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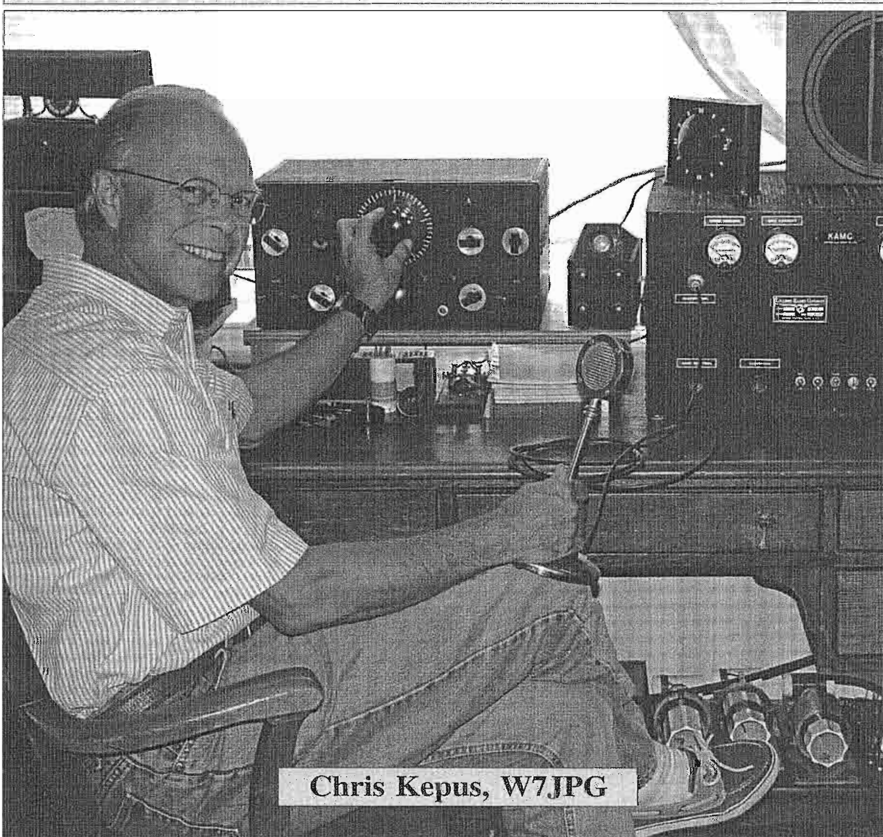
ELECTRIC RADIO

celebrating a bygone era

Number 220 September 2007



Chris Kepus, W7JPG

ELECTRIC RADIO

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

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

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

Editor's Comments

It's been a long, hot summer almost everywhere in the "lower 48" states this summer. Fortunately, it can't last much longer and we will have improving radio conditions to enjoy before too much longer. Don't forget the fall CX Exchange contest that is coming up September 30 and October 7. It's always a great, fun event, and provides a chance to work and hear equipment that is not on the air every day. Detail were mentioned in last month's issue.

The Lake Erie Boatanchors Group is having their fall meeting on September 22 at 9:00 AM Central Time. This will be happening in Daniels Park, about 20 miles east of downtown Cleveland, Ohio. The best way to get further information about the meet is to call Ron (W8KYD) on 440-888-1904, Jeff (WA8SAJ) on 440-951-6404, or Bill (K8DBM) on 440-333-6644. The group's attendance grows every year!

ER #219 Corrections

The cover of #219 shows W9UIG operating what is probably a HQ-120 Special, not the HQ-129X that the original caption claimed. In the Villard Negative-Cycle Inversion article, W8XO's name is "Muskopf." The schematic had a few errors. The .001-µf blocking caps are rated 3 kV. The grid-bias resistors should be 2.7k, *not* 27k. The filament bypass caps on the lower tube are .001 µf, 3 kV. The small type size made it difficult to read the ratings.

73, NØDMS, and Keep Those Filaments Lit!

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Cover: Northern California boatanchor collector Chris Kepus (W7JPG) spins the dial on a National NC-101X, which is next to a 1936 Collins 45A transmitter during a visit at K6GLH. Chris has been passionately collecting classic ham gear since retiring from Xerox and lives near Placerville, California. (Photo Courtesy Gary Halverson, K6GLH)

HONOR YOUR ELMER CONTEST

To date, we have received 17 entries in the Electric Radio "Honor Your Elmer" contest. I hope everyone with an Internet connection can visit www.ERmag.com and read them. There are some very excellent stories that have been sent in, including one from Victoria Sanita (AI4ZS) who is 11 years old. I am hoping to see many more than 17 stories posted before the end of the contest period, November 30, 2007.

We have lined up some great prizes for the winning stories. Bob Heil (K9EID) at Heil Sound has donated one of his excellent Classic Pro microphones. John Slusser (WF2W) at Radio Daze will be contributing a $100 gift certificate to one of the winners. Other prizes will include the MFJ-259B antenna analyzer and an electronic dial for vintage equipment. Other prizes include 1-and-2 year, 1st-class Electric Radio subscriptions. I hope to announce more prizes in coming months.

Again, here are the contest rules: The Electric Radio "Honor Your Elmer Contest" is an opportunity to honor the person who helped and guided your entry into amateur radio and have some fun doing it! As mentioned last month, we've got Mother's Day and Father's Day every year, but what about our Elmers? These folks deserve some recognition and respect too! The object is to tell your story and share it with the world. What better way to say "thanks" to whoever helped you become the ham you are today?

The contest rules are simple, just tell the story! 2000 words would be great, but the story is what's important. Because space is limited in the magazine, we'll put the Elmer stories we receive on the ER web site for the next 3 months. At the end of the year, readers can vote for the winning story, and the winner's story will be printed in Electric Radio.

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

ER

The 1938 National Transmitters
Part 3, The National NSA Speech Amplifier

By Jim Hanlon, W8KGI
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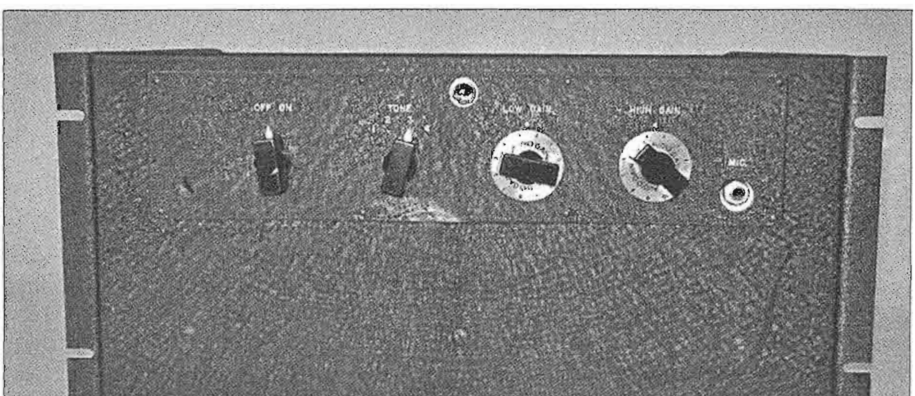
I have always thought that the NSA would be like the proverbial "purple cow." To paraphrase, "I've never seen an NSA, I never hope to see one. But I can tell you this right now, I'd rather see than be one." I certainly didn't expect to find an NSA for this article. But, a post to the Boatanchors Reflector brought a response from none other than Bill Fizette, W2DGB, the esteemed gentleman who provided me with my NTX-30 transmitter and NSM modulator. Bill does indeed have a marvelous collection. Bill hauled out his NSA, spruced it up, took the great photographs in this article, and wrote the sidebar that you will see at the end. So Bill, thanks very much one more time for your very real contributions to this dip into National history.

As I mentioned at the beginning of this series on the 1938 National transmitters, we are very fortunate to have QST articles detailing the development of the NTE exciter and the NSA speech amplifier. Dana Bacon, W1HZR, authored the QST article, "Some Practical Aspects of Speech Amplifier Design, Considerations in Obtaining Wide Frequency Response and Low Hum Level," that appeared in the April 1938 issue, just a month after the NTE article by Jim Millen was published. While it is certainly dated, this article contains a lot of solid, basic design information and would be a worthwhile read for someone designing or troubleshooting a tube-type speech amplifier, even today.

The design objectives for the NSA were to be a high-gain, high-fidelity speech amplifier for an amateur phone installation. It had an input system built for a high-impedance microphone,



A front-panel view of Bill Fizette's NSA speech amplifier, intended for rack mounting. Note the four-position tone switch, second from the left side.

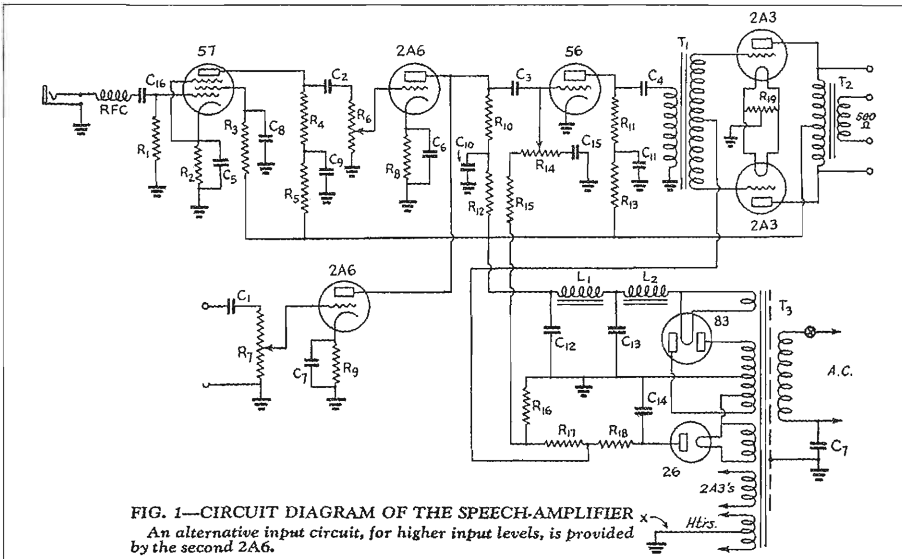


FIG. 1—CIRCUIT DIAGRAM OF THE SPEECH-AMPLIFIER
An alternative input circuit, for higher input levels, is provided by the second 2A6.

C_1, C_2, C_3, C_4—0.25-µfd. 400-volt paper.
C_5, C_6, C_7—25-µfd. 25-volt electrolytic (Aerovox MM25).
C_8—0.5-µfd. 400-volt paper.
C_9–C_{14}, inc.—8-µfd. 450-volt electrolytic.
C_{15}—0.005-µfd. 400-volt paper.
C_{16}, C_{17}—0.1-µfd. 400-volt paper
R_1—5 megohms, ½-watt.
R_2—1000 ohms, ½-watt.
R_3—1 megohm, ½-watt.
R_4—0.25 megohm, ½-watt.
R_5—0.1 megohm, ½-watt.
R_6, R_7—0.5-megohm volume control.
R_8, R_9—2500 ohms, ½-watt.
R_{10}, R_{11}—50,000 ohms, ½-watt.
R_{12}, R_{13}—20,000 ohms, ½-watt.
R_{14}—0.5-megohm volume control.
R_{15}—10,000 ohms, ½-watt.
R_{16}—2700 ohms, ½-watt.
R_{17}—11,000 ohms, ½-watt.
R_{18}—26,000 ohms, 1-watt.
R_{19}—10-ohm ct. (Yaxley).
T_1—Audio transformer, single-plate to push-pull grids (National HFI).
T_2—Class-AB output transformer, 2A3 plates to 500-ohm line (National HFO).
T_3—Power transformer, 400 volts each side c.t., with bias tap at 145 volts; with 5-volt, 1.5-volt and 2.5-volt windings (National HFA).
L_1, L_2—12 henrys, 125-ma. (National 80).
RFC—2.5-mh. r.f. choke.

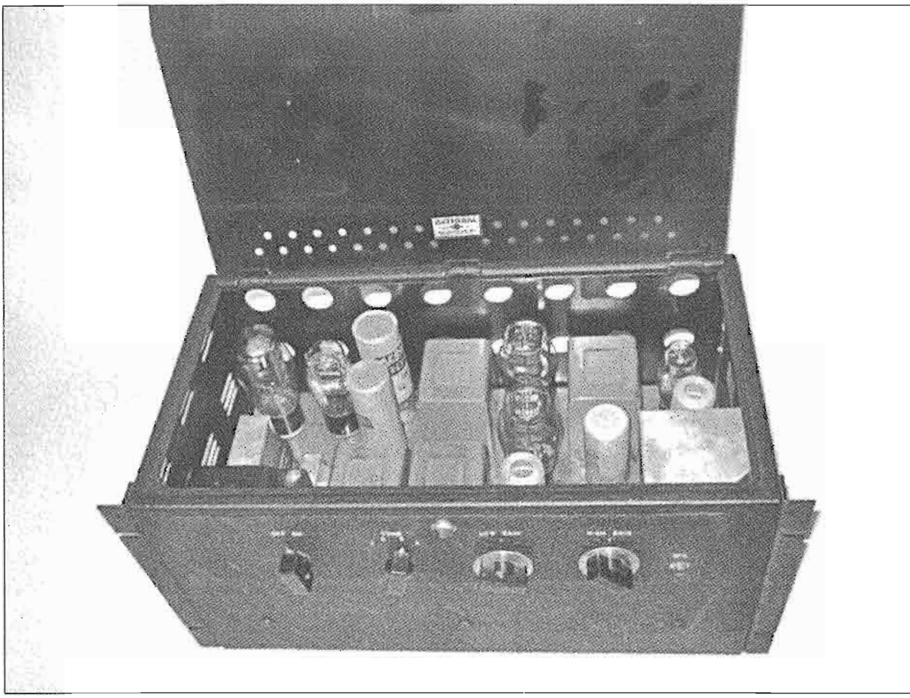
Figure 1: National NSA Speech Amplifier from QST, April 1938.

generally a crystal mike, an overall gain of about 125 dB, and a frequency response that was flat from about 30 to 10,000 cycles. There was to be sufficient power to drive a good-sized modulator and hum level, distortion, etc. must be so low as not to be noticeable.

The first choice that Bacon made was his power-output tubes. There were Class-B modulator tubes available in 1938 that could deliver 500-to-600 watts of audio output, plenty to modulate an AM kilowatt. They required a driving power of only 10 or 12 watts. So he wanted his speech amplifier to deliver about 15 watts of drive. Bacon reasoned that "Since most of the screen-grid tubes and pentodes are quite fussy as regards load impedance and since their plate impedances are high, making the Class-B coupling transformer quite critical in design, the obvious choice is low-impedance triodes, such as the 2A3s. Two of these tubes, when operated in push-pull with fixed bias, will deliver 15 watts with only about 2.5 percent distortion. Inasmuch as the same tubes self biased with a cathode resistor, will deliver only 10 watts with 5 percent distortion, it is well worth while to use a separate fixed-bias supply."

To acquire bias for the 2A3s, he used a tap on one side of the high-voltage winding of his power transformer and a half wave rectifier. He chose a 26 triode for that rectifier because it would heat up as quickly as the 2A3s and supply them with bias as soon as they needed it.

To drive the 2A3s, which were operating in Class AB_1 and thus did not require any power, Bacon chose a 56 medium-mu triode. He couldn't develop enough



This top view of Bill's NSA shows the power supply on the left side and the audio amplifier on the right side.

gain from the microphone to the 56 in a single stage, so he chose a 57 pentode for the microphone-preamp stage followed by a 2A6 high-mu triode. He specifically chose a pentode for the microphone-preamp stage to minimize the input capacity of the first stage that would be shunted across the high impedance of the microphone and thus would limit the high-frequency response of his amplifier. He explained that the grid-to-plate capacitance of the 57 was much smaller than that of a triode, so the Miller Effect capacitance at the grid—the grid-to-plate capacitance multiplied by the stage gain—would be much smaller. As you can see by his circuit in **Figure 1**, he also included a second 2A6 as a high-level input stage for a phonograph cartridge or a carbon microphone with its plate driving the same plate load as the 2A6 microphone amplifier.

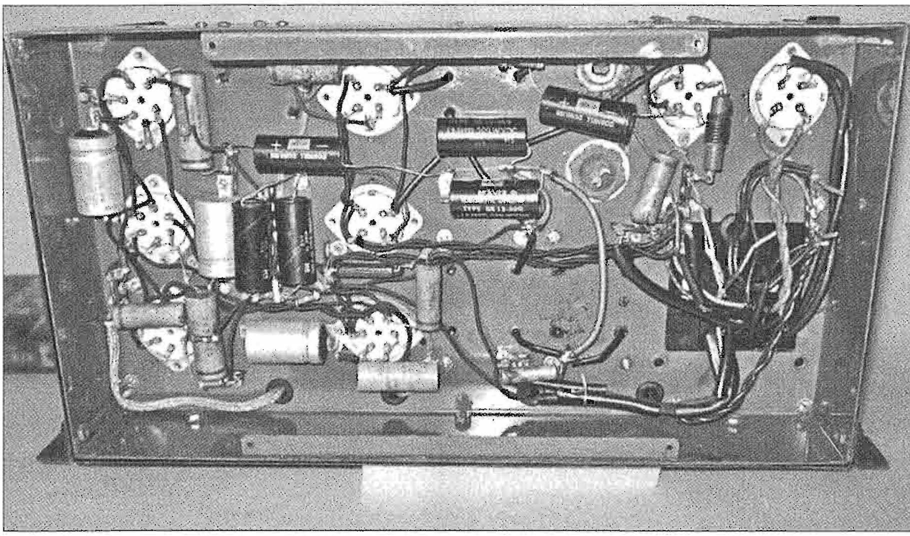
You will notice that Bacon chose to use 2.5-volt filament tubes throughout the prototype NSA as Millen did for the audio chain in his NTE. Bacon said that he actually started the design using 6.3-volt tubes, but it soon became apparent that the hum level from them was too high. Most of the hum originated in the heater circuit of the input tube, and of the many types he tried the 6J7 was the best, considerably better than a 6C6. He explained that the 6.3-volt tubes had two types of heaters. "One is of a double-spiral construction which overcomes the hum problem pretty well but is subject to microphonism, while the other employs a folded heater wire with no provision for balancing out hum. The latter is, however, very good from the microphonic standpoint. Even when using the 6.3 volt tubes having the spiral heater, it is usually necessary to center-tap the

In this rear view with the top of the cabinet removed, the power supply is on the right. The type 2A3 output tubes are just to the left of center, between the two transformers. The high-level input terminals are on the rear chassis wall, on the left. The two pairs of output terminals are on the right. The shield box on the upper left is the input stage and contains a type 57.

heater winding carefully and run it at a potential of 10 to 40 volts positive with respect to the cathode in order to prevent electrons emitted from the heater itself from reaching the grid. The situation is even more involved, however, since different tube manufacturers use different methods of heater construction and the dealers have no way of telling how any particular tube is built. All of these problems can be very easily avoided by using tubes with 2.5-volt heaters, since they are of uniform construction, and of the large number tested even the worst were considerably better than the average corresponding 6.3-volt type."

It is interesting to me that Bill Fizette reports that his production NSA also uses those same 2.5-volt tubes. National switched to the 6.3-volt versions of those tubes in the NTE exciter and used 6.3-volt tubes as well in the NSM modulator and in all of their receivers that they delivered in that time frame. James Millen explained this change in the National Ad in QST, April 1939, "In the past, we have strongly recommended the HRO's equipped with 2.5 volt tubes over those equipped with 6.3 volt tubes where operation was to be from an AC power pack rather than batteries. This recommendation was based largely upon the difficulty experienced with modulation hum encountered in the vicinity of 15 mc. when AC was used on the 6.3 volt tube heaters. For some months now, the 6.3 volt tubes we have been receiving from both of our suppliers have been so completely free of this former trouble that we are now able to offer a 6.3 volt tube HRO for AC operation that in every way equals the 2.5 volt tube model." But even though the tube manufacturers had gotten their act together as far as all of their other gear was concerned, National continued to build the NSA, their "high fidelity" amplifier of the day, with 2.5 volt tubes.

