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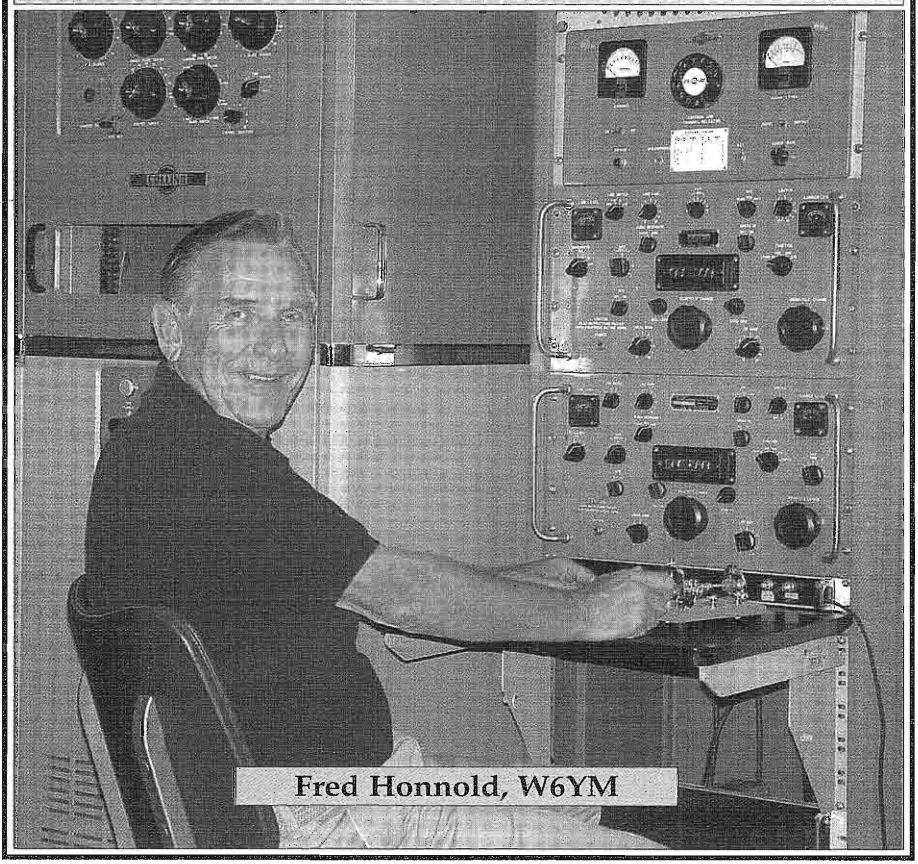
ELECTRIC RADIO

celebrating a bygone era

Number 207 August 2006



Fred Honnold, W6YM

ELECTRIC RADIO

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

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

Regular contributors include:
Chuck Teeters (W4MEW), Jim Hanlon (W8KGI), Tom Marcellino (W3BYM), Bruce Vaughan (NR5Q), Bob Grinder (K7AK), Bill Feldman (N6PY), Dave Gordon-Smith (G3UUR), Dale Gagnon (KW1I), David Kuraner (K2DK), Larry Will (W3LW), Gary Halverson (K6GLH), Brian Harris (WA5UEK), John Hruza (KBØOKU), Hal Guretzky (K6DPZ)

Editor's Comments

BPL System Forced to Comply With the Law

There have been recent BPL developments indicating that the pressure radio amateurs are applying is beginning to work in our favor in regards to enforcement of FCC Part 47 rules that apply to BPL system emissions.

A formal complaint to the FCC was made by Dwight Agnew (AI4II) about interference he received while operating HF mobile in Manassas, Virginia. What is significant about the developments in this matter is that the Office of Engineering and Technology is no longer looking into it. Now, the case is in the Enforcement Bureau's hands. Some have claimed that the OET did not have the necessary background to evaluate interference complaints.

The FCC Enforcement Bureau has determined that the Manassas, VA system, operated by the Comtek Company, is in violation of emission requirements, and not just inside HF ham bands. They have been ordered to reduce radiated emissions *20 dB below the level required for compliance* with Part 15 of FCC rules, *or they will be forced to stop operating the BPL system.*

Quoting in part from a letter from the FCC Enforcement Bureau to the City of Manassas and to Comtek, dated June 16, 2006: "...Based on our preliminary review of the Product Safety Engineering, Inc. report submitted on April 6, 2006 and the Rheintech Laboratories, Inc. report submitted on April 14, 2006, it appears that the BPL system is not in compliance with the Commission's emission requirements at several frequencies. We note that these frequencies are not part of the amateur band and thus, separate from Mr. Agnew's complaint. Accordingly, to fully comply with the Commission's roles, you are directed to take immediate steps to eliminate all excessive emissions. Upon your completion of any remedial actions, you must conduct additional measurements to demonstrate compliance with the Commission's emission requirements....you are directed to submit a report on the steps you have

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Fred Honnold (W6YM) reminisces in front of a rack of R-390s, at the QTH of K6GLH, about his days in the Navy as a radio operator. Fred lives on a mountain on the big island in Hawaii and is active on all bands through UHF. (Photo courtesy of Gary Halverson, K6GLH)

