcast receivers and owner of powerful WLW, Cincinnati. Power drifted in oblivion as Crosley dispersed his dwindled assets (Halper, 2001).

REFERENCES

Bergreen, L. (1980). Look Now, Pay Later. The Rise of Network Broadcasting. Garden City. NY: Doubleday & Co.

Boucheron, P. (1923, July). Radio Broadcast Central. Radio Broadcast, 3, 254-255.

Collison, P. (1922, September). Shall we have music or noise? Radio Broadcast, 1, 434- 438.

De Henseler, M. (1991). The Hallicrafters Story, 1933-1975. Charleston, WV: Antique Radio Club of America.

Douglas, S. D. (1987). Inventing American Broadcasting, 1899-1922. Baltimore: The Johns Hopkins Press. xi-xxix, 3-363.

Editor, (1923a, March). Supplemental List of Broadcasting Stations in the United States from December 25 to January 13 Inclusive. Radio Broadcast, 2. p. 426.

Editor, (1923b, June 30). Old Friends with New Wave Lengths. Radio World, 3, p. 25.

Editor, (1923c, July 20). Peak in Broadcasting Stations Reached. Radio World, 3, p. 18.

Editor, (1924, January). The transatlantic broadcasting tests and what they prove. Radio Broadcast, 4, 183-191.

Editor, (1938, January). Domestic set sales . . 1922-1937. Radio Retailing, p. 26.

Grinder, R. E. (2001, March). Bob Samuelson, Silent Key. Electric Radio, #142, pp. 2-3, 37-39.

Halper, D. L. (2001). The Rise and Fall of WGI, the First Station in Massachusetts. Http://www.bostonradio.org/radio/wgi.html.

Jackson, J. H. (1922, November). Should Radio be used for Advertising? Radio Broadcast, 2, 72-76.

Keller, W. A. (1927, May 24). Keller's Radio Call Book and Log. St. Paul: W. A. Keller Co., pp. 1-32.

Lynch, A. H. & Wing, W. K. (February, 1925). The International Radio Broadcast Test of 1924. Radio Broadcast, 6, 676-673.

Morecroft, J. H. (1922, May). Radio Currents. Radio Broadcast, 1, 1-4.

Morecroft, J. H. (1923a, July). The March of Radio. Radio Broadcast, 3, 179-189.

Morecroft, J. H. (1923b, August). The March of Radio. Radio Broadcast, 3, 269-281.

Morecroft, J. H. (1924, February). The March of Radio. Radio Broadcast, 4, 271-282.

Old-Timers Give Dinner in Honor of Bill Halligan. (1943, November).

Hallicrafters Tuner, 2, 1-12, p. 6.

Reporter's statement. (1916, January 2). American Radio and Research Corporation. Boston Sunday Herald.

Rodgers, W. W. (1923, June). Is Shortwave Relaying a Step Toward National Broadcasting stations? Radio Broadcast, 3, 119-122.

Wing, W. K. (1926a, February). The 1926 International Radio Broadcasting Tests. Radio Broadcast, 8, 462-466.

Wing, W. K. (1926b, April). What Happened During the 1926 International Tests? Radio Broadcast, 8, 647-651.

ER

VINTAGE NETS

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

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

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

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

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

Canadian Boatanchor Net: Meets daily on 3725 kc (+/-) at 8:00 PM ET. Hosts are AL (VE3AJM) and Ken (VE3MAW)

Collins Collectors Association Nets: Technical/swap sessions meet every Sunday on 14.263 mc at 2000Z. Informal ragchew nets meet Tuesday evening on 3805 kc at 2100 Eastern time, and Thursday 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 1700Z.**

Collins Collector Association Monthly AM Night: Meets the first Wednesday of each month on 3880 kc starting at 2000 CST, or 0200 UTC. All AM stations are welcome.

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

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

Drake Users Net: This group gets together on 3865 kc, Tuesday nights at 8 PM Eastern Time. Net controls are Gary (KG4D), Don (W8NS), and Dan (WA4SDE)

DX-60 Net: This net meets on 3880 Kc at 0800 AM, Eastern Time on Sundays. Net control is Mike (N8ECR), with alternates. The net is all about classic entry-level AM rigs like the Heath DX-60.