The frequency response of the circuit



Underneath the NSA chassis can be seen the high-quality ceramic tube sockets that were used in production.

Bacon developed had less than 1-dB variation in gain between 25 and 10,000 cycles and was down only "two or three dB" at 20 cycles. He explained, "It is a fairly simple matter to obtain an excellent frequency characteristic; there are only three or four points that must be watched. Cathode bias resistor bypasses must be at least 20 mfd.; 8 or 10 is not enough. Furthermore, these condensers should be of the low-voltage type in order that they will maintain their characteristics at the low potential at which they are used. Coupling condensers between stages are not fussy; if the grid leak resistor is at least one-half megohm, a 0.1 mfd. condenser will be large enough. Units of 0.25 mfd. are available at approximately the same price, however, and may be used if desired.

"The push-pull audio input transformer must be of good quality, and even the best transformer will be working at a disadvantage if the plate current of a tube is passed through its primary. The simple shunt-feed arrangement which supplies the plate of the 56 was found to be entirely satisfactory and with the particular transformer employed extended the lower frequency limit from 50 to 20 cycles. ...

"The transformer secondary should be balanced with respect to the primary, in order to obtain uniform high-frequency response. One of the inexpensive transformers that was tested had a secondary of conventional construction wherein one grid terminal was next to the primary and the other was at the outside end of the coil. This transformer had a rather peculiar characteristic since the end of the secondary that was nearest the primary had considerable shunt capacity which gave a dip in the frequency-response curve in the neighborhood of 6000 or 7000 cycles, while the outside end of the secondary contributed to a peak which showed up at about 10,000 cycles. While it would be possible to tune this peak to fill in the hollow, such practice is an unnecessary complication in view of the high-quality transformers that are available at reasonable prices."

Bacon then went on to describe how he eliminated low-frequency oscillations from his amplifier. This is a subject particularly dear to me, since my older brother had built a modulator for our rig back in the 1950s and had struggled mightily to eliminate those "motorboats" arising from feedback coupled through the B+ line.

As Bacon said, "Strangely enough, and very luckily, the same means used to obtain stability, or freedom from motor-boating will, at the same time, minimize hum and improve the frequency characteristic. The plate circuits of the three low-level stages are each individually filtered with 20,000 ohm resistors and 8-mfd. condensers. These were found to be entirely adequate and will eliminate any trace of motor-boating. At the same time, they constitute extremely efficient power-supply filters which prevent any ripple from the plate supply from reaching the signal circuits. Similarly, the 25 mfd. cathode by-pass condensers, in addition to extending the low-frequency response of the amplifier, serve to remove any 60-cycle component that is picked up by the cathodes from the heaters."

Bacon did a considerable amount of additional experimental work to minimize the hum in his NSA. He started by pulling out all of the tubes except for the 2A3 output stage, shorting the 2A3 grids together, and then adjusting a variable, grounded center-tap resistor across their filaments for minimum hum. He then removed the driver transformer short and twisted the transformer around on the chassis to find the orientation that produced minimum hum pickup. Next, he activated the 56 stage and checked its plate filter and the bias-supply leads for sources of hum. In this manner, he worked back through the amplifier to the input stage.

For the input stage he found that the tube and all circuit elements associated with the grid and the cathode had to be completely shielded, including the microphone jack, coupling condenser, r.f. choke, grid leak, cathode resistor, and cathode-resistor bypass. He mounted them all inside a rectangular shield can, which he found must be solidly grounded to the chassis and should not touch the front panel or cabinet, lest circulating currents in the shield cause hum or r.f. feedback. Also, the cathode resistor and its bypass condenser, the grid-leak resistor and the microphone jack needed to have a common ground point inside the shield. Since the input stage was fairly close to the power transformer, that ground point had to be "selected experimentally with considerable care." Lastly, the gain control needed to be of the non-inductive type and its leads had to be completely shielded.

Bacon included a tone control in his NSA, R14 in the grid circuit of the 56 driver. It attenuates either the high or the low audio frequencies. He suggested that it be used to compensate for microphone peaks in the high-frequency range or to weaken the bass-voice frequencies in order "to effect a much higher level of modulation on frequencies in the middle range, which are most necessary from the standpoint of intelligibility." As you can see from his pictures, in Bill Fizette's production model of the NSA, the tone control turned into a four-position rotary switch.

To eliminate r.f. feedback, in addition to the shielding and filtering techniques already employed, Bacon recommended that the amplifier as a whole be shielded. "All external leads; i.e., the microphone cable, the a.c. supply cord, and the output leads, either must be well-filtered or thoroughly shielded. In the case of the a.c. cord, a 0.1 mfd. condenser connected from one side of the line to the chassis will suffice. In addition, the power transformer should have an electrostatic shield to separate the primary from the other windings. The output circuit, being of fairly low impedance (not over 5000 ohms), can be by-passed to chassis with small mica condensers, although this will not be necessary unless the r.f. field around the equipment is exceptionally strong."

Bacon concluded his article, "Equipment built in accordance with the above suggestions will constitute a complete and self-contained unit which may be used with almost any microphone pickup, loud speaker, or transmitter. An amplifier of this type does not become obsolete and it is a worth-while addition to any radio shack, even though it may sink to the level of being used for p.a. work!"

I will also observe that the NSA circuit is very nearly the same as the speech amplifier built into the NTE exciter. The reader can compare the NSA schematic of Figure 1 to the NTE schematic published in ER #218 for July 2007. Differences are minimal. The NSA has a second, high-level input with its associated 2A6 amplifier, absent in the NTE. The NSA uses a radio-frequency choke in its microphone lead where the NTE uses a 50,000-ohm resistor. The screen-bypass capacitor on the first amplifier stage is 0.5 mfd in the NSA, 0.1 mfd in the NTE. The NSA uses 0.25 mfd coupling condensers between stages, while the NTE uses 0.1 mfd. The 56 driver in the NSA incorporates a tone control not found in the NTE. The NSA driver derives its bias from the 2A3-bias supply while the NTE driver uses cathode bias. And of course, the big difference is that the NSA uses fixed grid bias on the 2A3-output stage, producing 15 watts of output, whereas the NTE uses cathode bias, or should I say filament bias, on its output stage producing 10 watts of output.

The NSA was not widely featured in National advertising, so I suspect that not very many of them were built or sold. They were first advertised on the inside-back cover of QST for September 1938, where the power output was listed as 12 watts. In the October QST there was a four-page National insert that included the NSA. It was listed as having 15-watts output, flat response within less than 1 dB from 25 to 10,000 cycles, 125-dB gain in the microphone channel, and a high-level input for a phonograph cartridge. In the December 1938 QST and again in the April and July, 1939 issues, the NSA was pictured alongside an NTE as background for a large array of National Parts. There was a very brief mention of the NSA in the "National Ad" in QST for September 1939. The last time I found the NSA mentioned was on the "cover 3" ad in QST for October 1941. It said, in part, that the new 1942 National catalog had "old friends in new dress like the revamped NSA Amplifier."

If you could find an NSA today it would be great fun to combine it with an old, 78-RPM turntable or maybe a VM Tri-O-Matic and a D-104 mike and hire yourself out as a vintage DJ. Where did I put those Glenn Miller records anyway?

Next time, we take up the NSM, the modulator companion to the NTX-30, so stay tuned.

National NSA Article Supplement, Prepared by Bill Fizette, W2DGB

Description of the W2DGB NSA

The National Company's brief foray late in the 1930s into a line of transmitting gear included the NSA, a versatile eight-tube audio module, as described in Jim's article. His request for pictures of an actual NSA led to the rediscovery of one tucked away on a back shelf in a storage area at W2DGB. While it was more or less complete, with the original tubes, inspection showed considerable accumulated dirt, a damaged aluminum cover plate on the front panel, missing original filter capacitors, and a replacement power transformer. Considerable work was required before photos could be taken.

In preparation for cleaning, the rear panel/top lid unit, the bottom plate, and the front shroud were removed. All units were thoroughly washed with a detergent solution, rinsed and then dried in the hot summer sun. The damaged aluminum cover plate, held in place with eight rivets, was repaired in place, and the paint was patched with some gloss-black enamel. All black crackle finishes were then rubbed with some more of the black enamel, diluted 30% with mineral spirits. The black non-crackle finishes were either left alone or re-sprayed with a good-quality, black-gloss paint.

The original National power transformer had been replaced with a Stancor P6014, supplemented with a Thordarson 21F01 2.5-volt filament transformer, and a small transformer for the bias supply. All three units were mounted on an aluminum plate, over the hole left by the original transformer. Close inspection showed the work had been well done, so it was left alone. Unfortunately, the three double filter cans had been removed, and their functions replaced by six cartridges under the chassis. While this work was also well done, the gaping holes had to be filled by period cans from the local junk box.

One of the 2A6 tubes had lost its grid cap, although the lead seemed in good shape. Since the 2A6 is somewhat scarce nowdays, the repair was made by resoldering the grid lead to the cap and gluing it back in place with super glue.

An interesting add-on was the two adapters for rack mounting. These are of 1/8" steel, securely bolted to the cabinet and chassis. A search of old National catalogs didn't reveal the item, so it could have been an after-market item by someone else, or by special order from National. The weight of this NSA is approximately 35 pounds (listed 50 pounds shipping weight), and could be supported on a sturdy vertical rack without any additional back support. Dimensions are approximately 9 x 9 x 17 inches, with the weight of the five "iron" units evenly distributed.

Question: Does it work? Frankly, I don't know and don't plan to try. The main reason is that there are a number of original capacitors and most of the original resistors in place, many of which will need to be replaced. I felt it was better to leave the unit in the somewhat original shape, for future owners/historians.

ER

NTX-30/NSM from May 1939, QST

Vintage Linear Amplifiers, Part 3

By David Kuraner, K2DK
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Our current vacuum-tube RF-linear amplifier designs originated in the early 1950s. They employ plate voltage shunt-fed via an RF choke and a blocking capacitor to couple the tube's output into a PI-network that matches to the antenna load. Rarely will you encounter high-voltage DC in a link-coupled output network, except for 1940's, and earlier, equipment. Most of us give very little thought to the RF choke and blocking capacitor. But, they do interact with the output-matching network, and can become a design issue.

The Plate and Output Circuit

Ever since the early 1950s, almost every design has employed the PI or PI-L circuit. For an extensive discussion of this network see ER #197, October 2005, so I will not repeat myself here. But, I will remind the reader that the purpose is to match the plate impedance to the antenna load impedance and that a Q of 12.5 is ideal for amateur purposes. The benefits can clearly be seen in **Figure 1** showing the amount of harmonic suppression for this value of Q.

Occasionally, the RF choke will self resonate at the operating or a harmonically-related frequency. Cliff Kurtz (N6ZU) shows how to find this

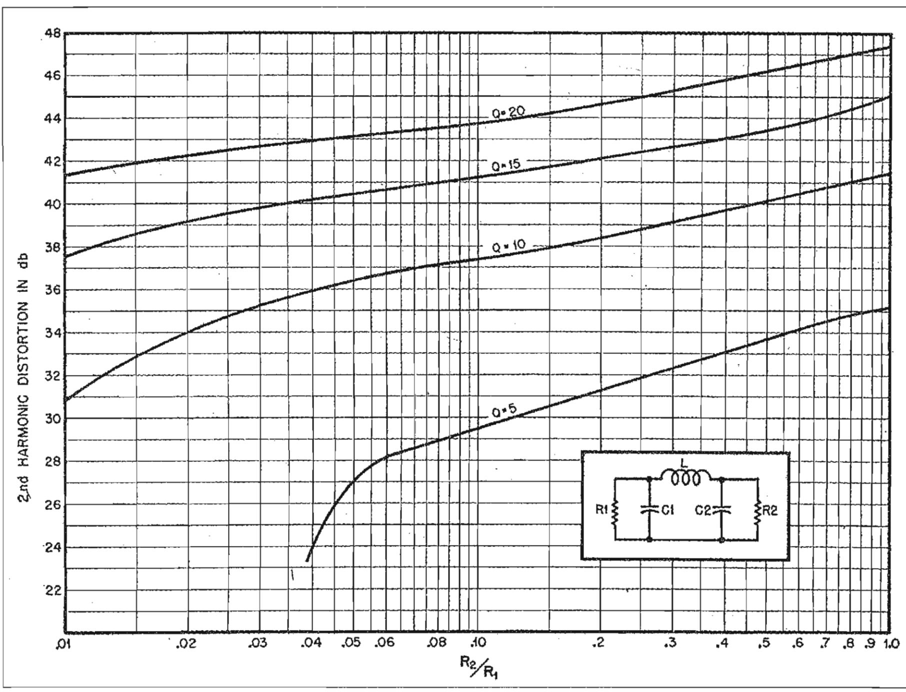

Figure 1: Second-harmonic distortion vs. the ratio of the output impedance to the tube load impedance for 4 common values of "Q."

frequency in his amplifier construction article in ER #218, July 2007. His test shorts the choke leads together and finds the frequency with a grid-dip meter. This is a very wise precaution. In converting broadcast transmitters to ham frequencies, I have heard of several instances of damaged self-resonating chokes and heard the tales of woe regarding that super-power linear. The following true story I call "A Tale of Two RF Chokes" (Sorry, Charles Dickens). It may convince you that predicting choke resonance can be more voodoo art than science.

Once upon a time, there were these two identical RF chokes in two identical broadcast transmitters on the same identical frequency. One was happy and contend to live and work in its transmitter on 80/75 meters. The other disliked the situation. As a result, the second rig produced low output. Eventually, as the frequency was lowered to cover the expanded phone privileges, it protested by letting its smoke out. Checks were made and everything in the circuits were identical leading to much bewilderment and head scratching. Yet one was fried to a crisp while the other was as cool as the Fonze from "Happy Days."

Sarcasm aside, there obviously was a difference which was not readily apparent. The difference was the output circuit and possibly the physical layout. In the first, a fixed-loading capacitor of 1000 pf was used. In the second, a variable in parallel with a fixed 500-pf capacitor was used. Why would this cause the RF choke to self resonate? It may not be self resonating. More likely, it's interacting with the PI-network tuning capacitor, or other external factors, to form its own tuned circuit. Changes were made in the cabinet design and newer components were used.

In the first instance, the tuning capacitor is larger to compensate for the smaller coil needed to resonate the network with the larger fixed output capacitor. The circuit works because loading is now adjusted by changing the tap on the coil. Also, with the smaller coil, there is a higher "Q" and greater harmonic suppression. In the second case, the loading capacitor is adjustable and both the coil and capacitor are optimized for the "ideal Q." The "Q" is lower now because more of the coil was used and less capacitance is used for the tuning element.

Perhaps the smaller tuning capacitor value formed a resonant circuit with the RF choke at some critical frequency. The result is that two tuned sections, one unintentional, reduced the output and eventually caused failure in the RF choke. Surely this is a much more scientific explanation than "mystical powers at work." Predicting component or parts layout interaction comes close to predicting the next major earthquake. This is mostly because you are not expecting the other circuit components to interact with the RF choke to form a tuned circuit at a harmonically-related frequency. The same thing occurred to another identical transmitter. So, just by pure-dumb luck, the first rig didn't have this problem.

Often, in the design and implementation of commercial amplifiers for the amateur market, compromises are made in the output-PI network and plate choke. The design may be suitable for one part of the RF spectrum and not the other end. One would expect the output to drop as the frequency goes higher. Perhaps this is from reduced drive and/or other factors. When it happens on the lower frequencies, there definitely has been some design compromise involved.

The case in point is the Dentron Clipperton L on 160 meters. Squeezing top band into the small cabinet of the Clipperton L does make for some compromise. The component values can be changed to arrive at the correct Q and proper match. I have an example of a Heathkit SB-200 which was clearly modified to favor the CW portion of 80 meters. And, some ARRL Handbooks show a "160 through 40 meter only 'modification' " to the SB-200.

Some of the newer commercial amplifiers should be avoided if used on AM. The toroids used in the tank circuit on the three common AM bands, 160 through 40 meters, do not fair well with a constant carrier. They tend to overheat and eventually burn. In the case of the QRO HF-2000, there was no cure. It simply was not AM friendly.

Heat and Cooling

As everyone knows, heat is the enemy of electronic equipment. When dealing with ceramic tubes, the techniques can become complicated and the tube is unforgiving. Since we are primarily discussing glass-vacuum tubes, we will limit the scope to forced air blowing across or around the bottles.

Many commercial linear amplifiers just don't seem to have enough air flowing unless the blower noise can wake up the dead. Amplifiers using such tubes as the 811A/572B or 3-500 can always benefit from a small muffin/Rotron-type fan blowing directly into the tube compartment. And, it is especially needed when generating the heat associated with AM operation. I have used small and relatively quiet fans with the SB-200, Clipperton L and QRO HF-2000 (a pair of 3-500s). The difference in the heat from the cabinet is amazing.

Now, when we start looking at some of the big broadcast transmitters, they use a different approach. Older boxes such as the 250-watt class just use convection for cooling. As we get into the 1-kW class, the cooling is no longer passive. An older design, such as the Collins 20V series, will use squirrel-cage blow-

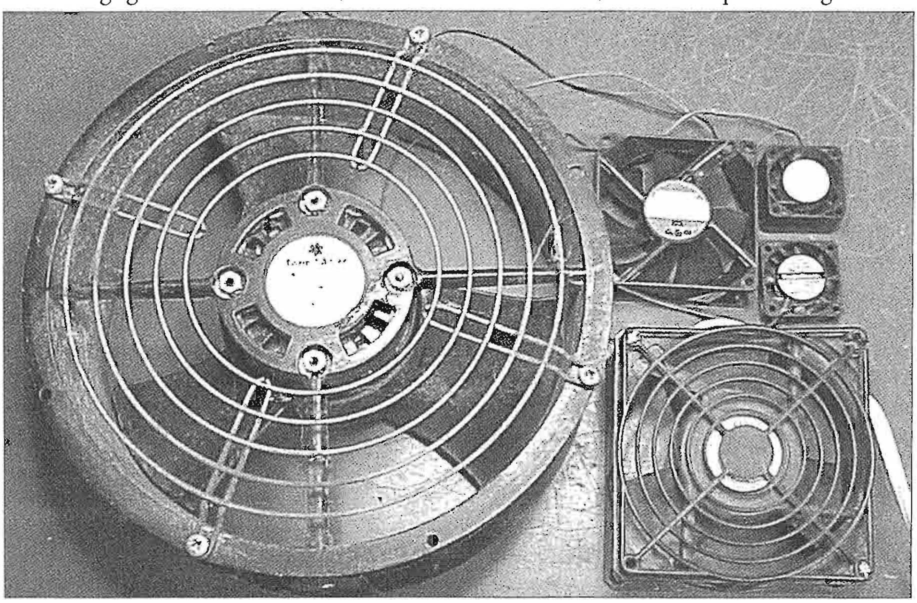

Figure 1: Here is an assortment of cooling fans, starting on the left side with a large 240-VAC type, which pressurizes a 1-kW broadcast transmitter box. A 120-VAC fan would be usable in lieu of this noise generator. Also shown are small 12-VDC fans. The text discusses fans and cooling.