The Johnson Viking 500 Power Cable Fix

By Tom Marcellino, W3BYM
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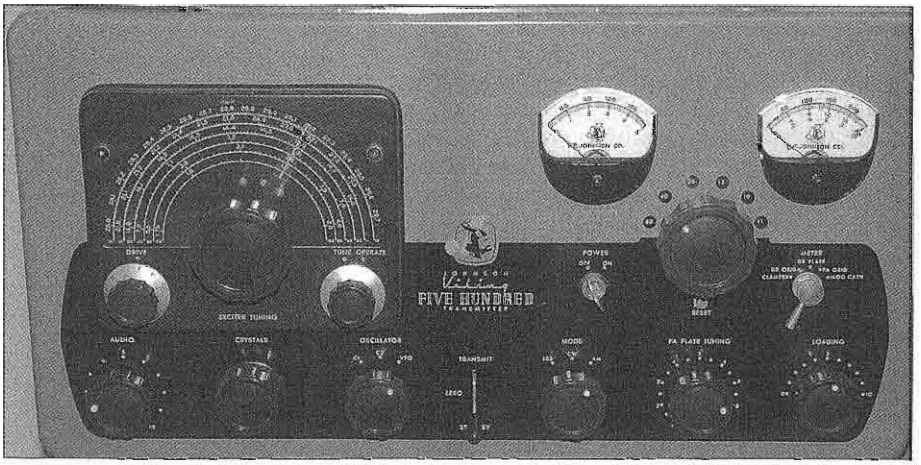
The Viking "FIVE HUNDRED", as it was labeled in the manual, was another great transmitter of the last century and still is a front runner for AM operation today. The 34th Edition of the 1957 ARRL Handbook was the first edition to show the transmitter in the catalog section. The price then was $649.50 in kit form and $799.50 factory wired and tested. I dare say the value in today's market has increased considerably–probably 3 fold–and they seem to be getting scarcer as the years go by.

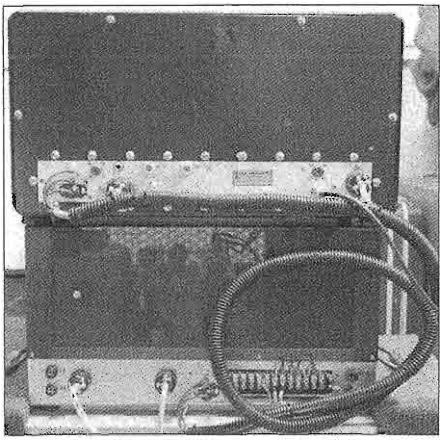
The transmitter shown in the photos came as two units; the power supply-modulator on one chassis and the RF deck on the other. The RF deck weighs only 57 pounds compared to the power supply deck that weighs in at 120 pounds. I said in the beginning this was another great transmitter, but like all transmitters, it had some design issues.

On the other hand, the Johnson Five Hundred had some innovative features when compared to other E.F. Johnson transmitters of that period. My favorite is the very complex dial cord arrangement used for tuning. Other transmitters, like the Rangers, didn't use dial cords. In the Five Hundred, all the frequency changing and tuning of the various stages up to the PA are accomplished by turning one knob –the VFO dial. On the rear of the VFO enclosure, a pulley was attached to the VFO tuning shaft and this pulley was connected to all the other stage-tuning capacitors with dial cord. Replacing this dial cord would not be a fun project. I hope mine will last for another 50 years.

The Class-B modulator tubes, a pair of 811As, are mounted on the power supply chassis and the secondary of the modulation transformer has an adjustable air gap to protect the modulation transformer–another good design feature. The 811As are run at the same plate voltage as the PA, which is 2000 VDC. This, in itself, is interesting because the RCA Transmitting Tube Manual, TT-5,



The Johnson Viking Five Hundred "RF unit".

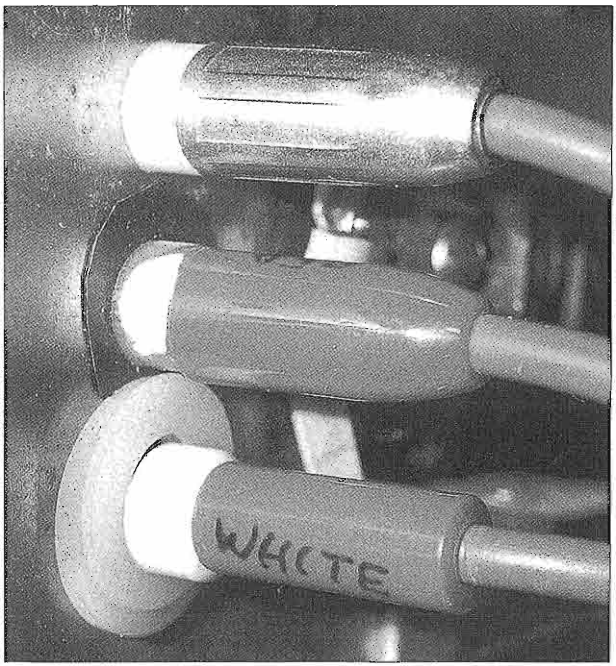


Rear view with the RF unit sitting on the power supply/modulator. The inner-unit cabling is shown.

states 1500 VDC maximum for the 811A in Class-B service. Apparently, this is a non-issue as the 811As are very happy with the higher potential on their plates.