Eastern AM Swap Net: Thursday evenings on 3885 kc at 7:30 PM Eastern Time. Net is for exchange of AM related equipment only.

Eastcoast Military Net: Check Saturday mornings on 3885 kc +/- QRM. Net control station is 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 at 7 PM Eastern Time on 50.58 mc. This is another long-time net, meeting since the late '50s. Most members use vintage or homebrew gear.

Gray Hair Net: The oldest (or at least one of the oldest at 44+ years) 160 meter AM nets. Net time is Tuesday evening on 1945 kc at 8:00 PM EST and 8:30 EDT. Also check www.hamelectronics.com/ghn

Hallicrafters Collectors Association Net: Sunday on 14.293 mc, 1730-1845 UTC. Control op varies. Midwest net Sat. 7280 kc 1700Z. Control op Jim (WB8DML). Pacific Northwest net Sunday 7220 kc at 2200Z. Control op Dennis (VE7DH).

Heathkit Net: Sunday on 14.293 mc 2030Z right after the Vintage SSB net. Listen for 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 on 14.286 mc has been in continuous operation for at least 20 years. It starts at 5:00 PM Pacific Time and goes for about 2 hours.

Midwest Classic Radio Net: Meeting Saturday morning on 3885 kc at 7:30 AM, Central Time. Only AM checkins are allowed. Swap and sale, hamfest info, and technical help are frequent topics. Control op is Rob (WA9ZTY).

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

Northwest AM Net: AM activity is daily 3 PM to 5 PM on 3875 kc. The same group meets on 6 meters at 50.4 mc. Times are Sundays and Wednesdays at 8:00 PM. 2 Meters Tues. and Thurs. at 8:00 PM on 144.4 mc. The formal AM net and swap session is on 3875 kc, Sundays at 3 PM.

Nostalgia/Hi-Fi Net: Started in 1978, this net meets Friday at 7 PM Pacific Time on 1930 kc.

Old Buzzards Net: Daily at 10 AM local time on 3945 kc in the New England area. Listen for net hosts George (W1GAC) and Paul (W1ECO).

Southeast Swap Net: Tuesday at 7:30 PM Eastern Time on 3885 kc. Net controls are Andy (WA4KCY) and Sam (KF4TXQ). Group also meets Sunday on 3885 kc at 2 PM Eastern Time.

Southern Calif. Sunday Morning 6 Meter AM Net: 10 AM on 50.4 mc. Net control op is Will (AA6DD).

Swan Nets: User's Group meets Sunday at 4 PM Central Time on 14.250 mc. Net control op is usually Dean (WA9AZK). Technical Net is Sat, 7235 kc, 1900Z. Net control is Stu (K4BOV)

Vintage SSB Net: Sunday 1900Z-2030Z 14.293 & 0300Z Wednesday. Net control Lynn (K5LYN) and Andy (WBØSNF)

West Coast AMI Net: 3870 kc, Wed. 8PM Pacific Time (winter). Net control rotates between Skip (K6YKZ), DJ (K6RCL), Don (W6BCN), Bill (N6PY) & Vic (KF6RIP)

Westcoast Military Radio Collectors Net: Meets Saturday at 2130 Pacific Time on 3980 kc +/- QRM. Net control op is Dennis (W7QHO).

Wireless Set No. 19 Net: Meets the second Sunday of every month on 7270 kc (+/- 25 Kc) at 1800Z. Alternate frequency is 3760 kc, +/- 25 kc. Net control op is Dave (VA3ORP).

CLASSIFIEDS

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Deadline for the February 2004 Issue: Friday, Jan. 30

FOR SALE: Repair and restoration on all vintage equipment; 45 years experience. Barney Wooters, W5KSO, 8303 E. Mansfield Ave., Denver, CO 80237. 303-770-5314

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: WW2 prop pitch motor for P-38. Appears ready for service. $225 + shipping. Tom, 281-996-5835, N5ACA@juno.com

FOR SALE: FRR/59A receiver in a rolling Bud cabinet, needs alignment, $400. George Portell, W8QBG, 480-986-5797.