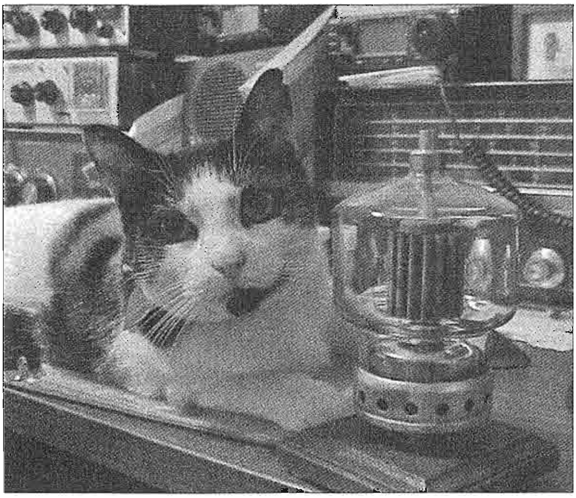

Figure 2: Like the Queen of Hearts, the local sovereign Queen Tinkerbelle is calling "Off With His Head!" This outlaw 4-400A caused great grief over a two-year period with an intermittent-grid connection. It was likely due to poor air flow. Pressurized air coming from beneath the socket flows out of the holes visible in the base. Air just simply directed at the glass envelope of these bottles will not cool the tube's base. Yet, many commercial designs using bottles do not cool the base.

ers to pressurize the air-tight compartment underneath the tubes. The air flows up into the bottom of the socket and into the base of the tube. This, in my estimation, is the preferred method. The tube base is cooled and soldered tube pins will not develop open circuits resulting in tube failure. Or worse yet, intermittent contact failure which can really drive you crazy. See the photo above of a really bad boy! Many designs will also use a glass chimney which surrounds the tube, and thus forcing the air escaping from the tube base to pass up and hug the sides of the tube's glass. And, almost all designs use a metal-radiator type of plate cap to dissipate heat so the plate-cap seal is not damaged. These techniques can be found in many vintage published construction articles.

The Collins broadcast rigs and similar designs may also include a whole-box fan to address the heat remaining within the transmitter cabinet. Many of the later designs may only pressurize the entire cabinet. However a pressurized transmitter cabinet tends to require considerable force and resulting noise from this cooling system. It can be incredibly annoying, and in intermittent service such as the typical amateur operation, not really needed. The transmitters I use, which employ this cooling technique, have been quieted by running the 240-VAC fans on 120 VAC or switching to a smaller 120-VAC unit.

Another approach to cooling is to start the blower only when the amplifier is transmitting. The full-air flow and associated noise is off in the standby mode keeping the shack relatively quiet. The only drawback is that you can hear the blower or fan spooling up within the first few seconds when the rig is placed on the air. And, it usually is heard on the air.

Often, even for lower-power equipment, I'll place a small computer-style DC fan blowing into the equipment cabinet. Some DC power, stolen from the filament supply with a simple rectifier/filter, powers these things. The improvement in cooling is well worth the effort and the gentle hum of the motor and air movement is actually a rather pleasing sound.

And, it goes without saying that any equipment generating heat and needing blowers or fans needs access to an adequate air supply. Now, one would just assume that I'm talking about keeping other equipment, walls, etc., at a distance to insure adequate air movement. But, often in a commercial piece of equipment, air filters are found which must be cleaned or changed periodically. Also, fan or blower blades collect dust and should be cleaned for maximum efficiency. This is all part of normal preventive maintenance and has to be accounted for with the initial equipment design.

The BC Transmitter as a Linear Amplifier

For those that wish to—or must—give this a try, rewiring the grid-and-cathode circuits for grounded grid should pose no real problem. The modulator section would have to be disabled. However, if your box uses 4-400s and they are all in-line, you just may be able to parallel the modulator tubes with the RF section. Paralleled-quad 4-400s would give you 1600 watts of plate dissipation and the creation would loaf along, providing plenty of RF output.

Quad 4-400s were shown in ER #203, April 2006. The transmitter was a 1-kW Continental broadcast rig which originally was grid modulated. The owner, Bob Raide (W2ZM), claims it works from 160 through the 10-meter band. He uses a neutralizing circuit to insure there are no problems on the higher bands. This is a grid-driven, Class-C final. A Class-B quad, grounded-grid configuration should be stable at least up to 40 meters where most of the AM activity is concentrated. Operation on 20 and above would require extensive modification to the output network. This is still quite doable by using different components as would be needed if the final was still Class-C plate modulated. See the referenced article.

Biasing and Control

Many of the vintage commercially built and HB amplifiers use control voltages for T/R relays which are not compatible with modern solid-state equipment. Examples would be the SB-200 and Gonset GSB-201series. They employ a DC voltage of about 120-volts negative to operate the relays. Another reason for the negative high voltage with respect to ground is to apply bias. The tube's idling current is stopped during standby periods. When mated to a modern transceiver, an intermediary relay must be used.

Reducing or eliminating this current is very desirable for both heat dissipation and noise being generated in the receive mode. The current can act like a noise-generator diode and mask weak signals. It could sound like the natural-noise floor, but in reality, could be generated within a few feet of the receiver. Some designs employ a zener diode in the cathode circuit to bias and thus reduce this idling current.

Conclusion

We have been primarily focusing on equipment of 30-year-old vintage or greater. Also, the assumption has been that the primary use will be for AM operation with either a vintage or modern exciter.

Some of the more recent tube-based amplifiers have much more sophisticated control, protection and sequencing circuitry. They are surely not as simple and basic as what has been described within this series. Are they better? Probably not, but they surely are far more expensive than any vintage equipment currently on the used market. Whether HB or commercial, the technology has remained the same for over fifty years. And, it's likely to keep chugging along for many more decades. Much thought and design went into this technology and its implementation, which surely stands the test of time!

ER

A Dual-Amplifier, Phased-Dipole, Concealed Antenna System for 75 Meters

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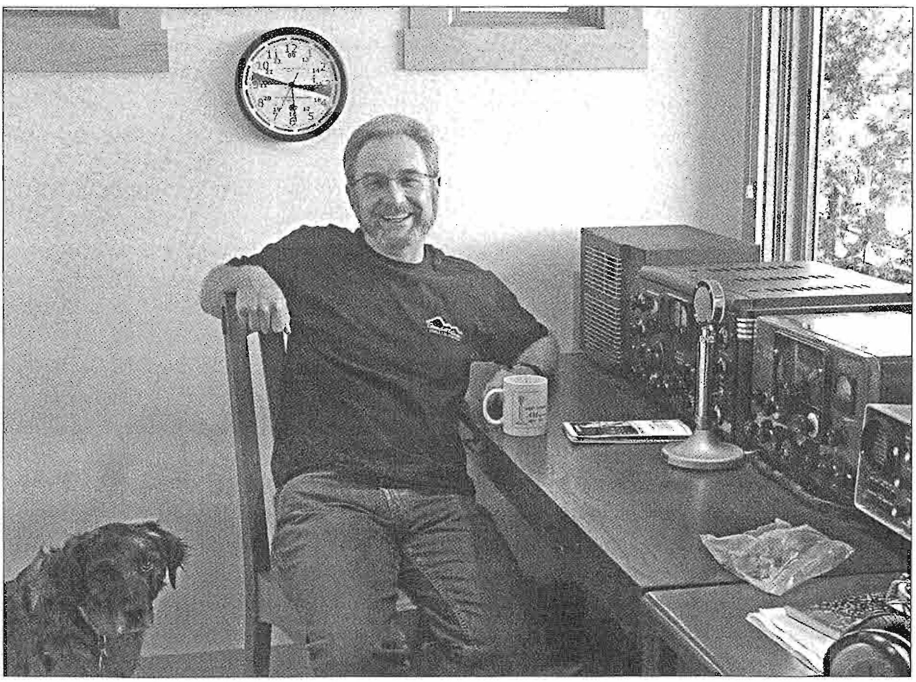
Power to the People (Not to the Fishes)

"Possibly the world's best 75-meter antenna" is what Tom, K1JJ, calls a pair of driven, phased dipoles.

Radio K6JEK, Monterey, could use the world's best something because the station has a lot going against it. There are the 1927 CC&Rs, which prohibit the "erection of aerials" without the approval of the nonexistent "supervising architect." It's halfway up a hill with a nice path to the Pacific but the hill behind blocks the continental United States. And, there is no place for a station on the first floor. It has to be on the second floor, third really, when viewed from the back of the house where it actually is. In this environment, the station squeaked along with a modest setup, a Drake C-line feeding a stealth off-center-fed dipole through the re-purposed cable-TV coax. At least there was that high-quality RG-6 plumbed from the small shack down to the basement. Reception is wonderful in this low-noise environment but the transmitter didn't get out for beans.

These hobbling circumstances motivated project Power to the People, "P2P," a plan for more RF and more of it going

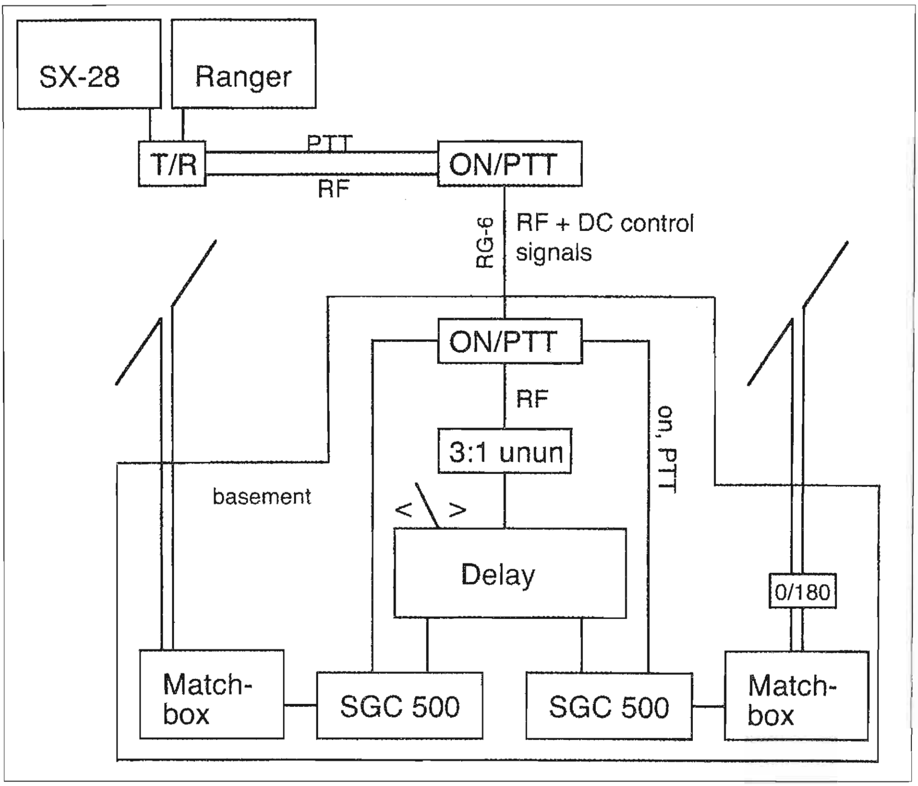


Jon (K6JEK) is at his AM station in Sunnyvale, California. The SX-28 reeiver once belonged to Bill Feldman, N6PY.

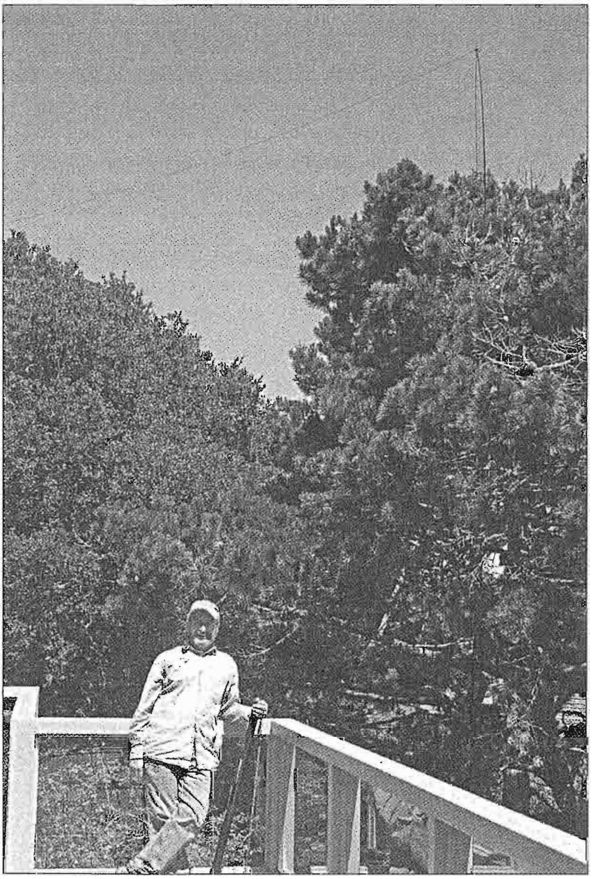
east to people instead of west to the fishes. The more-power part, an amplifier, ended up in the basement, as a concession to the difficulty of establishing an RF ground on the third floor. My wife, Patty, wasn't keen on hot stuff glowing unattended in her basement. There were phrases like "You're going to burn the house down," and "are you crazy?"

She had a point, so a solid-state amplifier was acquired instead of one with tubes: an SGC-500 that is designed to be remotely located. It's a pretty cool beast. Give it some power and some RF, it figures out the frequency, sets the band pass filters, and keys the amp all in the blink of an eye. If it gets hot, it starts its fan. If it gets too hot, it turns off. Has lousy SWR? It turns off. Has too much current or too few volts? It shuts down. Sitting there unattended it promises to not burn down the house. And, that's the way things sat for a couple of years, Drake C-Line, OCF dipole, SGC-500 in the basement. The station still wasn't very loud but it was better than nothing.

One hundred-and-fifty watts of carrier is a big improvement over twenty five but can still be marginal out here in the expansive west. One SGC-500 is nice. How about twin amps driving separate dipoles in a "world's best" configuration? Egged on in daily QSOs with bemused spectators, Rod (KQ6F), Jeff (K6JCA), Mike (W6THW), and Gary (K6GLH), I evolved a plan for doubling the power and doubling the antennas, too. The



System Diagram of K6JEK's "P2P" Dual-Amplifier, Phased-Dipole Installation



One of the author's masts is visible, upper right.

antenna. Things were taking shape, slowly, with more talking about it than doing but still there was progress.

Enter Hildegunn

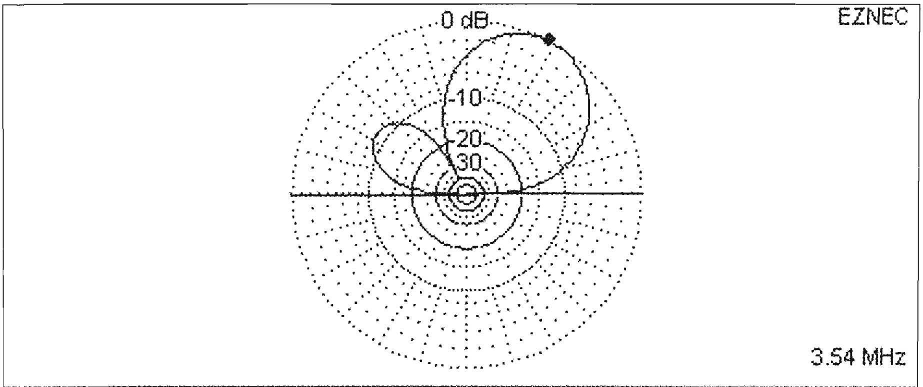
"Do you mind if I trim that big pine tree? It's blocking my view."

Sure enough, the designated aerial #2's location was right in the uphill neighbor's view (and what a view it is). She probably wouldn't think the tree plus antenna would be an improvement.

The project went on hold. The second amplifier sat un-powered, the matchbox unconnected. The conversations stopped. Finally, a way to put the second dipole above a different tree a little closer in and not so visible to Hildegunn was mapped out. After a great amount of difficulty stringing the wires through the trees from the ground using slingshots and long poles, while wires tangled and poles snapped, aerial number 2 was in the air.

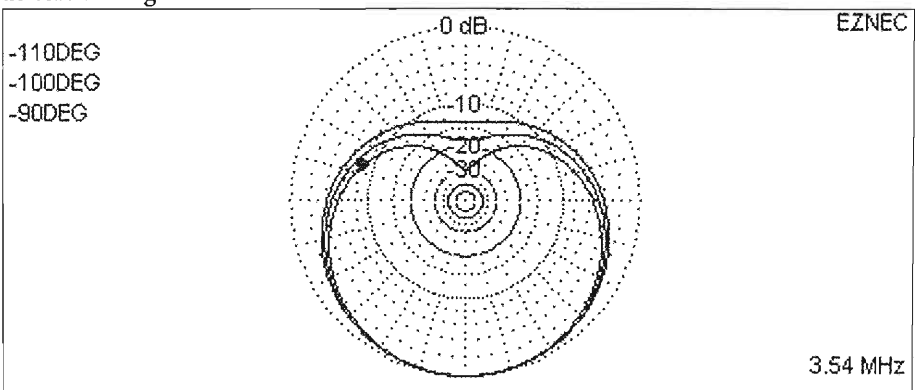
stealth-OCF dipole was replaced by a semi-stealth antenna, a resonant 75-meter dipole held aloft in the center by a 40-foot DK9SQ telescoping-fiberglass mast poking out of the trees. The light mast meant light feed line, 300-ohm window line, now matched with a Johnson Matchbox. The big pine on the other side of the house was eyed for a second stealth aerial. Measurements were made. Rod did some antenna modeling (see **Figures 1 and 2**, the EZNEC plots). A 110-degree phase shift might yield 6 dB of gain over just one dipole. Mike came up with a second SGC-500. Jeff had a spare Johnson Matchbox for the second

The two 124-foot, inverted-V dipoles are oriented north/south with the centers at forty feet and the ends at about thirty feet. They are spaced 105 feet apart on an east/west axis, and are reasonably parallel. They are fed with equal lengths of 300-ohm window line. Trees support the end ropes of the inverted Vees. The centers are supported by 40-foot DK9SQ telescoping-fiberglass masts that poke up through trees. There are no guy lines. The light masts are held in place by the small branches they weave their way through. Despite strong costal winds the masts have stayed up. To keep the visual impact and weight to a minimum,



Elevation Plot		Cursor Elev	62.0 deg.
Azimuth Angle	270.0 deg.	Gain	10.03 dBi
Outer Ring	10.03 dBi		0.0 dBmax
Slice Max Gain	10.03 dBi @ Elev Angle = 62.0 deg.		
Beamwidth	53.5 deg.; -3dB @ 33.8, 87.3 deg.		
Sidelobe Gain	1.84 dBi @ Elev Angle = 146.0 deg.		
Front/Sidelobe	8.19 dB		

Figure 1: "EZNEC" is a computer program that can be used at home to calculate antenna patterns. Above is the elevation plot, showing how much power is delivered at certain angles above the horizon.



Azimuth Plot		Cursor Az	161.0 deg.
Elevation Angle	66.0 deg.	Gain	1.84 dBi
Outer Ring	10.01 dBi		-8.12 dBmax
Slice Max Gain	9.96 dBi @ Az Angle = 270.0 deg.		
Front/Back	29.14 dB		
Beamwidth	136.5 deg.; -3dB @ 201.8, 338.3 deg.		
Sidelobe Gain	< -100 dBi		
Front/Sidelobe	> 100 dB		

Figure 2: The azimuth plot shows which compass direction radiated power goes.