FOR SALE: Collins 75A-4 with three filters. Very Clean. Works fine. $1285. Joel, W4SLH, 337 Compass Point Dr., Oriental, NC 28571, 252-249-2344, jmele@always-online.com

FOR SALE: SR500, 75A-4, SX-115, HT-32B, KWM-2, SE-150, T-4Xb, R-4b, TR-4, SX-117, HT-44, More. Bob Ryals, KIØGF, 719-265-9950, Joebob1@Adelphia.Net

FOR SALE: Johnson Viking 500. Fully operational an on the air. Peter Dahl plate transformer. $1575. Joel, W4SLH, 337 Compass Point Dr., Oriental, NC 28571, 252-249-2344, jmele@always-online.com

FOR SALE: 1 each Collins MP-1 mobile power supply. 2 each Collins CC-2 Samsonite carrying cases, very good condx. Made offer to Roger, W8CRK, 1-513-481-5885.

FOR SALE: Taking offers on General Curtis LeMay's Collins S/Line. (While stationed in the pentagon) .75S2/32S2/312B4 with orig boxes. (except 312B4) A 516F/2 is included but it's not part of LeMay's rig. For furthur info please contact JOE/K2QPR at the following E/Mail address: poil721@cs.com or fone # 772 215-6773 pix available on request.

FOR SALE: RME-45, $50. Harvey Wells TBS-50C w/Pwr Sply, VFO good condx for restoration, no manual $50. Rider manuals Vol's 7,8,9,10,11,12,14 $10 each or $50 all 7. Drake: R4-B, T4-XB, cables, spkr, pwr sply in cabinet, mic and 2nd T4-XB plus pwr sply $450 for all, clean equipment. Hammarlund SP-600-JX-26 no cabinet, rack version, good condx, $200. IC-2AT, charger, batt. Pack $35. Tripp Lite PV1000FC 1KW sq wave 60 cy power inverter $25. All plus shipping. Jack Hemp, W8JNH, 5046 SR 49 S, Greenville. OH 45331-9750, 937-548-4110.

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FOR SALE: Collins speech processor model LC-1-32S for all 32S series transmitters. $145. Joel, W4SLH, 337 Compass Point Dr., Oriental, NC 28571, 252-249-2344, jmele@always-online.com

FOR SALE: Request free vintage flyer. USA only. 50 years of mail order electronics. Bigelow Electronics, POB 125, Bluffton, OH 45817-0125

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FOR SALE: 1920's oak-cased radio room clock by Warren Electric of Ashland, MA. Paul Recupero, 265 Union St. Portsmouth, RI 02871-2264

FOR SALE/TRADE: Original manuals: 30L-1, 75S-3B/C, KWM-2/2A, 32V-2, HQ-100, HQ-110A, HQ-145, HX-500, HRO-500. 407-351-5536 ni4q@juno.com

FOR SALE: Knight KN-4550 cardioid dynamic mic, circa 1960; 60-13,000 HZ, scratch free, full chrome luster 150 ohm or hi-z. $100.00 Bob, kd9gi@msn.com 815-332-9520

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FOR SALE: Galena crystal radios, homemade, also parts, with pix available. Radio tubes, most used, free lists. Len Gardener, 458 Two Mile Crek Rd., Tonawanda, NY, 14150. email: radiolen@att.net

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

FOR SALE: General Radio 1606A antenna bridge w/manual and carrying case. Stuart T. Carter, II. W4NHC, 680 Fernwood Drive, Melbourne FL 32904-1995, 321-727-3015

FOR SALE: L&N Wheatstone bridge, $35. GR 726-A VTVM, manual copy, $35. GR 1312 Oscillator, manual copy, $45. Ross Wollrab, 229 N. Oakcrest Ave, Decatur, IL 62522-1810. rewollrab@aol.com

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FOR SALE/TRADE: Original manuals: National, Drake, Johnson, Hallicrafters, Hammarlund, Gonset, Swan, WRL, B&W, Knight, Lafayette, others. Ni4q@juno.com 407-351-5536

FOR SALE: KWM-2A plug-in relays K2 & K4 manufactured by Allied Signal, P/N T163-6C-115D and T163-4C-115D. $35.00 for a set + $3.85 priority mail. Mike Hutnick, 450 Riverview Ave., Bloomsburg PA, 17815, hutnick@epix.net

FOR SALE: Lafayette HA-410 AM transceiver, $125; Tecraft Criterion II 6 & 2 meter converters, $100 both. Richard Prester, 131 Ridge Road, West Milford, NJ 07480. 973/728-2454. rprester@warwick.net

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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 Prky, Escondido, CA 92029. 760-747-8710, w6zz@cox.net

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

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FOR SALE: Collins reproduction items available through the CRA on www.collinsra.com. Join the CRA and subscribe to the Collins Journal. Dave, W3ST

FOR SALE: 2-meter Yaesu HT, FT-207R w/ acc, no battery pack, manual, works OK, #35.00. Len Gardner, W2QBC, 458 Two Mile Creed Rd., Tonawanda, NY, 14150. email: radiolen@aol.com

FOR SALE: NRI Training Course and Dictionary, $20 US. **WANTED:** March 1964 Trains Magazine. Louis L. D'Antuono, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612

FOR SALE: American All 80 TRF wood grain metal, nice chassis, Guild Victrola 1950's. Paul Recupero, 265 Union St. Portsmouth, RI 02871-2264

FOR SALE: Pair of ART-13's $250. Navy TDB Xmtr. Pick up only western PA. Brian Roberts K9VKY, 130 Tara Dr., Fombell, PA 16123 , 724-758-2688.k9vky@arrl.net

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FOR SALE: YAESU's FT-902DM HF Transceiver Excellent $450.00, FT-221 2mtr all mode Transceiver Excellent $175.00. John W8DKI jalw8dki@hotmail.com, 1-936-872-3755.

WANTED: Fully functional with manuals: Johnson AN/FRT505 transmitter, Swan F51 and FC76. Contact Ric at C6ANI@arrl.net

WANTED: Schematic for Bogen DB-20 amplifier,or service amnual. Will pay $20 cash. Charles Graham, K2GVE, 4 Fieldwood Drive, Bedford Hills, NY. 10507.

WANTED: Cabinet for RME-45. Panel opening 101/2" X 19" by at least 101/2" deep. Will buy non-RME cabinet or junker. Robert Haworth, W2PUA, 112 Tilford Rd. Sommerdale, NJ, 08083 856-783-4175.

WANTED: BC-456 or MD-7 modulator. Tim, N6CC, 925-830-9474. timsamm@attglobal.net

WANTED: One good-to-excellent working condition Heathkit DX-60. Prefer the original model but will settle for an A or B in good shape. Luke, K4JEJ, 561-262-5668. k4jej@adelphia.net

WANTED: "The Care and Feeding of Power Grid Tubes" by Robert Sutherland, W6UOV. Keith Kunde, K8KK 216-524-7698 k8kk@arrl.net

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

WANTED: Operating instructions or diagram for a Hickok VTVM model **209B**. W.J. Klewchuk, POB 927, Wadena Sask., Canada SØA 4JØ.

WANTED: Meter or meter lens for Gonset Communicator IV. KEØQM. 913.782.9092 ke0qm@planetkc.com

WANTED: Anything by DAVID GRIMES: radios, Especially Model 3XP, advertising, ephemera, literature; please contact: Mike Grimes, K5MLG; 3805 Appomattox Cir; Plano, Texas, 75023, (972) 867-6373. Email: rimesm@flash.net

WANTED: Sonar FR-104 30-50 MHz receiver, also Dynaco Mark II or Mark III audio amp. Bill Smitherman, KD4AF, 336-699-8699

WANTED: Hallicrafters SX-25 parts: S-meter, top cover with lid, bottom plate. Ken, K8AXH, Ken Kolthoff, PO Box 215, Craig MO, 64437, work # 913-577-8422

WANTED: Escutcheon for a Westinghouse WR-5 Low Boy console built by RCA as a Radiola 80. James F. Kelly, WAØFBQ, PO Bos 25, Long Lane, MO 65590

WANTED: Johnson 250E30 variable capacitor. W9KV, jimscott@bresnan.net or 970-247-5563

WANTED: Coils for an EICO model 710 grid dip meter. Bob Farricy, K2QZ, 315-472-2702

WANTED: Please, help me in my NC-183D restoration. Need: S-meter, knobs, toggle switches, bottom covers, L40, T12. If needed, have contact in USA for shipping purposes. NC183D Winter Project: http://jvgavila.com/nc183d.htm. Thanks! JOSE <eb5agv@ctv.es>

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

WANTED: Diversity panel to hook up two Hammarlund SP-600-JX's in diversity mode. K8CCV, Box 210, Leetonia, OH 44431-0231, 330-427-2303.