Delay Line Lengths 3.850 MHz		
	Velocity .72	Velocity .78
Degrees	Coax feet	Coax feet
45	23.00	24.92
22.5	11.50	12.46
11.25	5.75	6.23
5.625	2.88	3.11
2.8125	1.44	1.56

Figure 3: Chart of Delay-Line Lengths

the antennas are made of insulated, stranded #18 copper-clad steel wire, "Wireman 532." The end-and-center insulators are the very lightweight HQ-2 glass-filled ABS insulators from the Radioworks. These are not designed to be center insulators, but with some finagling can be used that way. The center insulators rest in a V of insulated coat-hanger wire secured to the mast with wire ties and tape. Everything is black or dark green. One antenna is nearly invisible from anywhere but the back of the house. The other is visible, but inconspicuous.

What about the phasing? The idea is to get the signals to add in one direction, subtract in the other. For example, if the antennas are physically ¼-wavelength apart and the eastern antenna is fed with a 90-degree delay from a phasing network, the antenna system will be directional to the east. Signals transmitted by the western antenna will arrive at the eastern antenna delayed 90 degrees by traveling through space that quarter wavelength while signals emitted by the eastern antenna are delayed 90 degrees by the phasing system. The signals are in phase and add to the east. Going west, the signal from the eastern antenna starts with a 90 degree delay from the phasing network and picks up an additional 90-degree delay traveling through space so when it gets to the western antenna it is 90°+ 90°= 180 degrees out of phase with the western antenna. The signals cancel. Of course, nothing's perfect, so complete addition and cancellation doesn't happen in practice. This works for spacing besides 90 degrees, too. The phase-network delay must equal the physical-space delay.

The simple way of phasing antennas, adding an extra fixed length of coax in the feed line one of the antennas, just wouldn't suffice. The stealthy fiberglass poles require lightweight feed lines which require matching networks which throw the phase relationship up in the air. Something variable is needed. What? A visit to the Computer History Museum, on the Internet at http://www.computerhistory.org/, inspired a binary progression of delay lines switched in, or bypassed, by toggle switches [see photo, page 25] like the control panel of a 1970's mini-computer. Coax lengths of 45°, 22.5°, 11.25°, 5.625°, and 2.812° can be inserted into the input side of either amplifier in any combination. The leftmost switch controls the 45-degree phase line, the next switch the 22.5-degree line, and so on. The five switches can be represented as five binary digits, 00000 up to 11111 where "1" means the corresponding delay line is inserted, and "0" means it is bypassed. Just count up, in binary, any phase delay you like, up to almost 90 degrees in approximately 3-degree (2.812) increments, and flip the switches. For example, 10101 is 45 + 0 + 11.25 + 0 + 2.812 = 59 degrees. The next higher increment from 10101 is

10110, which is 45 + 0 + 11.25 + 5.625 + 0 = 62 degrees. Two up from 10110 is 11000, which equals 67.5 degrees. A DPDT knife switch in the feed line of one of the dipoles gives a 180-degree shift there.

Between ±90 and +180 the whole phase circle is covered. Whatever phase shift is needed can be accommodated.

Using delay lines for phasing instead of an L network or other scheme made the system easy to build, inexpensive, and easy to adjust. The drawbacks are the room needed for the coils of coax and the impedance bumps from the box and all those coax connectors. But, this is on the input side of the amplifiers and in the basement so the downsides aren't significant. The phasing lines are simply lengths of RG-8X, measured for velocity factor using an advanced feature of the MFJ-259B antenna analyzer.

Different brands of RG-8X have different velocity factors. My coax ranged from .72 to .78. For example, the 45-degree delay line is constructed from .72 velocity factor RG-8X. So, at 3.850 MHz, it needs to be:

$$\frac{\left[0.72x\left(\frac{45}{360}\right)x984\right]}{3.850} = 23 \text{ feet},$$

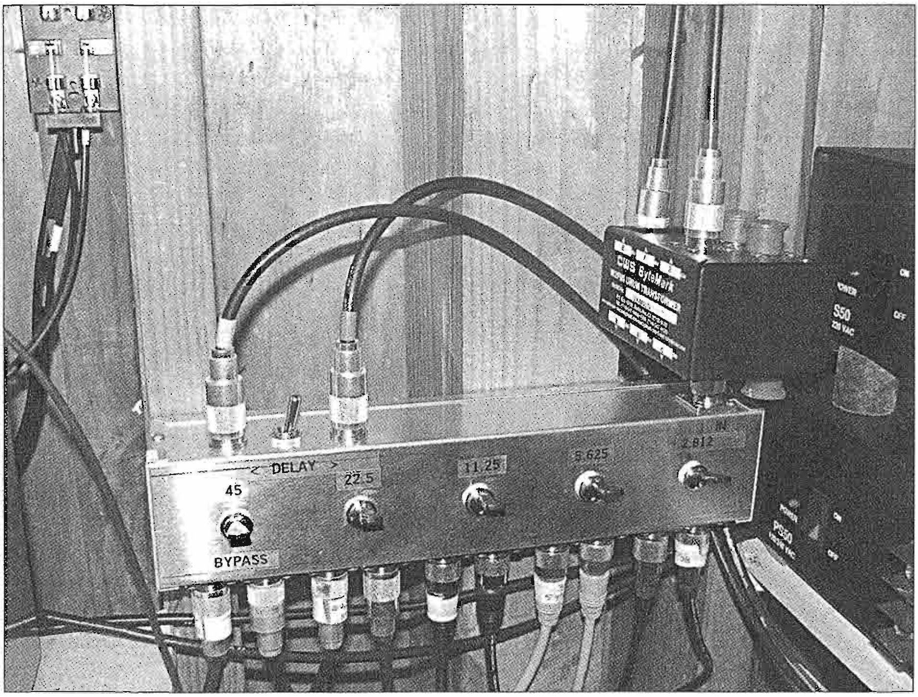
(see **Figure 3**). The delay box simply switches in or out each length of coax with five DPDT switches (see schematic, **Figure 4**).

To minimize the impedance bumps inside the delay box, the line running from the input to all the switches is a minimally-disrupted length of RG-8X. It runs right behind the switches. At each switch, an incision is made in the coax outer sheath, the shield braid is pushed aside, and the center conductor is pulled out just enough to reach the switch connections. There it is snipped and the two resulting ends are connected to the two center contacts of the switch. In "bypass," the two pieces are reconnected through a short length of bare copper between the appropriate switch contacts. In "delay," they are connected to two SO-239 connectors and the delay line. The output of the delay box is two more SO-239s, one going through the switches and delay lines, and one connected directly to the input via a piece of RG-8X which is the same length as the switch assembly. Which output connector goes to the delay lines and which goes directly to the input is chosen via another DPDT switch so the delay can be inserted in either amplifier input.

This construction technique might be a problem for VHF but seems to fine for the lower-HF bands. The SWR for the switching mechanism measures 1:1 at 3.850 MHz. Insertion loss wasn't measured. The switches are labeled in degrees for 75 meters, but the system works on any band; just double numbers for 40 meters, halve them for 160.

Because the amps and antennas are effectively "tee'd" (tied together via this delay box) the system presents a 25-ohm resistive load to the 75-ohm, RG-6 running from there up to the driving transmitter upstairs. Concern over having enough drive for two amplifiers through this mismatch motivated the inclusion of a 3:1 UNUN at the input side of the delay line.

A transceiver is installed in the basement so this two-amp, two-antenna set up can be tuned up from there. Two power/SWR meters on the output of the two amplifiers tell what's going on with the system. Ideally, the system would be tuned for equal currents on the two antennas. RF ammeters weren't available so SWR had to suffice as a metric. The two sets of adjustments interact. Changing the antenna tuning with the matchboxes changes the phase relationships. Changing the phase delay with the switches changes the



Outside View of the Delay-Switching Box

SWR. Luckily they converge, close enough anyway. The tuning sequence is:

1). Adjust each matchbox for a 1:1 using the MFJ antenna analyzer.

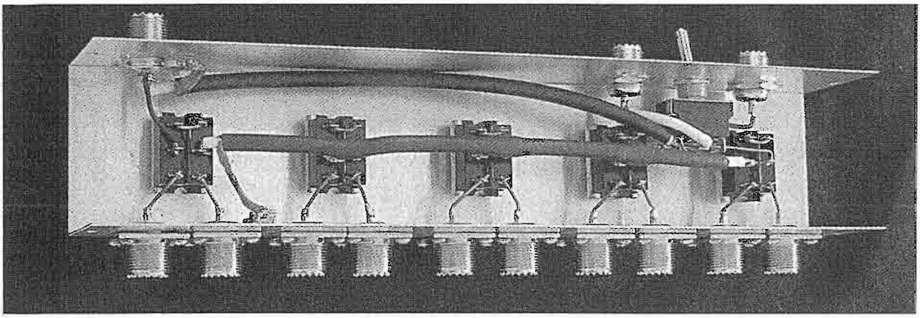
2). Apply power and readjust them for 1:1, back and forth one antenna then the other.

3). Listen to a station in the right direction with system switched in the opposite direction. Adjust the phase for minimum signal level.

4). Flip the phase 180 from the minimum.

5). Apply power and check the SWR. So far it's always been close enough that another iteration is not needed. This isn't as tedious as it sounds. Writing down settings for different frequencies saves trying to do this in a hurry. Resetting is easy with the switches on the delay box and the indicators on the Johnson Matchboxes.

For convenience, a remote "power on" switch is installed at the upstairs operating position. DC voltage is imposed on the coax along with the RF. Downstairs, this DC is separated from the RF with chokes and capacitors so the RF can feed the amps while the DC energizes a relay to power everything up. Although the amplifiers key up when they sense RF, there is a short delay. To get rid of this delay, this "remote on" system was enhanced to send PTT down the coax too. Now, –12V means "on" and +12V means "on and PTT." The power relay is energized through a small bridge rectifier with a little electrolytic cap so +12 or -12 energizes the power relay and it doesn't bounce on the transition. On-Off and PTT functions are now controlled comfortably from the operating position, but band changes and significant frequency excursions require a trip to the basement. Eventually this will



Inside the Delay-Switching Box, with the Cover Removed

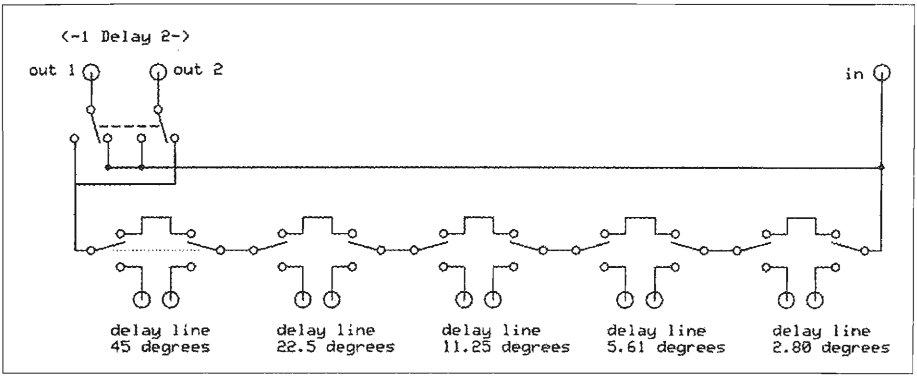


Figure 4: The Delay-Box Schematic.

have to change.

"Your dual-amp phased antenna kicks," is what Gary (K6GLH) said about the smoke test of this whole lash up. By now, the C-line had given way to a Johnson Ranger with extensive audio mods and the late Bill Feldman's (N6PY) SX-28 (see ER numbers 189 and 190). QSO #1 with Mike, Gary, and Jeff, and an evening on the West Coast AMI net using the P2P set-up, proved that it was indeed delivering a lot more power to the people. Too bad for the fishes.

Observations

1). It's a good antenna system. I don't know if it's the world's best 75-meter antenna, but it is excellent. The front-to-back is significant. Changing the phase 180 degrees sometimes makes signals pop right out of the noise and become Q5 copy. Of course, sometimes it makes little difference. Extensive gain tests have not been run. One experiment showed a 10-dB improvement with a 180-degree shift, right about what the model predicts.

2). It is a rag chew antenna, not a DX antenna. A 62-degree main lobe is great for communication within a few hundred miles but isn't great for DX-ing. With more height, it could be a DX antenna.

3). This is doing things the hard way. The two-amp, two-tuners business was dictated by the constraints of this peculiar situation and by history. It's very flexible and fun to experiment with but something simpler like one transmitter or one amplifier with the customary phasing on the output side should work as well.

ER

A 160-Meter Box-Loop Antenna

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I have used this box-loop antenna for receiving on 160 meters, and I am surprised at how well it works. I can null out interference from defective light fixtures. I use it with an inverted-V antenna for transmit, and interference that I hear on the inverted-V antenna can nearly be eliminated when receiving on the loop. Also, receiving with the loop antenna is extremely quiet. The loop is shown connected to my National NC-183D in **Figure 1.**

Construction of the Loop Antenna

Figure 2 shows the completed loop antenna. To wind my 160-meter frame-receiving antenna, I used about 100 feet of number 22-gauge, plastic-covered wire, but number 20 bare-copper wire can be also used for the main winding. It should be wound to get a whole number of turns. Seven turns gets it to 1.80 MHz if built using information from the plans.

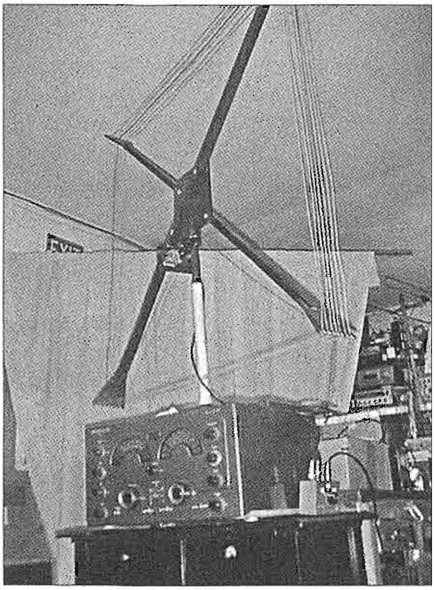

Figure 1: The 160-meter box-loop antenna is connected to the author's National NC-183D receiver.

The inductive link is over the 4th turn and a piece of RG-8/U mini coax with a PL-259 connector on the end is used to connect to the National receiver.

For tuning the loop, I use a salvaged 500-pf variable capacitor.

Figure 3 shows the "paddles" that are used to space the wire turns. Originally, I used a cardboard template to make the paddles. The paddles are 1" across the bottom and 4" across the top. They are ¾" thick and 6" long. The 7 notches at the top have a ½-inch pitch. I cut all 4 paddles from some old oak-drawer sides I had on hand.

The two long spreaders are made from wood pieces, 1" x ¾" by 53" long, and were cut with slots in the ends 2" deep so the paddles could be fit to the ends and glued in place. They spreader arms are mounted on an 8" square center plate using plastic nuts and bolts.

The upper 2" x 5 ½" support plate has solder lugs for the coax and six ½" nuts and bolts to secure the main frame wiring and inductive turn.

The lower support plate is used to hold the 500-pf variable capacitor.

When the loop was completed, I stained it with red mahogany.

If one uses the measurements from the plan, the windings and general construction will come out as symmetrical as possible since the depth of the rejected null depends on the electrical balance. Just tune in the signals on 160 meters, peak the antenna tuning control (500 pf) for maximum pickup or for maxi-

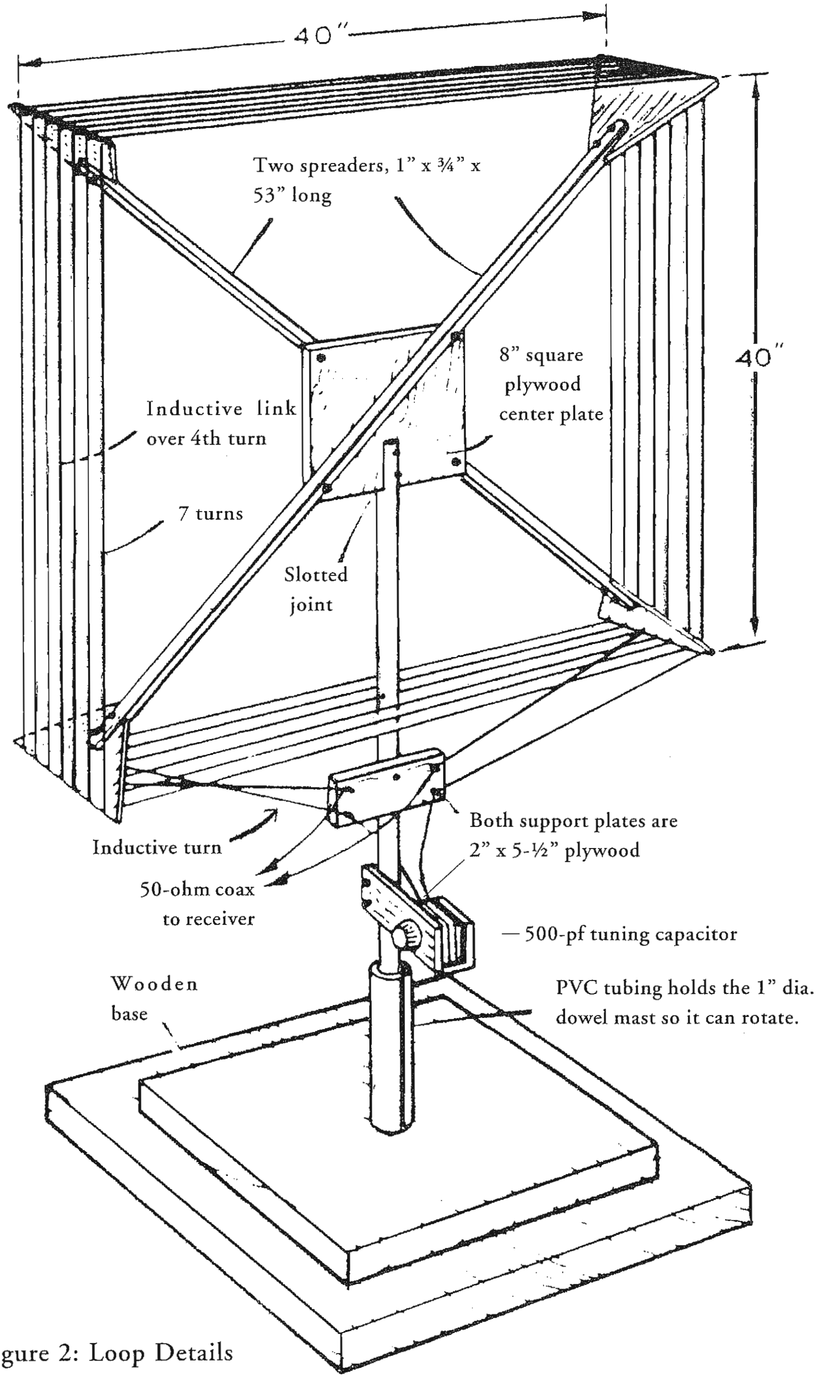

Figure 2: Loop Details

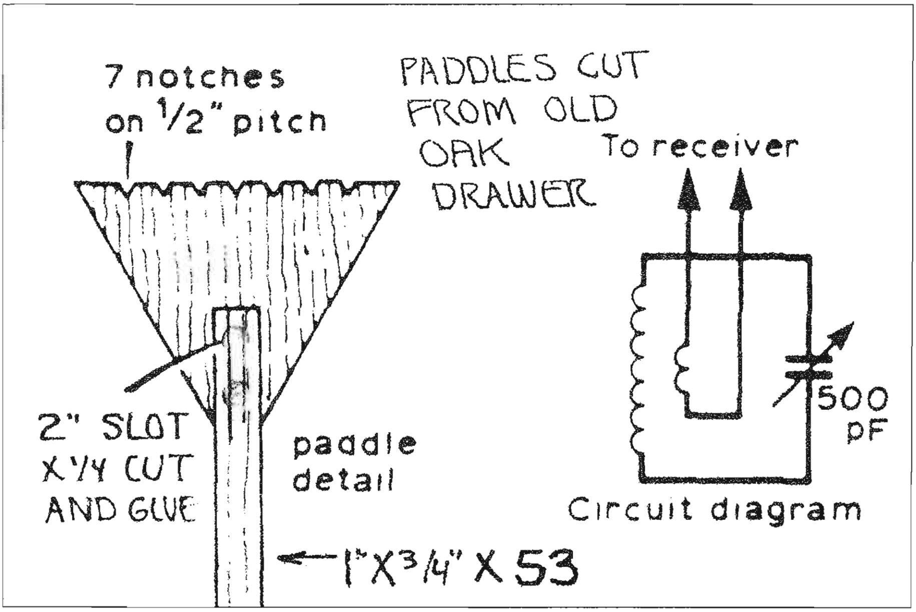

Figure 3: Detail of the paddle construction and the loop-tuning schematic. Paddle is 4-¾" across the top and 1" across the bottom, attached to spreader.