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

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

WANTED: WW2 Navy MBF transceiver, hopefully unmodified. John Svoboda, W6MIT 530-672-0903 or svoboda@directcon.net

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: HQ129X cabinet. Condition not important since I can strip and re-paint if necessary. Joe Fell, W3GMS, e-mail joseph.fell@Unisys.com or phone 610-648-4425.

WANTED: James Millen coils 42080, 42040, 42015, 43015. Navy SE2511/SE2512 receiver, SE2513 coil set. Gary Carter, WA4IAM, 1405 Sherwood Drive, Reidsville, NC 27320. Phone: 336-349-1991. Email: gcarter01@triad.rr.com.

WANTED: R-1051/URR top condition top price. IZ1FID federico.baldi@virgilio.it fax +390384672219

WANTED: Correspondence with others (am incarcerated) on Military (especially R-390's & backpacks) and tube rigs. Also looking for copies of old surplus catalogs postwar thru 90's. W.K. Smith, 44684-083, FCI Cumberland Unit A-1, POB 1000, Cumberland, MD 21501.

WANTED: #33A and #35 Universal SW-3 coils for cash or other coils. Hank Bredehorst 2440 Adrian St Newbury Park, CA 91320. 805 498-8907 quailhill@earthlink.net

WANTED: 23 channel tube-type CB radios for 10-meter conversions. Also tube-type 10-meter linear amplifiers. Ed, WA7DAX, 1649 East Stratford Ave., Salt Lake City, UT., 84106. 801-484-5853

WANTED: Looking for the emblem of National "NC". Katsu JO1GEG/ex.N8EYH, khirai@ieee.org

WANTED: Audio transformers, with good windings, for Westinghouse RADA and Aeriola SR. amplifier. Paying $40.00 each plus shipping. Roland V. Matson, POB 956, Lake Panasoffkee FL

WANTED: WW-2 Japanese Military Radio of any kind. Yokohama WW-2 Japanese Military Radio Museum, Takashi Doi, 1-21-4,Minamidai, Seyaku, Yokohama, 246 Japan takadoi@carrot.ocn.ne.jp http://www.yokohamaradiomuseum.com/

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, www.r-389.com

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: Older rigs & accessories. Brian Carling, AF4K, 117 Sterling Pine St., Sanford, FL 32773. http:/ /come.to/AF4K/

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

WANTED: National Co. emblems, escutcheons, and logos from equipment, also National AN/WRR2 in working order. Don Barsema, 1458 Byron SE, Grand Rapids, MI 46606. 616-451-9874. dbarsema@prodigy.net

WANTED: ARC-5 rcvrs, racks, dynamotors. Jim Hebert, 1572 Newman Ave. Lakewood, 0H 44107.

WANTED: Top prices paid for globe shape radio tubes, new or used. Send for buy list or send your list for offers. Write or email: tubes@qwest.net See WWW.Fathauer.Com or send for catalog of tubes for sale. George H. Fathauer & Assoc., 688 West. First St., Ste 4, Tempe, AZ 85281. 480-968-7686, Call toll free 877-307-1414

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

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

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

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

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

WANTED: R-390A rcvrs, parts rigs or restorable, will restore yours at reasonable prices. Walter Wilson, KK4DF, 706-733-8323 wewilson@knology.net, www.knology.net/~wewilson

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

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

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

WANTED: Orig Heath manuals for ham & test equip. Please state condx & price. Warren, K1BOX, NC, 828-688-1922, k1box@arrl.net

WANTED: WW II German, Japanese, Italian, French equipment, tubes, manuals and parts. Bob Graham, 2105 NW3Oth, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

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

WANTED: I wish to correspond with owners of National FB7/FBXA/AGS coil sets. Jim, KE4DSP, 108 Bayfield Dr., Brandon, FL 33511 j.c.clifford@Juno.com

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

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

WANTED: Any books featuring panel meters, gauges, or flight instruments. Chris Cross, POB 94, McConnell, IL 61050.