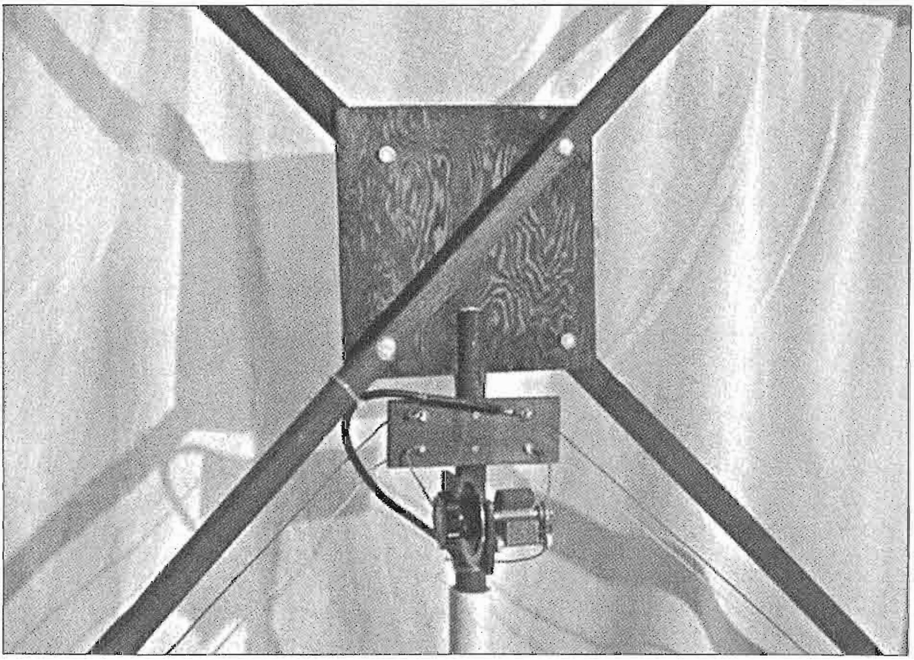

Figure 4: Closeup of the center plate and loop-tuning condenser.

ER

Low-Noise Modification for the HP 8601A Generator/Sweeper

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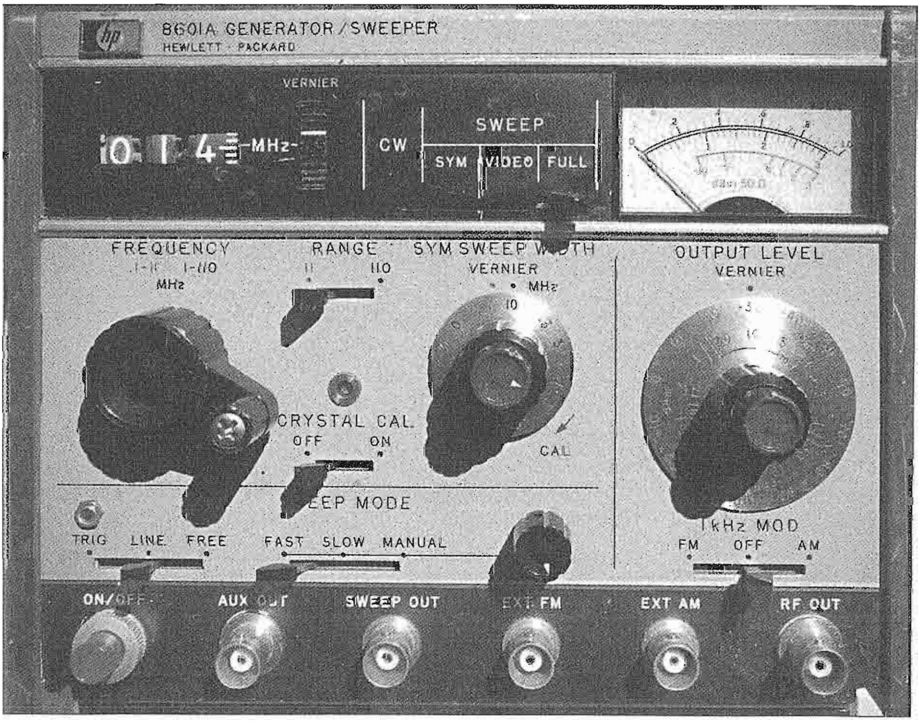
1115 S. Greeley Hwy.
Cheyenne, WY 82007

These solid-state HP generators are showing up for $100, or so, at swapfests, and are frequently available on the Internet. They're small and fully metered, and cover roughly 110 kc to 110 Mc. The problem is that the output signal is broad and very noisy. The signal at 455 kc is too wide to get a useful look at a narrow IF in the sweep mode. I spent some time the other day rooting around in mine and came up with this useful modification.

I found that the negative 75-volt reference had about 3-to-4 volts of 60-cycle line frequency and other broadband noise on it. This power supply "rail" references the ramp generator, the ALC/ modulator, and probably everything else. The power supply filter cap (C9, **Figure 1**) has only 50 µf, which is another kind of ramp generator. If you replace it with a 470-µf, 200-volt electrolytic, you can get rid of the power supply, ramp, and most of the signal noise. See **Figure 2.** Unfortunately, not every fix is this easy!

The 8601A is now useful in the sweep mode for IF alignment and endless tweaking of filters, using the receiver's AM detector, direct coupled, and an audio-bandwidth oscilloscope. The scope needs a provision for external-horizontal sweep, or be able to use two vertical plugins, which gives the best accuracy.

With this type of sweeper, you can



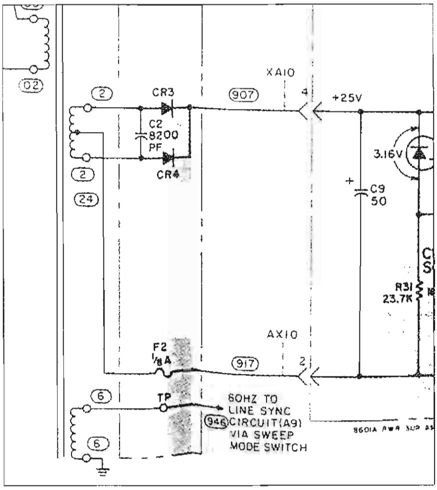


Figure 1: C9 Location on the "A10" Power Supply Schematic

insert the sweeper signal at receiver antenna jack on 80 meters (3.885 kc), turn off the AVC, and adjust the gain with the manual RF gain control to get the same detector level as the AVC provides, and look at the bandpass of the entire radio. This will, hopefully, be dominated by the IF filter.

You'll need some kind of external frequency counter to use with the 8601A. Between a counter and the manual sweep, you can get very precise results. When setting the frequency in manual sweep, you'll notice the single-dot trace becomes a vertical slash when traversing the edges of a sharp filter. The fast amplitude change with frequency is acting as a sensitive discriminator, displaying system frequency and phase noise, with both the transmitter—the 8601A—and the receiver added together. It's not calibrated, but in fact this is what's going on. Most of what shows is probably from the sweep generator.

If you want to verify the effects of the capacitor change, do a before-and-after view.

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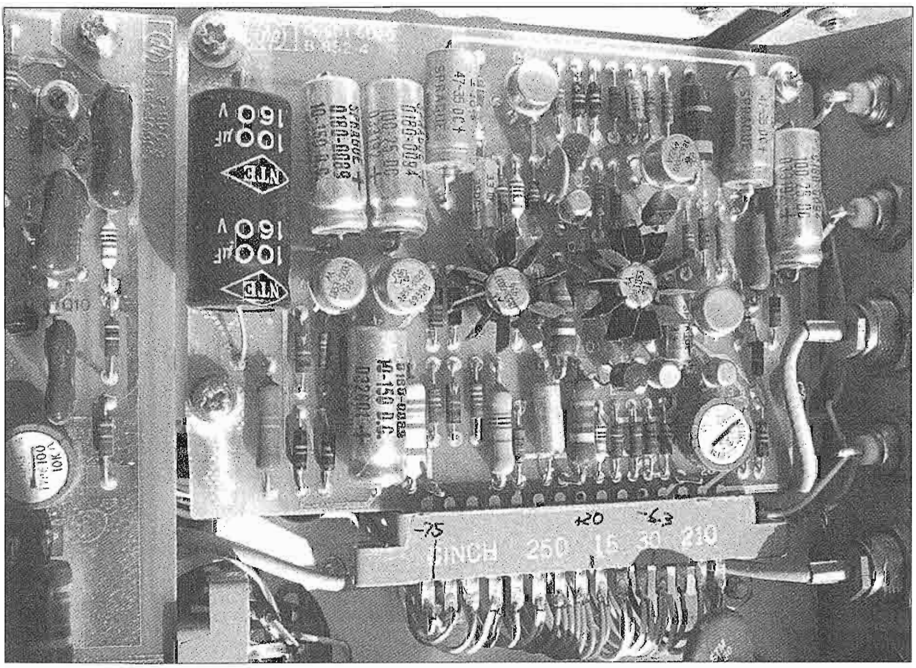

Figure 2: This is the "A10" power supply board in the bottom of the 8601A. C9 has been replaced with the NTE capacitor, top left, but it's value should be 470 µF.

Tracking Generator Modification for the HP-8601A Sweep Generator

By Ray Osterwald, NØDMS

Just What Is a Tracking Generator, Anyway?

A tracking generator is a signal generator that has an RF output frequency that matches the display on a companion spectrum analyzer at any instant of the analyzer sweep. The DC ramp voltage, coming from the sweep circuits on the spectrum analyzer, drive the signal generator's RF sweep.

The tracking generator is an extremely useful tool because you can use the spectrum analyzers's log display to see at least 60 dB of a device's response curve. Usually, a sweep generator is used with a diode probe and you can only display maybe 15 dB of the response. Log-detector probes can be built, but they usually require integrated circuits and lots of patience.

The HP-141T spectrum analyzer system is now over 30 years old, and is easily available from many sources because they have been sold as surplus. The 141T and the 8601A can be found at nearly give-away prices.

The 141T has a voltage-tuned oscillator (VTO) that is the same as the one in the 8601A. By changing a few things in the 8601A, an output from the 141T can be used to drive the 8601A to provide a swept RF output that matches the sweep rate of the 141T display. You will have a very powerful, inexpensive tool for RF work.

The drawback to the mod is that only the output controls on the 8601A will work—the output level and vernier, and modulation. Also, there is no "tracking" adjustment as found on expensive tracking generators. Without a tracking adjustment, the center frequency of the 8601A and the center frequency of the 141T display probably won't exactly agree. This means that very narrow span settings on the 141T won't display properly. For wider filter networks, IF amplifiers, and RF preselectors it will work great.

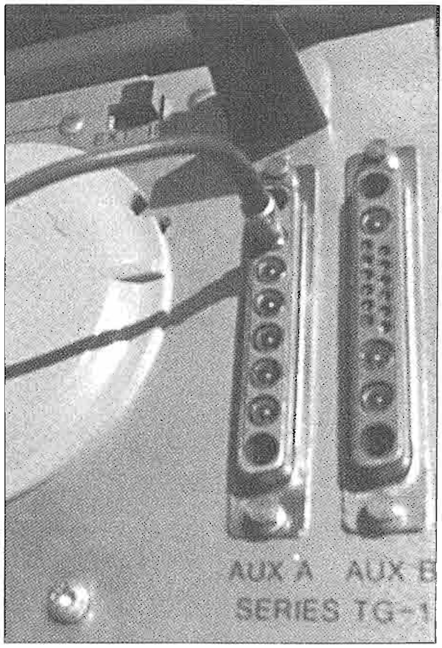

Figure 1: Location of the VTO output jack on the HP-141T analyzer "AUX A" connector.

A cable will need to be made up to match the special output jack on the rear of the HP-141T mainframe. The location of the proper jack to use is shown in **Figure 1.** I made a cable with a plug

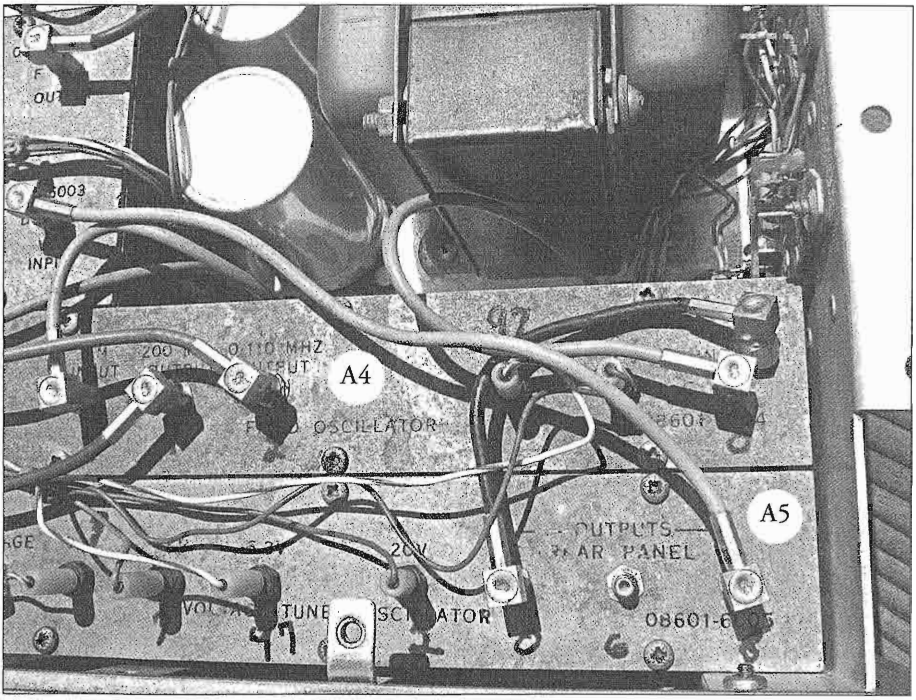

Figure 2: This is the top of the 8601A with the cover removed. The modules "A4" and "A5" are shown in the highlights. The rear jack on "A4" now connects to the rear-panel "VTO Output," and that jack becomes the input from the 141T spectrum analyzer.

taken from a connector found on a defunct HP plugin, and I installed a standard BNC plug on the other end to go to the 8601A's rear-panel BNC jack.

Here are the 8601A modification steps:

1) Remove the 8601A top cover and find the two castings "A4" and "A5" that are shown in the highlights of Figure 2.

2) Disconnect the short SMA cable that connects into the A4 "VTO Output" (1st jack, counting from the rear of the casting) The other end goes to A5, the 3rd from the rear. Don't disconnect the end at A5 because you may want to go back to stock operation.

3) Disconnect the SMA cable that normally runs from A5 "Outputs," second connector from the rear to the rear panel "VTO Output" connector.

4) Reconnect the long cable coming from the rear panel to the A4 jack, 1st from the rear.

That's it! Be careful of the small SMA connectors. It is easy to damage the fragile center pin on the SMA plugs if they are not aligned properly. It is not necessary to get the SMA connectors overly tight, just get them snug.

To use the tracking generator, the device under test is fed from the 8601A RF output jack. You can use a X10 scope probe, connected to the "RF Input" of the 141T, to examine the output of the devise under test. For more precise level measurements, the 141T RF input requires a 50-ohm input.

ER

Hi–Fi Audio for the National NC-183D Receiver

By John Svoboda, W6MIT
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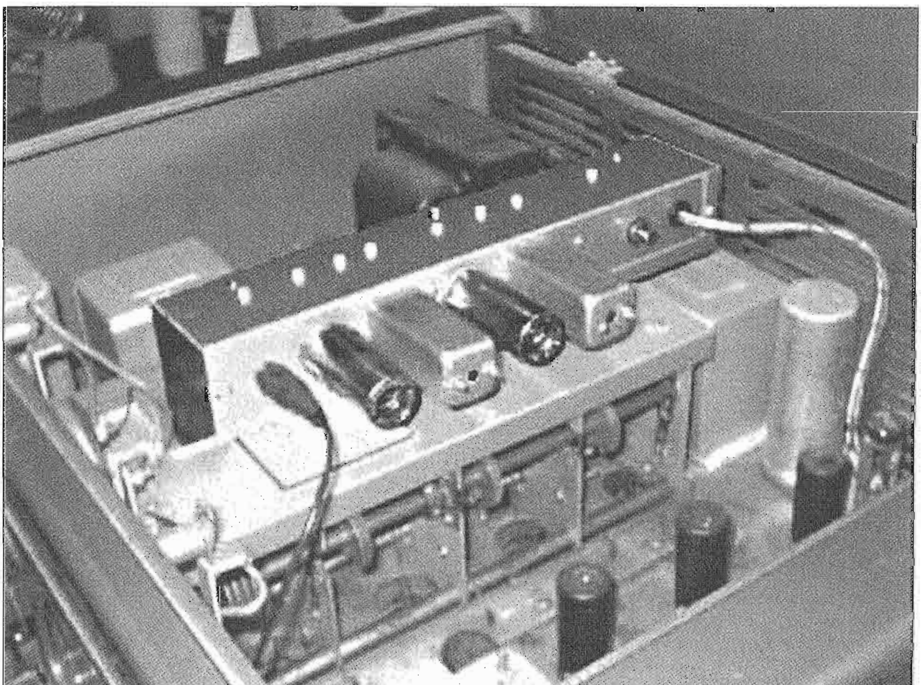
The National NC-183D is a great old receiver. It was a big improvement over the older NC-183. In recent times, Chuck Felton (KDØZS) in ER #191 and #192, took a crack at updating it. The results were outstanding. After all was said and done, one problem remained. There was no practical way to change the selectivity, and AM signals sound rather "pinched."

My Hi-Fi intermediate frequency amplifier works well with the Felton modifications and gives the push-pull 6V6s something to do.

It occurred to me that a separate, relatively-simple IF could be built and plugged into the receiver's accessory socket for power and audio. There was plenty of room on top of the main tuning condenser if the tubes and coils were mounted sideways. The junk box turned up IF coils from an R-390 IF strip and an unused LMB box of just the right size. None of the parts are critical. The IF transformers from an AC/DC junker broadcast receiver with a 455-kc IF will work just fine.



The Hi-Fi IF strip is installed on the NC-183D. The aluminum LMB box is mounted on a plate that is secured to the tuning condenser cover using existing screws. The white "dots" on the top of the box are Teflon tie points that are pressed in from the inside. The first one is an AGC test point.

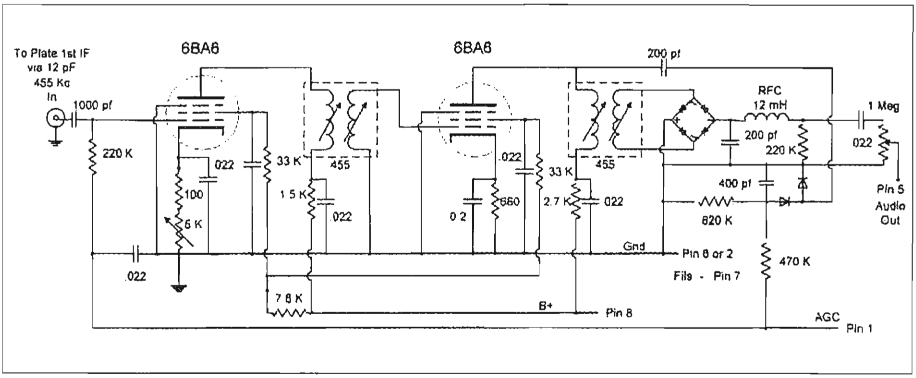


Figure 1: The NC-183D Broad-Band Amplifier and Full-Wave Detector

The circuit is quite basic, see **Figure 1**. The only notable difference is the full-wave detector, "FWD." There is very little written about it. The ARRL handbooks through 1975 mentioned it using a center-taped IF transformer. Dallas Lankford wrote a short article titled "R-390A Full Wave Bridge AM Detector," dated 2005. Lankford felt the FWD improved readability of fading signals. The ARRL stated that audio "highs" were improved. I found the FWD handled high levels of modulation with little distortion. In any event, it seemed like a good time to try out the idea. I used four ordinary signal diodes in my unit. A half-wave circuit is used in most AM receivers. The diode-load resistor, in that circuit, must be selected with some care to avoid clipping at high modulation levels, which produces associated distortion.

NATIONAL RADIO PRODUCTS MALDEN, MASS.

Alignment of the completed IF strip is straightforward and can be done on the bench using a bench power supply:

•Set the signal generator to 455 kc and connect a VTVM to the diode load resistor (220k and RFC).

•Short the AGC line to ground.

•Set the generator to produce about 5 volts.

•Adjust the transformers for max. Reduce the generator output as necessary so not to exceed 5 volts.

The signal into the broad IF is taken from the plate of the receiver's 1st IF. Use a piece of miniature coax and thread it through the hole where the dial lamp and S-meter wires run. Place the 12-pf capacitor near the 1st IF-stage's plate connection. Ground the braid somewhere near. You will need to touchup alignment later.

After attaching the IF pickoff, the adapter can be tested in the receiver (before the switch has been modified). Tune in a signal in "RADIO" mode, and then switch to "PHONO" mode, but probably little difference will be heard. However, when tuning to one side or the other, the signal will get much louder. This is because the receiver is controlling the AGC. As one tunes off the signal

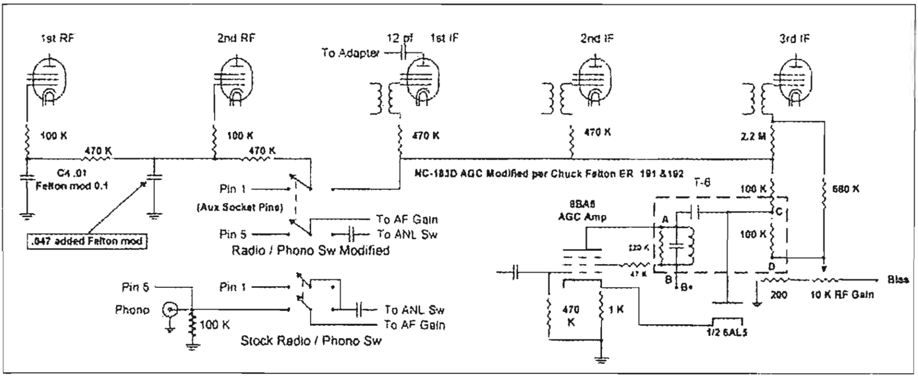


Figure 2: AGC Switching Modifications

the AGC voltage is reduced – the gain is increased. In order to get the AGC to cooperate with the adapter, the RF amplifiers are switched to the adapter's AGC line. The receiver IF still controls the S-meter.

At this point, you will probably want to modify the switch. Remove the 100k-ohm resistor at the "PHONO" input jack. The jack can stay, although not required. Also remove the jumper wire on the "RADIO/PHONE" switch, see **Figure 2.**

I disconnected the AGC at the terminal strip near 1st RF and ran shielded wire back to the switch. The receiver AGC connection to the switch is easily accessible from the side of the chassis near the switch. Now that everything is connected, you should find maximum signal in the same place in both modes. You will find the S-meter is working, although not in total agreement with the stock IF. The crystal filter, also, works in both modes. If you haven't done so already, adjust the audio output from the adapter to balance the receiver when switching modes.

For those of you who may have completed the Felton mods, the value of C4 was changed from .01 to 0.1 mfd and an additional filter capacitor of .047 mfd was added to the AGC string. See **Figure 2.** I suggest that the two capacitors be changed to .01 mfd in order to keep the adapter's AGC happy. The change will not materially effect a Felton-modified receiver.

Important Note: Clean the switch! The "PHONO/RADIO" switch, along with the rest of the radio, is over 50 years old, but in that lifetime it has not been flipped very often. I can't say it was *never* used because the NBFM Adapter and Select-O-Ject required switching to "PHONO." Because of infrequent use, the switch contacts may be well oxidized. It is difficult to get DeOxit® into the switch, so perhaps standing the receiver on its back so as to let the cleaner drain into the contacts will work. Then, actuate the switch until your arm falls off. As you may have guessed, I had a lot of trouble with it in my receiver,

ER

Telegraph and Time Service

By Billy B. Johnson, WB5RYB
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I have noticed the Editor's Comments page in Electric Radio is now displaying a picture with a wall clock and a bank of Teletype machines.

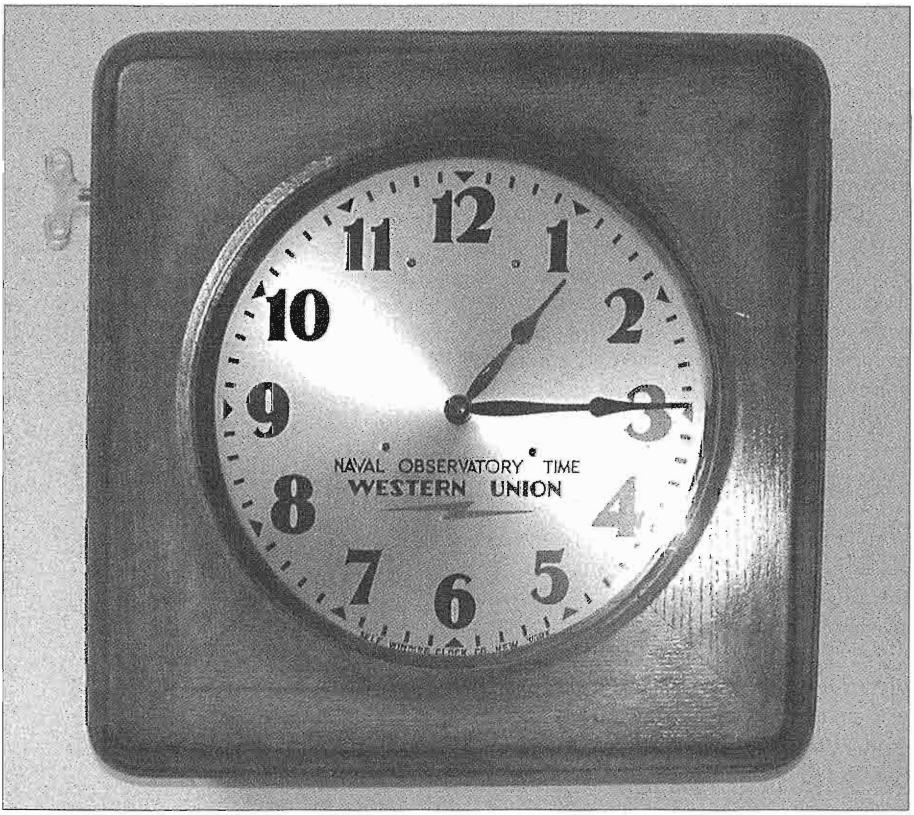
This wooden wall clock is a Model 29 made by the Self Winding Clock Company. Judging from the banks of the Teletype sets and the way these clocks were used, this picture was probably taken in a Western Union office.

In addition to ham radio, I enjoy collecting and restoring antique clocks and I thought the Electric Radio readers might enjoy a little information on this clock and the role it played in the telegraph and time service.

This clock is an early electrical clock that has a large brass movement and the traditional pendulum. It is a little unique in that it is not wound with a key, as are most antique clocks.

It is wound once an hour by a small electric motor powered by two 1.5-volt D-cell batteries. Originally, two large No. 6 dry-cell batteries powered these clocks. Sometimes these batteries are referred to as telephone batteries.

Electrically-wound clocks of this era



were often called self-winding clocks since they were wound automatically by the use of a battery. This was a very unique feature when the movement was patented in 1894.

Another unusual thing about this clock was its ability to have its time synchronized or corrected from a remote location. Clocks of this type allowed the railroads to synchronize time across various time zones through out their systems.

In the late 1800s, the Self Winding Clock Company and the Western Union Company formed a partnership to distribute time across the nation. The Self Winding Clock Company furnished the clocks in this agreement. Western Union installed the clocks and furnished their telegraph system to synchronize the time. The clocks were not sold; they were rented by the month. Rental on a clock of this type was usually $1.00 per month. A second hand could be included for an additional $0.50 a month.

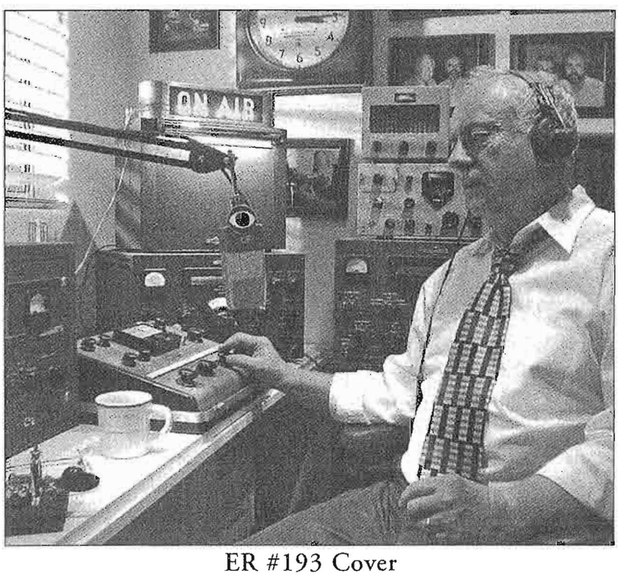
Synchronization was performed each day at noon except Sunday. To accomplish this synchronization, Western Union obtained the correct time from the National Observatory and transmitted it in Morse code over their telegraph lines.

This signal was received by the regional and local Western Union offices and relayed to businesses, schools, train and bus stations, and others that rented these clocks. This system allowed these clocks to be accurate to within one or two seconds of National Observatory time. By distributing time over their telegraph lines, Western Union became know as the nation's timekeeper.

The sale of time by Western Union was continued until the late 1960s. By this time the system had become obsolete and Western Union discontinued the service.

The picture on page 34 is a Model 29 Self Winding Clock that hangs in my shack. Please note the logo on the dial reads "National Observatory Time—Western Union". I often wonder how many Western Union telegraph operators used this clock to enter the correct time on their telegrams.

This clock is not only an excellent timekeeper, but since I operate mostly CW it lends a little nostalgia to my shack.



ER #193 Cover

The cover picture of the June 2005 issue #193 of Electric Radio shows a similar clock in a metal case, in the shack of Ron Hinze, KBØWAR. The cover of the October, 2005 issue #197 also shows an old Navy clock that is used aboard the Vessel LST-325.

Time is an important part of our hobby and it's fun!

ER

Radio-Electronics, Patents, and Prior Art

By Chuck Teeters, W4MEW
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A patent is an exclusive right granted by the Federal Government to an inventor to make, use, and sell his invention for a term of 20 years (17 years prior to 1996). The early days of radio were marked by many courtroom patent battles. Marconi had over 20 battles going around the world. The patent fight over regeneration between Major Edwin Armstrong and Lee DeForest went on for 13 years. When the court finally declared Deforest to be the winner, the Institute of Radio Engineers (the IRE), predecessor of the IEEE, took Armstrong's side, as the true inventor of regeneration, and supported his appeal until he won three years later. Armstrong's untimely death several years later was result of his on going battle with David Sarnoff, president of RCA, over FM broadcasting and TV sound.

Many inventors, like Major Armstrong, were more concerned with the invention than the patent. By WWII, most inventions were group works, as opposed to the single inventor of the early radio days. These groups were usually part of a large organization which provided the necessary paper work for patent protection. For example, the Federal Government established, in1941, the Signal Corps Patent Agency at The Signal Corps Research and Developments labs at Fort Monmouth, NJ.

The patent agency procedure was to provide a disclosure notebook to all the engineers and scientist working at Monmouth. The book provided a place to record each step in a project, with dates and witness signatures. Disclosure books were collected by the patent agency, examined, and potential inventions were investigated by a group of senior engineers and technically qualified attorneys. If a disclosure was accepted, the originator got a small monetary award, and an investigation was made to see if the idea was eligible for a patent and of value to the Signal Corps. If a patent was sought and awarded, ownership was assigned to the government, but if it did not involve a direct connection to a government project, the originator was given commercial rights.

Some Signal Corps high-visibility patents were radar, by Col Fred Elser (W2SC), overtone crystal oscillators by Marv Bernstein (W2PAT), and printed circuits by Harry French (W2KQJ). None of these hams were granted commercial rights, as the disclosures were associated with Signal-Corps projects. However, in some cases the originator got an invite to speak at national conventions, or was invited on tours of companies that were building equipment similar to the patent. Even if you didn't get any invites, you got a nice fancy patent to hang on the wall and an additional cash award.

By the mid-fifties, patents had lost some of their allure for many companies. With complex electronics, there were many ways to circumvent a patent and infringement battles were very expensive. Also, in a few cases a company only wanted name recognition and did not want to restrict use as this would limit sales. For example, the VHS-tape system was licensed to everyone so that it would predominate in the video market. Occasionally, the government also got into the act. A condition of the FCC standardization on the RCA color-TV system was that RCA allowed everyone to use the system. Also, the term "patented" had lost some of its impact due to wide spread use of the terms "patent pending" and "patent applied for." These were usually delaying tactics. The 17-year patent term began when the patent was issued, hence the time between application and issue pushed the expiration date downstream by a corresponding amount, and some stretched it out as much as possible. The current 20-year term is from date of application, so any delay in the issue is no longer of any value. Some still use the term "patent pending" but it offers no protection, and is usually associated with a provisional, 12-month, temporary patent application.

Another change is in the time government patent examiners look at applications. In the past, the examiner took many days to look over the relevant items submitted with the application, and in many cases uncovered additional information in contention with the application. Today, due to the large number and complexity of applications, the examiner takes only a few hours, and depends upon the applicant, his lawyer, contending patent holders, and other applicants to point out earlier patents, articles, uses, or prior art relevant to the application.

A particularly problematic area is when someone, applying for a patent, appears to have either been ignored or is ignorant of published details about an invention and represents it as their own. A patent application for an invention that has been in a printed publication accessible to the relevant parties one year, or more, prior to the application date is considered "prior art" and applications are not accepted. Patent applicants and their lawyers are under a legal obligation to disclose to the patent examiner prior art that is material to their application. Failure to do so can render a patent unenforceable, particularly if the examiner knew about the prior art and would have rejected the application. If it is found the applicant derived the invention from prior art publications the patent is invalid.

An interesting case is the broadband folded dipole, patented by Elmer R. Bush and assigned to Barker and Williamson, B&W. The 1980 application presented two prior art (1941 and 1942) patents on single-frequency, folded-dipole antennas to the patent examiner, along with the application for a broadband-folded dipole, which used a terminating load similar to a rhombic and therefore was aperiodic and broadband. The two existing patents did not use a terminating load and were not broadband. The B&W patent for the antenna was granted on December 27, 1983. The antenna was sold by B&W to amateurs and the U.S. Government as their unique, patented design.

Records show the broadband-terminated dipole was developed at the US Navy Yard, Boston. It was a project of Captain Glen Countryman (WIRBK) in 1947. In the Navy test report 947-12E, it was determined that the 6-to-12 db loss in radiated power outweighed any advantages of broad banding for Navy applications. Countryman thought the antenna still might be useful for ham-radio operators with limited antenna space; therefore he submitted an article for publication in the June 1949, QST, "An Experimental All Band Antenna." He followed up with two articles in CQ, November 1951, "Terminated Folded Dipole," and in February 1953, "More on the T2FD." The term "T2FD" was his nickname for the antenna. Countryman had changed his call to W3HH when he wrote the CQ articles as he had been transferred to Washington DC. All three of the referenced publications have advertising by B&W, and they received advertiser's copies. The terminated, folded-broadband dipole was well known after the W3HH articles, both overseas and in the USA. There were follow up articles in CQ, CQ-DL (Germany), and the RSGB Antenna File (England). Was this prior art?

For those who remember B&W, their plug-in coils and the 5100 AM transmitter, Barrie Barker (W3DGP) and John Williamson (W3GC) sold the company in 1964, sixteen years before the broadband-dipole patent application. Both are now SK.

A similar case with a different outcome was the mechanical-IF filter, announced by Collins Radio at the 1952 Institute of Radio Engineers annual show in New York City, with a big fanfare. Collins then proceeded to establish a monopoly on mechanical-filter production. What Collins did not do, however, was apply for a patent.

The first mechanical-IF filters were built in 1946 by Bob Adler at Zenith Radio. Articles by Adler in trade publications, particularly Electronics, April 1947, put the filter into the realm of prior art. Art Collins was wise enough to avoid filing an application. Collins instead published articles about the difficulties and cost of producing the mechanical filter in an attempt to discourage competition. However, the Collins monopoly was eroded first by RCA and then by Japanese production of cheap mechanical filters and even cheaper ceramic mechanical filters. However, the advertising kept Collins in the lead for many years. Later, Collins did secure patents on improved filters.

Despite a lack of a patent, Collins advertising succeeded in associating the Collins name with mechanical filters, so no one remembers Bob Adler at Zenith as the inventor. This never bothered Bob, because after the filter he developed the TV-remote control, then sat back and enjoyed the notoriety and money. He was known around the Evanston, Illinois nursing home, where he lived for the last few years, as the Supreme Guru of couch potatoes. Bob did not quite make it to the fiftieth anniversary of his original mechanical-filter article. Rest in peace Bob, and thanks for giving WØCXX a chance to show there *were* ethical CEOs in the electronics industry.

ER

Operating and Servicing Notes for the Hallicrafters HT-32 and HT-37 Transmitters

By Dave Miller, K7ALR
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When I returned to ham radio in 2002 after a 44-year hiatus, I wanted to get back on the air with a vintage HF rig. To this end, I acquired a Hallicrafters SX-101 and a HT-37, both in working condition. The HT-37 rig served me very well on both CW and SSB for over a year. However, the HT-37 was really meant to mate with the SX-111 and looked a bit out of place alongside of my SX-101. Hallicrafters was big on style and manufactured much of its equipment to provide pleasing matches. I then acquired a HT-32 in excellent shape and it immediately replaced the HT-37. I must say, the HT-32 and SX-101 are as handsome a pair to grace a ham shack as anything I have seen.

The HT-32 was manufactured from 1957 to 1959, and the HT-37 was made from 1959 to 1963. The HT-37 did not replace the HT-32; rather later iterations, the A and B models of the HT-32 kept it in production through 1964.

My HT-32 weights in at a hefty 80 pounds and sold for $675.00, while the HT-37 weights a mere 68 pounds and sold for $495.00. Think of the HT-37 as an "economized" version of the HT-32. I do not say "cheapened" because the two transmitters are fully equal in performance, and $495.00 was not "chump change" in 1959.