WANTED: Eico 628 tube tester Window & lever knob; Zenith 5C-01/5D-011 Consoltone radio cabinet. Robert P. Morrison, 10238 117th Lane, Live Oak, FL 32060. Ph: 386-362-521. E-mail: rmorison@suwanneevalley.net

WANTED: National NC-173. Armond Noble, N6WR, 916-457-3655. 2120 28th St., Sacramento, CA 95818 N6WR@msn.com

The Collins Video Library

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The Collins 75A-4 Video (4 hours, $89.95) This video is four hours of great information on how to repair, maintain and restore this classic receiver. Butch Schartau (K0BS) guides you through all aspects of keeping your 75A-4 running like a top.

R-390A Video (7 hours, $109.95) At last it's available! Long awaited by serious "boatanchor" enthusiasts this is a great video all about the ultimate receiver. Now you will have the ultimate video to go along with it. R-390A expert Chuck Rippel (WA4HHG) covers an absolutely incredible array of information in this "heavy duty" video. This video looks at operation, the receiver modules, complete circuit description, front and rear panel details, complete mechanical and electrical alignment, PTO details, and performance evaluation, modifications, troubleshooting, and restoration. There is nothing like this video available today, at any price!

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WANTED: "Radio Engineering Handbook", 5th Edition (1959), by Keith Henney. Keith Kunde, K8KK 216-524-7698 k8kk@arrl.net

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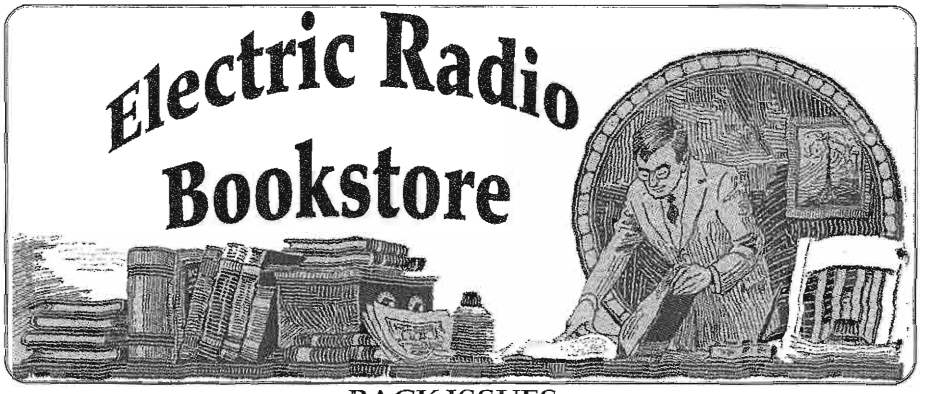

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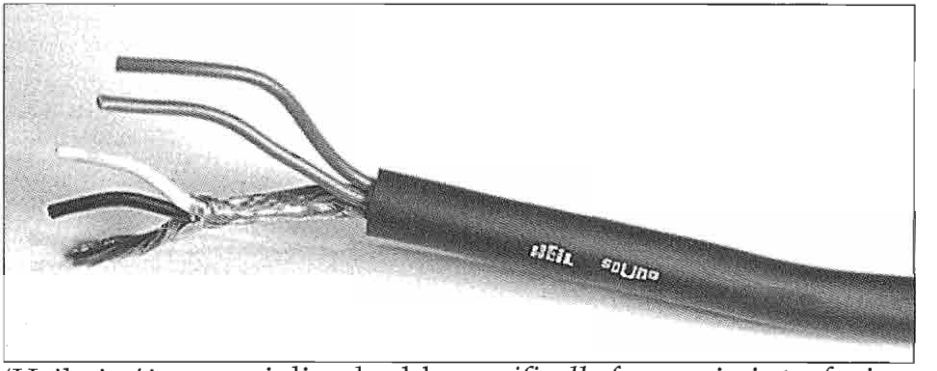

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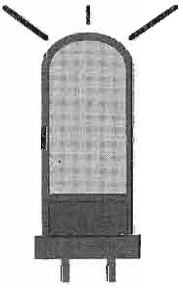

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