Physically, the HT-32 is a bit larger in all dimensions and more robust. The cabinet is one piece with a hinged lid. It has a fan to help cool the 6146 finals. All tubes, except the rectifiers and voltage regulator, are shielded. There is even a shield over the 6146s. The high-voltage filter condenser is an oil-filled, 10-µfd unit rated at 1000 volts. It will probably last another 50 years!

Anyone who has used either of these transmitters on SSB will tell you of the great audio reports they have received.

Dave Miller (K7ALR) is using a lot of great-looking equipment in his shack. The HT-32A on the left side of the shelf is discusssed in the text.

Even though their SSB generation is different, the HT-32 uses a filter system while the HT-37 uses a phasing system, they produce great audio. I prefer using the HT-37 simply because it is easier to "zero in" on a SSB signal. The HT-32 manual suggests: "On SSB a sideband signal is obtained when talking into microphone to 'talk onto frequency.' " This is not very elegant.

Incidentally, the HT-37 push-to-talk (PTT) modification in Electric Radio number 25, May 1991, by Steve Carson (KE4MN), can also be adapted to the HT-32. The HT-32A and B models incorporate PTT from the factory.

The VFO on these transmitters is fairly stable, and after about a 20-minute warmup I detect no noticeable drift on CW. The band frequencies are derived from mixing the VFO, the 9-Mc, crystal-controlled sideband generator, and band-selected frequencies from the heterodyne-crystal oscillator. The VFO frequency is 5.0 to 5.5 Mc, so there is only 500 kc of bandspread on each band. Four heterodyne crystals are required to cover the full 10-meter band, and a fifth for the 11-meter band on the HT-32. The service manual theory of operation provides a good explanation on how these frequencies are developed. The HT-37 manual has a handy table included with the block diagram.

I have performed alignments on both transmitters and found the procedure fairly straightforward with a couple exceptions. The HT-32 RF alignment procedure for the 2nd-and-3rd mixer and driver stages (HT-37 1st and 2nd stages, respectively) instruct you to disconnect the screen lead of V11—the 6146 final amplifier—from the terminal lug on underside of chassis. This equipment was wired in the days when leads were tightly wrapped at least one full turn on a terminal and lots of solder was used. I am loathe to unsolder anything for the mere purpose of test and alignment, so I did not do this. I am not sure of the reason for this, but the result was that accurate alignment of the driver output was not possible on the upper bands, 10 meters being the one that was most adversely affected. However, I performed the alignment as otherwise instructed and for final alignment I replaced all the tubes and loaded the transmitter into a dummy load. Keeping the output power around 40 watts, I touched up the alignments for 20, 15, and 10 meters. With a decent 12BY7 driver and 6146 finals you should be able to get at least 90 watts of RF output on all bands with slightly less on 10 meters.

Before performing the 3rd mixer (HT-37 second mixer) and driver alignment, the procedure disables the VFO, the sideband generator, and the heterodyne oscillator by removing certain tubes, crystals, and an RF cable. And, oh yes, remember to remove the 5R4 high-voltage rectifier as well. Unfortunately, the procedure neglects to tell you to replace these tubes, crystals, and RF cable but not the HV rectifier, in order to perform the 2nd mixer (1st mixer in the HT-37) and heterodyne-oscillator alignments. Apparently, they assume you should be smart enough to know that!

A voltmeter with an RF probe is recommended for observing and setting various levels during alignment. I use a 250-Mc oscilloscope with a 10X-probe for this purpose. Multiply the RMS value by 2.8 for the peak-to-peak reading on the oscilloscope.

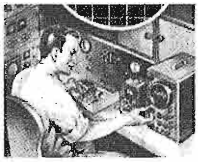
Because I work mostly CW, I like to always check the voltage and current across the key contacts on these vintage transmitters. These transmitters use grid-block keying, the best kind. I measured –45 volts key up and 180 microamps through the contacts on key down. This should be quite safe for any straight-or-electronic keying system. On the rear of the chassis, near the center, there is an existing hole where I mounted a ¼-inch phone jack. From there, I ran a wire to pin 8 on the nearby output connector. This provides a rear CW-key jack, into which I plug in my keyer and this helps clean up the clutter in front of my equipment.

For CW work, I run the RF power at about 20 percent below maximum output, about 75 to 80 watts on my rigs, using the "RF Level" control. This results in a nice clean CW signal. I have specifically asked a number of ops for a critical evaluation of my "T" and have always received excellent reports.

These transmitters, paired with my SX-101, have provided many hours of enjoyment, both on the air and trying to maintain them in top working order. They have been fairly reliable, requiring only replacement of a few leaky condensers and an occasional tube. When conducting a CW conversation, after the usual reports of RST, name, QTH, etc. the mention of using vintage equipment often stirs up comments of "My first rig was..." or "I wish I still had..." and the like. Even better is conversing with another vintage equipment user. Those extended QSOs usually end after my CW starts getting ratty.

ER

The Restoration Corner



Please send in your short restoration topics so this column can run regularly!

Source of Audio Hum

By Garey Barrell, K4OAH

Some have wondered why Drake used an 8BN8 tube in the 2-A/B receiver rather than the "normal" (for the 6.3-VAC filament supply) 6BN8.

A speculation has surfaced over the years that it might have been a typo, an error, or even a "good buy" of some surplus 8BN8s—'a la early Heathkit products. Actually, the answer is "none of the above." There is a reason for it to be an 8BN8.

There is a phenomenon in vacuum tubes whereby the heater (filament) and cathode of the tube form a "parasitic diode." One side of the filament is grounded; and so on the negative half-cycles of the filament supply, rectified 60-Hz pulses are superimposed on the cathode, resulting in hum in the audio.

The "cure" is to reduce the filament voltage slightly, since the parasitic diode action falls off much faster than the indirectly heated "real" diode of the tube's cathode and plate. This is not a problem in most conventional uses of tube diodes, since the cathode is usually operated at, or near, ground and/or at fairly low impedance. The culprit in the 2-A/B is the noise limiter diode, since its cathode is connected directly to the high-impedance audio input.

Hallicrafters used a series resistor in the filament circuit of the 6H6 that they used in their ANL, but Drake had the option of an 8-volt tube designed for series-string TVs and could eliminate the resistor.

Restoring the Heathkit Marauder Transmitter

By Mike Waldrop, W5RKL

The Marauder is a great vintage transmitter. If you have the manual, I recommend performing the alignment and paying close attention to the 40, 20, and 15-meter traps. Usually, these traps have either never been adjusted or were adjusted incorrectly. The traps in my Marauder were not adjusted properly. The manual is a bit fuzzy on this procedure. I ended up keying the Marauder into a dummy load and adjusting the 3 traps by listening on a separate receiver.

Check to ensure the carrier generators are aligned properly. I used a stable separate receiver for this adjustment. I aligned the carrier generators for zero beat in the receiver.

The sideband balance was accomplished using a 2-tone test while watching the transmitted signal on a monitor scope to ensure each sideband was equal in strength.

The VOX delay, used in CW and voice modes, is too short and is not a couple of seconds long with the delay turned all the way up. I ended up changing the resistor to ground that is in series with the "DELAY" pot with one having twice the resistance the original circuit calls for. This helped a lot and gave about 5 seconds of delay before unkeying the Marauder. Prior to this, the Marauder would unkey after 2 seconds with the "DELAY" turned all the way up.

Neutralize the final! This is a step that usually has not been done or not done properly.

Make sure the heterodyne oscillators are properly adjusted with the specified output levels stated in the manual. I found mine to be way off and the output was about 40 watts max on 80 meters with less on 40 and above. This also means to ensure the driver coils are adjusted for maximum output as well. I used the middle of each band starting on 80 meters and working my way up the bands.

Clean all the relay contacts with a piece of card stock and DeoxIT®. These tend to become quite dirty. There is no direct replacement relay available. If you need a replacement, you will have to find an original relay from a parts radio which is quite difficult since there are not many Marauders being used as parts radios these days.

Align the VFO as instructed in the manual. This makes a big difference in the accuracy of the dial. The VFO operates between 5 and 5.5 MHz, with the low end of the dial being at 5.5-MHz VFO output.

If the glass-dial cover is broken or cracked, replace it with "Lucite." Clear Lucite is available at most hardware stores. I replaced all of my Marauder, Apache and Mohawk glass dials with this plastic material and it looks great. You have to remove the bezel to replace the cover, but you *do not* have to remove the front panel. Just keep the dial mechanism from rotating. I used a rubber band or string to hold the dial steady after removing the bezel-mounting screws. Clean *all* of the old glue from the bezel then cut the Lucite to fit, sanding the edges so it fits snug in the bezel. I used super glue to hold mine in and it's been holding tight for a couple of years now.

Always Use 6146 or 6146A tubes. Do not use 6146B or any "B" version. The Marauder is designed to operate with 6146 "plain Jane" or the "A" version or any "A" variation. Do not be led to believe that the 6146B or any "B" variation will work. Read Glen Zook's articles titled "The 6146 Family of Tubes" in ER #153 for further details.

Clean and lubricate the cooling fan. If the fan will not clean up, use a 120-VAC muffin fan. The finals need to remain cool. The original fan on my Marauder was a piece of junk and would spin at half speed, at best. I threw it in the garbage and went to a new 120-VAC muffin fan. I removed the original final-cage top cover and replaced it with a piece of perforated aluminum, cut to the same size with the muffin fan mounted on top. It clears the cabinet and keeps the final much cooler than the original fan and it's much quieter as well.

Check *all* wafer switches, clean as needed. Check *all* diodes in the modulator and speech amplifier. I found a couple that were installed backwards. The caps are usually 10 µfd at 35 VDC, easily found at Radio Shack or Mouser for cheap prices. Radio Shack may be a bit higher in price than Mouser. Replace *all* of the electrolytic caps. Remember, they are 46-plus years old and more than likely will be dried out or give you problems down the road. The tall black high-voltage filter caps, 125-µfd, 450-VDC caps, are no longer available. These can create problems with the final's HV supply. Replace them with modern, low-profile caps using a mounting ring. Replace the equalizing resistors as they are quite old and more than likely out of tolerance.

Check the radio over thoroughly *before* applying power. Use a Variac when first powering the Marauder up. If everything checks out OK, the "Mic Gain" pot may need to be cleaned and turned up no higher than 10 o'clock for good modulation. Do not exceed 100 mA in AM mode if you do not plan on replacing the finals rather frequently. The finals are not designed for long QSOs at 100% duty cycle and neither is the power supply.

Drift will be experienced when the Marauder is first turned on. If the frequency "jumps" off frequency (not slowly drifting off frequency) this is more than likely caused by a dirty mode and/or function switch. The VFO tube should be checked and replaced if it fails to meet specifications.

Output of 100 watts DC on CW and 100-watts PEP on sideband is not unusual. With my Marauder, I get about 105 watts or so, depending on the band, and it is quite stable for a 46-year old filter-type sideband transmitter. I love mine, and use it with an SB-303 receiver.

The Mohawk receiver is not designed as the matching receiver for the Marauder. The Marauder came out in 1962, well after the Mohawk and Apache combination hit the market. The Marauder was the last of Heath's *big* boatanchor transmitters. Heath stopped production of the *big* rigs when Collins came out with the first S-Line, 75S-1 and 32S-1 in the late 1950s. That was the end of the *big*-radio era with Heath and other manufacturers. Heath went to the SB-300 and 400 series along with the HW monobander series until the SB-100 and HW-100 series transceivers took over.

Good luck, and have fun with your Marauder. It's a very nice, and is a great filter-type sideband, CW, AM, and FSK transmitter.

More About Using Military-Surplus Microphones

By Jim Haynes, W6JVE

All the T-17 microphones I have ever encountered have been terribly insensitive. I don't know if this is because the carbon element has gone bad or if the mike was deliberately made insensitive to reduce pickup of engine noise and the airman was told to yell into it to overcome the noise.

Some T-32 mikes have the really old fashioned carbon transmitter, where the diaphragm is practically the full diameter of the element and there is a mouthpiece shaped like a shot glass that screws into the faceplate. The one in the picture in the article "Speaking of Microphones" in ER #217, by K3HVG, appears to be fitted with a "bull dog" adapter, which allows use of an F-1 telephone transmitter. This is a considerable improvement over the older kind. I was able to get a bull-dog adapter from a telephone collector I contacted on a collector's web site http://groups.yahoo.com/group/singingwires/

Considering the popularity of candlestick phones these days, you can probably get an old-looking faceplate and mouthpiece that takes a modern T-1 carbon transmitter element.

The H-33*/PT handset has a seven-wire cord connected to the U-77/U connector as follows:

- A - Receiver - white wire
- B - Receiver - black wire
- C - Transmitter - red wire
- D - Transmitter - blue wire
- E - Transmitter ground through PTT switch - green wire
- F - PTT Switch - brown wire
- H - PTT Switch ground - yellow wire

There is another kind of handset out there, the H-156/U, which also has a U-77 connector. This has only a four-wire cord, and as it comes, will not work with a radio that uses the H-33 handset. (Somebody should be shot for doing this. If you are going into battle you need a technician to be sure you have the right handset for the equipment you are going to be using.)

The nice thing about the H-156 is that it takes standard, modern-telephone elements, specifically the T-1 carbon transmitter. I found that by moving one wire in the U-77 connector I can make this handset work with the radios I have, because the U-79/U connectors happen to be wired in a way that makes this possible. The trick is to open the U-77 and move the red wire from pin "E" to pin "F." This depends on the fact that in the radios pins "B," "E," and "H" are all grounded. If your radio is wired that way you are in luck.

Because carbon transmitters do not improve with age, I was able to get an electret replacement from Mike Sandman, www.sandman.com. This was made to fit into a G-type handset with a modular connector on the handset, but with a little trimming it will fit just fine in the H-156 or any other non-modular handset.

H-156 wiring

- A - receiver - black
- B - common - white
- C - transmitter - green (Other side of transmitter goes to common through PTT switch.)
- E - PTT switch - red (Other side goes to common.)

I measured the resistance of a few carbon elements:

- T-1 dated 51-84: 600-1000 ohms
- New T-1 from Mike Sandman: 300-500 ohms
- TA-117/PT (T-1 equivalent) from some old H-156 handsets: 60-75k, 3.5k (dated Dec 1975), 500 ohms (dated June 1983)
- T-32 with bull-dog adapter and F-1 dated 5/43: 150-170 ohms
- H-33 replacement transmitters from Fair Radio: One is 70 ohms and one is 170 ohms.

73, Jim Haynes, W6JVE

6E5 Magic Eye Problems and a New Electronic Formula

By Mike Hardie, VE7MMH

During the restoration of a 1940-ish G.E. table-top radio one of the problems was that the "tuning eye" wasn't working properly. The 6E5 tube checked out as good. The radio had been repaired at least once, and one of the solder lugs on an IF transformer showed no evidence of ever receiving solder where the schematic indicated a connection should be, so all bets were off.

The tuning eye tube was mounted in the typical clamp arrangement with the "eye" pointing outward from the middle of the dial. The tube socket (small 6 pin, two large pins) had four wires that disappeared down into the chassis and were connected to where they should be. In addition, the schematic indicated there should be a 1-Meg resistor between the plate and the B+, but I couldn't find the resistor, and measuring the resistance on the associated socket pin indicated it wasn't connected to anything.

The tuning-eye tube sockets are commonly not the chassis type, instead, they are in bakelite "case" that push fits over the end of the tube. The case has wires extending from it down through the chassis. When examining the connections to these sockets, it's important to remember the pin numbering runs counterclockwise, because you're looking at it as if you are looking at a normal socket from above the chassis. This particular bakelite case had an interior removable baffle, with holes for the tube pins, accessible after removing the tube from the socket. I removed the baffle and there was the 1-Meg resistor, between the socket pins, and invisible until the socket was opened up. The resistor measured open, so it was removed and a new one soldered in.

Viola, I had a functioning tuning eye. Why did it fail? That has yet to be determined, maybe just heat and age; the socket is relatively close to the 5Y4 rectifier. I don't like to think of it failing due to age, because the radio and I were "born" about the same time!

New Electronic Formula

While repairing an RBL-3 receiver, I've stumbled onto a new formula, or perhaps electronic law. The law is:

Cfr = 1/Ca

Where: Cfr is the component failure rate, Ca is component accessibility

(Note: Cin can be substituted for 1/Ca, Cin being component inaccessibility.)

Put simply, the components "buried" under layers of other components are the ones that seem to fail most often.

Quality Hardware Source

By Rich Baldwin, KD6VK

One of the best things I ever did when I got into boat anchors was to buy a piece of Collins military gear that no one else wanted, probably at a flea market, I don't really remember, it was so long ago. I do remember however that I only paid $5.00 for it and it was gigantic. I took it to my shop and took it apart, saving all of the hardware, nuts, screws, washers, etc. I put them in a box marked "military hardware," and to this day I find myself going to that box almost every day for some single part to finish a project. I always find what I need there, and have added additional items as time passed so that I am never without the quality components that Collins used in assembling their radios.

I don't think there is a better way to accumulate the stainless steel hardware that Collins used in their construction and which we need on a continuous basis with our current projects. You do end up trashing a large part of the item, but the good parts will last forever in the box or some new, current project.

Patent Number Suggestion

By Peter Anderson, KC1HR

I have a suggestion for an addition to the great articles in Electric Radio: At the end of each article, how about if authors include a footnote containing the patent numbers found on the described equipment? This would permit readers to look up the patents themselves, and learn more of the inventor's thought processes. Over time, we would build up a database of the technology development. One example: In U.S. patent number 1,172,017, Reginald A. Fessenden disclosed a working, direct-conversion receiver and switching-mode CW and AM transmitter a century ago.

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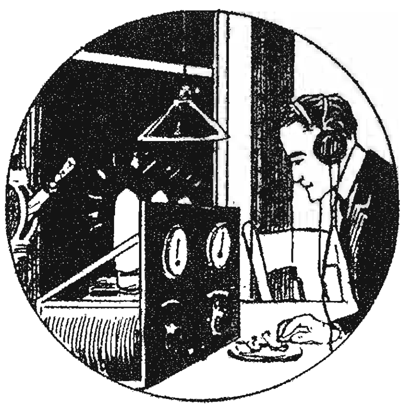

VINTAGE NETS

AM Carrier Net: Sunday mornings, 8:30AM local Eastern time, 3835 kc. QSX W2DAP. Friendly format.
Arizona AM Nets: Sat & Sun: 160M 1885 kc @ sunrise. 75M 3855 kc @ 6 AM MST. 40M 7293 kc 10 AM MST. 6M 50.4 Mc Sat 8PM MST. Tuesday: 2M 144.45 7:30 PM MST.
Boatanchors CW Group: QNI "CQ BA or CQ GB" 3546.5, 7050, 7147, 10120, 14050 kc. Check 80M winter nights, 40 summer nights, 20 and 30 meters day. Informal nightly net about 0200-0400Z.
California Early Bird Net: Sat. mornings @ 8 AM PST on 3870 kc.
California Vintage SSB Net: Sun. mornings @ 8AM PST on 3860 +/-
Colorado Morning Net: Informal AMers on 3875 kc daily @ 6:00 to 6:15 AM, MT. QSX KØOJ
Canadian Boatanchor Net: Daily 3725 kc (+/-) @ 8:00 PM ET. Hosts are AL (VE3AJM) and Ken (VE3MAW)
Collins Collectors Association (CCA) Nets: Sunday, 14.263 Mc @ 2000Z. Informal ragchew net Tue. evening, 3805 kc @ 2100 ET, Thu. 3875 kc. West Coast 75M net, 3895 kc 2000 PT. 10M AM net 1800Z, 29.05 Mc Sunday, QSX 1700Z. CCA First Wednesday AM Night each month, 3880 kc starting @ 2000 CST, or 0200 UTC.
Drake Technical Net: Meets Sun. on 7238 kc, 2000Z. Hosted by John (KB9AT), Jeff (WA8SAJ), and Mark (WBØIQK).
Drake Users Net: Check 3865 kc, Tue. nights @ 8 PM ET. QSX Gary (KG4D), Don (W8NS), and Dan (WA4SDE)
DX-60 Net: Meets on 3880 Kc @ 0800 AM, ET on Sun. QSX op is Mike (N8ECR), with alternates. The net is all about classic entry-level AM rigs like the Heath DX-60.
Eastern AM Swap Net: Thu. evenings on 3885 kc @ 7:30 PM ET. Net is for exchange of AM related equipment only.
Eastcoast Military Net: Sat. mornings starting 0500, 3885 kc +/- QRM. QSX Ted, W3PWW. It isn't necessary to check in with military gear, but that is what this net is all about. Late checkins are welcome.
Florida AM Group: A large group meeting every Sunday, 7:30AM ET, 3875 kc and pre-net checkin 7:00AM ET, 3675 kc. QSX Maury, N4GUI. Also, Florida vintage SSB net "AFLAC" meets Wed., 3910 kc, 9PM ET. QSX Warren, W1GUD.
Fort Wayne Area 6-Meter AM net: Meets nightly @ 7 PM ET on 50.58 Mc. Another long-time net, meeting since the late '50s. Most members use vintage or homebrew gear.
Gulf Coast Mullet Society: Thu. @ 6PM CT, 3885 kc, QSX control op W4GCN in Pensacola.
Gray Hair Net: One of the oldest nets, @44+ years ,160 meter AM Tue. evening 1945 kc @8:00 PM EST and 8:30 EDT. Also check www.hamelectronics.com/ghn
Heathkit Net: Sun. on 14.293 Mc 2030Z right after the Vintage SSB net. QSX op W6LRG, Don.
K1JCL 6-meter AM repeater: Operates 50.4 Mc in, 50.4 Mc out. Repeater QTH is Connecticut.
K6HQI Memorial 20 Meter Net: Flagship AM net 14.286 Mc daily for 25+ years. Check 5:00 PM Pacific Time.
Lake Erie Boatanchor CW Net: Saturday morning, 1 PM ET, 7094 kc QSX op Steve (WA3JJT) or Ron (W8KYD).
Midwest Classic Radio Net: Sat. morning 3885 kc @ 7:30 AM, CT. Only AM checkins. Swap/sale, hamfest info, tech. help are frequent topics. QSX op is Rob (WA9ZTY).
Mighty Elmac Net: Wed. nights @8PM ET (not the first Wed., reserved for CCA AM Net), 3880 +5 kc. Closes for a few summer months. QSX op N8ECR.
MOKAM AM'ers: 1500Z Mon. thru Fri. on 3885 kc. A ragchew net open to all interested in old equipment.
Northwest AM Net: AM daily 3870 kc 3PM-5PM winter, 5-7 PM summer, local. 6M @50.4 Mc. Sun., Wed. @8:00 PM. 2M Tues. and Thurs. @ 8:00 PM on 144.4 Mc.
Nostalgia/Hi-Fi Net: Started in 1978, this net meets Fri. @7 PM PT, 1930 kc.
Old Buzzards Net: Daily @10 AM ET, 3945 kc in the New England area. QSX op George (W1GAC) and Paul (W1ECO).
Southeast AM Radio Club: Tue. evening swap, 3885 @7:30 ET/6:30 CT. QSX op Andy (WA4KCY), Sam (KF4TXQ), Wayne (WB4WB). SAMRC also for Sun. Morning Coffee Club Net, 3885 @ 7:30 ET, 6:30 CT.
Southern Calif. Sun. Morning 6 Meter AM Net: 10 AM on 50.4 Mc. QSX op is Will (AA6DD).
Swan Nets: User Net Sunday 2200z winter 14.250Mc ±QRM. QSX op rotates Jim (WA5BDR), Jay (WB6MWL), Norm (W7RXG), Bill (W4WHW). Tech Nets: Wednesday 2300z 14.251Mhz / Saturday 1900z 7235 kc QSX op Stu (K4BOV)
Texoma Trader's Net: Sat. morning 8:00AM CT 3890 kc, AM & vintage equip. swap net.
Vintage SSB Net: Sun. 1900Z-2000Z 14.293 & 0300Z Wed. QSX op Lynn (K5LYN) and Andy (WBØSNF)
West Coast AMI Net: 3870 kc, Wed. 8PM Pacific Time (winter). Net control rotates between Brian (NI6Q), Skip (K6LGL), Don (W6BCN), or Vic (KF6RIP)
Westcoast Military Radio Collectors Net: Meets Sat. @ 2130 Pacific Time on 3980 kc +/- QRM. QSX W7QHO.
Wireless Set No. 19 Net: Meets second Sun., monthly, 7270 kc (+/- 25 Kc) @ 1800Z. Alternate 3760 kc, +/- 25 kc. QSX Dave (VA3ORP).

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FOR SALE: Receivers, transmitters, test equipment, parts. email, or long 2-stamp SASE for list. W7HDL, George Babits, 167 Highway 93 South, Salmon, Idaho 83467 gbabits@salmoninternet.com 208-756-4147

FOR SALE: DX-100B, restored, satin black cabinet, new front panel, $450 , manual. Victor, 810-367-2087, wd8dwr@arrl.net

FOR SALE: Western Electric volume indicator panel, model 754-B. Make offer to Bob, W7SC, 3932 Mesa View Ln., Boise, ID 83706

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FOR SALE: Hammarlund RV-11 VHF receiver $125. Bendix BC-639-A VHF WWII lend-lease receiver $175. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777, 989-595-6483

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FOR SALE: Radiotron Designer's Handbook: Langford-Smith, 1953, the "red" one, fourth edition, excellent condition, $60. Mike Grimes, 5306 Creekside Ct. Plano, TX, 75094. 972-898-7251. K5MLG@verizon.net

FOR SALE: Two ARRL books, 1954 & 1963, clean, $10 ea. or two for $15. Four Cornell-Dubilier Capacitor Monthlys, May, July, Aug, Sep. 20 pages ea. Useful info, 4-for $5. Bernie Samek, 113 Old Palmer Rd, Brimfield, MA 01010 413-245-7174 bernies@samnet.net

FOR SALE: T-195A transmitter with meters & manuals. $360 plus shipping. Doug, KE6WVS, 559-683-0530, dwheeler@sti.net

FOR SALE: Terabeam 10dB bi-directional amp, covers ham band, etc. 1/2W output, $56 postpaid. Power supply for older HROs w/ 4-pin input. Has 2.5 or 6.3 volts for fils, + plate 230V at 75mA. Tested, in nice cabinet, $99 +shpg. Robert Enemark, W1EC, POB 1607, Duxbury, MA 02331 781-585-6233

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FOR SALE: Collins SM80 mic. Collins military speaker 76F3. VFO for ham bands. Meissner signal calibrator. Set of Bud plug-in coils, others. HT37 transmitter/exiter. National 5866 power supply for parts. RDO receiver. Bill Coolahan, 1450 miami Dr NE, Cedar Rapids, IA 52402, 1-319-393-8075

FOR SALE: Audio transformers, UTC Linear Standard LS-12X mic. to grid $95. LS-52 output $75. LS-141 hybrid NOS $75. LS-56 modulation 20 watts $90. Western Electric IIIC $40. Buyer pays shipping. James Owens, NWØO 1363 Tipperary St. RR#3, Boulder, CO 80303-1621 303-673-9019 evenings.

FOR SALE: Modulation transformers: Thordarson T-I1M77 300 watt multi-match $150. T-21M61 60 watt multi-match $50. T-21M61 NOS $60. TCS $25. ART-13, $40. BC-375 $25. Buyer pays shipping. James Owens, NWØO, 1363 Tipperary St. RR#3, Boulder, CO 80303-1621 303-673-9019 evenings.

FOR SALE: Radiotron Designer's Handbook, 4th.edition, $50 postpaid in USA. James Owens, NWØO, 1363 Tipperary S1. RR#3, Boulder, CO 80303-1621, 303-673-9019 evenings.

FOR SALE: Ten Tec Omni 6, factory updated to Omni 6 Plus, all filters, w/pwr sply, $800 + shpg. Please call Earl, 603-434-8326

FOR SALE: Racal RA-6778C receivers with DVD of manual. Pickup only, no shipping facilities. Bill Ford, VE3CK, 23 George St. N., Smiths Falls, ONT, Canada K7A 1Y3. 613-284-0700

DRAKE OWNERS: Solid State lamp replacements for all 4-line and 7-line equipment. Don, N9OO, Web: http://home.wi.rr.com/n9oo/products/products.html or phone 262-654-0072

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

FOR SALE OR RENT: 17.5 acre antenna farm w/garage & shack, 80-2M Telrex beams, 160m-4-square, 6kw amp linear, 12-towers Richard, K8CCV, 330-427-2302

FOR SALE: Antique Plastic Radio Dial Covers! No waiting, Quick turnaround. 1200 molds in stock. West Tech Services 570 Hazelgreen Rd. Smithville, WV 26178. 304-349-2149. Email: westtechservices@yahoo.com or Website: www.west-techservices.com. $15 ppd. Thanks, Gib & Linda

FOR SALE: Older tube type AM/FM radios, test equipment, parts. SASE gets list. Virginia Chen, 2609 Dudley Rd., Kilgore, TX 75662 903-984-4259

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

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

FOR SALE: WØITD estate: Yaesu FT2400, Icom IC735, Knwood TR7950, 2400, TM241A xcvrs. Tripp Lite PR25A & Astron RS20 pwr supplies. SASE for 70 plus items list. E.F. Hayes, ØJFN, 3109 N. Douglas Ave, Loveland, CO 80538

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

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

FOR SALE: 50 year collection of radios and parts, PU local in W. NY Buffalo area. Rudy, W2ZIA, 716-937-9279

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

FOR SALE/TRADE: Manuals: Swan, Multi-Elmac, Morrow, Gonset, Harvey-Wells, Ameco, Clegg, Layayette, Polycomm. Al, NI4Q, POB 690098, Orlando, FL 32869 407-351-5536 ni4q@juno.com

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

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

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

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

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

FOR SALE: KWM-2 CDs. All original material, not a copy of the manual. High resolution color pictures which will really help locate parts, plus much more. For more information

visit my web page at http://www.heavymetalradios.com/ or E-Mail me at boatanchors@comcast.net, DW Holtman, WB7SSN

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

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

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

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

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

FOR SALE: Galena crystals and detector assemblies. Also radio tubes at very low prices. Len Gardner, 458 Two Mile Creek Rd, Tonawanda, NY 14150, radiolen@att.net

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

WANTED: Tektronix 453A scope. Set of low frequency coils for Millen Grid Dip Meter, also a 3WP2 CRT. Contact Mike at 604-988-0112 or mike46@shaw.ca

WANTED: HQ-145 parts chassis. Tony, K8PVW, 313-882-2815

WANTED: Aircraft radio frequencies, SCR-178, legs, cables, generator. Test equipment latches. GN-37A, antenna, cables. FT-250 for BC-630. Manual OS-8G/U. Bill, KØIKP, 303-979-1860

WANTED: HP-14 mobile power supply and/or schematic and HP-24 base stn. power supply for the Heath HA-14 amplifier. Any condition. Ken, KH7TU, 808-647-0645, captdale2@hotmail.com

WANTED: Lafayette or Trio/Kenwood tube shortwave radios. David, KM6RI, 408-243-9326, varns@att.net

WANTED: The book "Riding the Airwaves" by Eric Palmer. Walter, 561-236-1821, 4317 Honeysuckle Palm Beach Gardens, FL. 33410 or WB4LWE@arrl.net

WANTED: ARN-6 Bendix ADF receiver. Contact Jim, WB9ORV, at janer@msn.com or 928-261-9070

WANTED: NC-125, any condition considered. AB5WG, Ron, 830-438-8588, ab5wg@satx.rr.com.

WANTED: Swan 117C power supply/ speaker accessory. Martin Piepenburg, W9OLD, 5536E 500N, Monterey, IN, 46960 574-542-2591

WANTED: Manual for Canadian Marconi SSB transceiver CP-34/AN PRC-514. Also military coils for the T-4/VRC transmitter. Also QSTs 1930, '31, '32 complete, good condx. George, K1ANX, 413-527-4304, k1anx@charter.net

WANTED: BC-348 IF transformer. Buy or trade for a basket case BC-348-M, O, P, or S, if IF transformers are ok. Clint, K4KRB, gormano@Charter.net 828-299-1276

WANTED: Manual, schematic, or any info on Rycom 2174A-610. Doug, 507-835-1175 dougsterr@juno.com

WANTED: A shaft gear clamp split, 9/16 id, 7/16 thick for a R392. Al Royce, alan.royce@ngc.com

WANTED: Manual for Dumont model 245 oscillograph, and looking for model 241 scope. Steve Bartkowski, 1-708-863-3090

WANTED: 4-pin Jones plug with two vertical and two horizontal contacts. Bill Landby, WØDCM, 218-386-1654

WANTED: Set of knobs for the R-390A receiver. Phil, w1gee@yahoo.com

WANTED: I am looking for a Grebe CR-18 receiver in good to excellent condition. Will pay any reasonable price, and most unreasonable ones! Bruce, W1UJR, w1ujr@arrl.net

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

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

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

WANTED: Hallicrafters SX-117 rcvr, restorable or parts unit. Still need bias and filament xfmr for HT33, A or B model. John, W8JKS, 740-998-4518

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

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

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

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

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

WANTED: Someone with a collection of Short Wave Craft, Radio Craft from the 1930s to collaborate on a series of articles on a substantial collection of original items from that time period. Please call Chuck, WØIUH, 320-277-3242

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

alan.royce@ngc.com

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

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

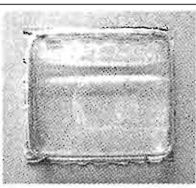
WANTED: SCR-602 components, BC-1083, BC-1084 displays, and APS-4 components. Carl Bloom, 714-639-1679

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

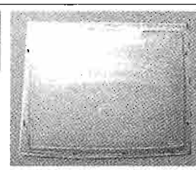
WANTED: Tektronix memorabilia & promotional literature or catalogs from 1946-1980. James True, N5ARW, POB 820, Hot Springs, AR 71902. 501-318-1844, Fax 623-8783 www.boatanchor.com

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

WEST TECH SERVICES



Hammarlund Clock

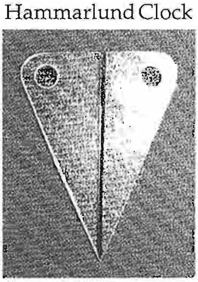


NC-240

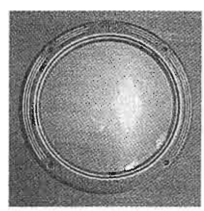
Antique Radio Plastic Dial Covers

We have the solution to old plastic dial covers that have become cracked, warped, and discolored!

West Tech Services now provides the service of making Antique Radio dial covers. West Tech purchased the Doyle Roberts Dial Cover Business in Arkansas. For 15 years, he made molds for *approximately 1200 radios*!



Skybuddy Pointer



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WANTED: HBR Receiver! HBR-11 HBR-14 etc. any condition–dead or alive, unfinished considered Jeff, KEØMT, ke0mt@aol.com

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

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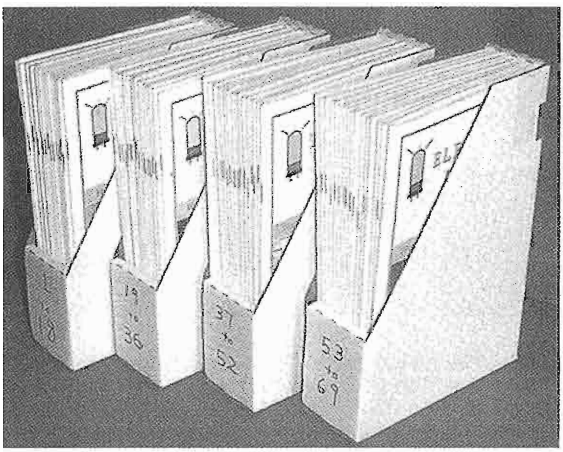

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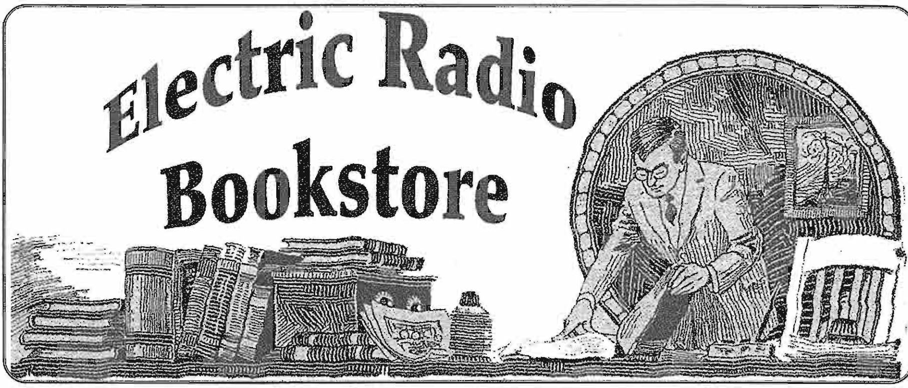

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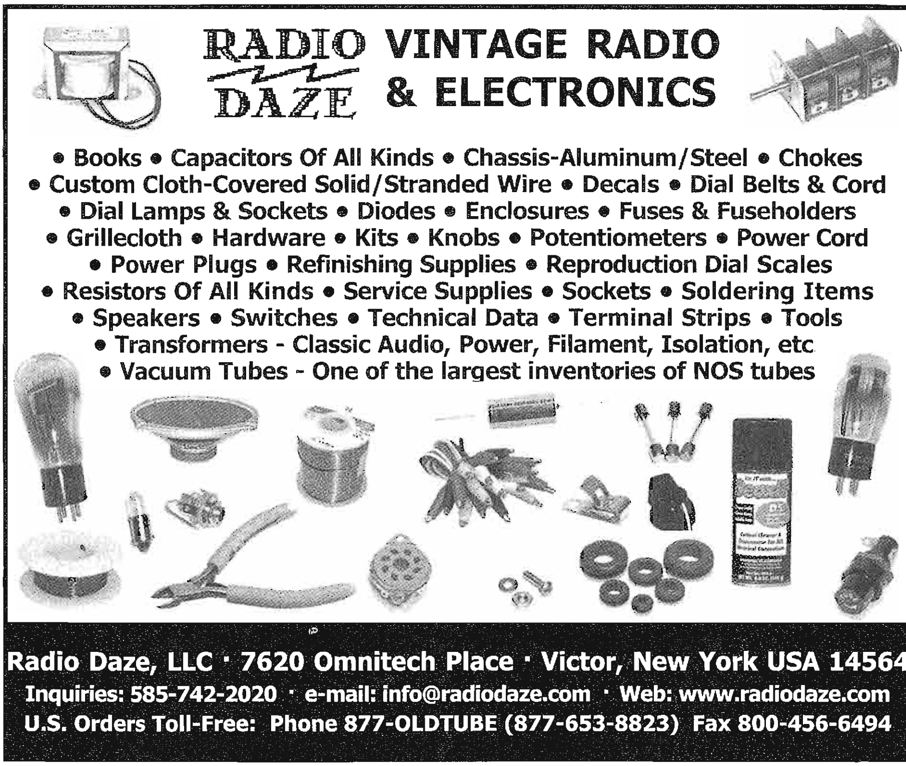

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