When I received my Five Hundred, the main issue I had was the interconnecting power cable. The high voltage connectors on the cable and mating connectors on the power supply unit and RF unit were my biggest concern. To put it bluntly, the cable and chassis connectors were an extremely poor choice. There were better parts available at the time, which were designed for high voltage, and they should have been used. These connectors, especially the ones mating to the RF unit were the wrong gender with the good possibility of high voltage exposure to the operator. Besides being the wrong gender, the chassis connectors were grossly underrated, leading to voltage breakdowns.

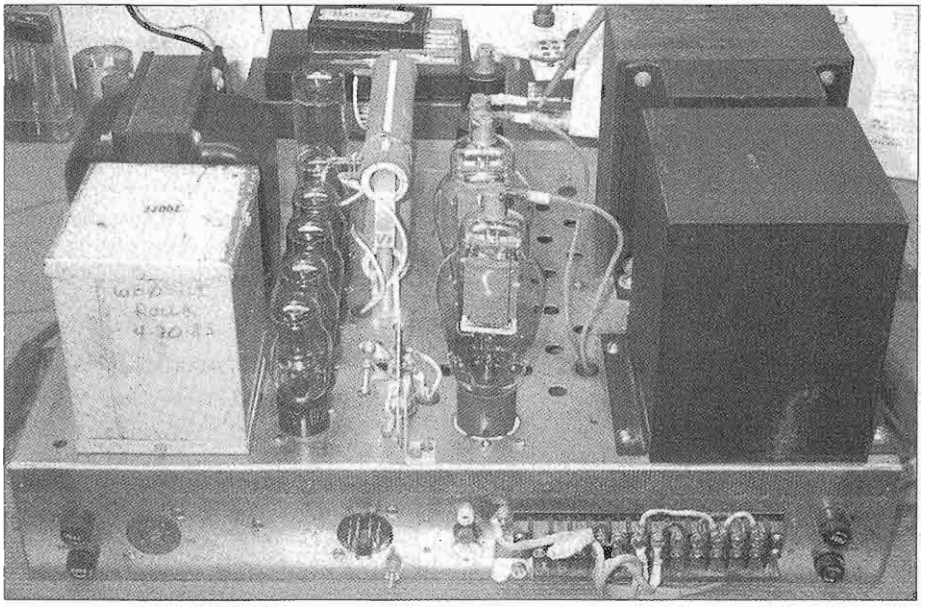
The high voltage connectors on both units were nothing more then very small plastic female pin jacks. Obviously, the high voltage cables going to the RF unit had to have mating exposed male pin plugs. To further complicate the problem, the modulated high voltage line used this same arrangement. So, with 100% modulation and 2 kV, the peak voltage could reach 4 kV! I believe you, the reader, should be getting the "picture" now. You can see in the photo of the rear RF unit that a previous owner had made an attempt at increasing the spacing on the lower panel jack with a couple additional plastic washers.



The "as found" high-voltage connectors on the rear of the RF unit.

This did work, but was poor engineering. On the inside of the chassis, there was evidence of previous voltage breakdowns. This was apparent from the black marks on the chassis.

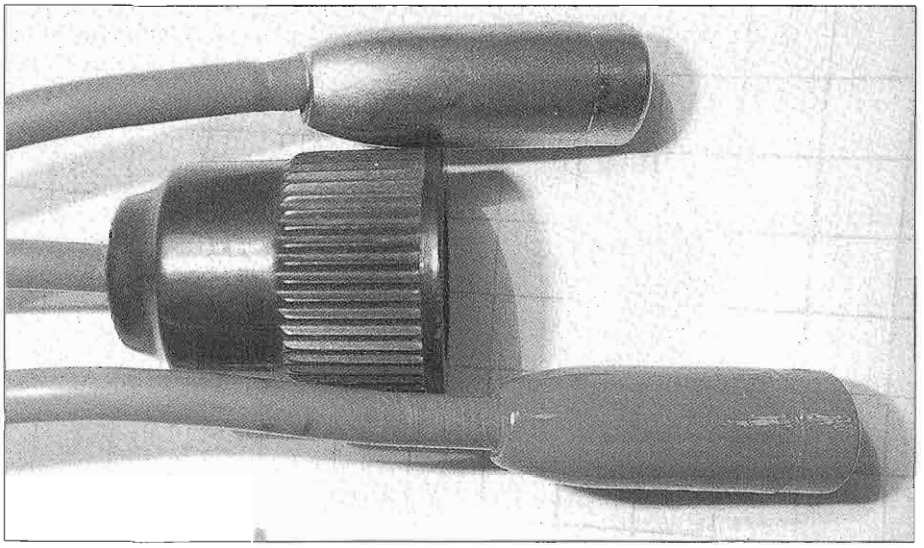
My solution can be seen in the modified high voltage connector photo. On the



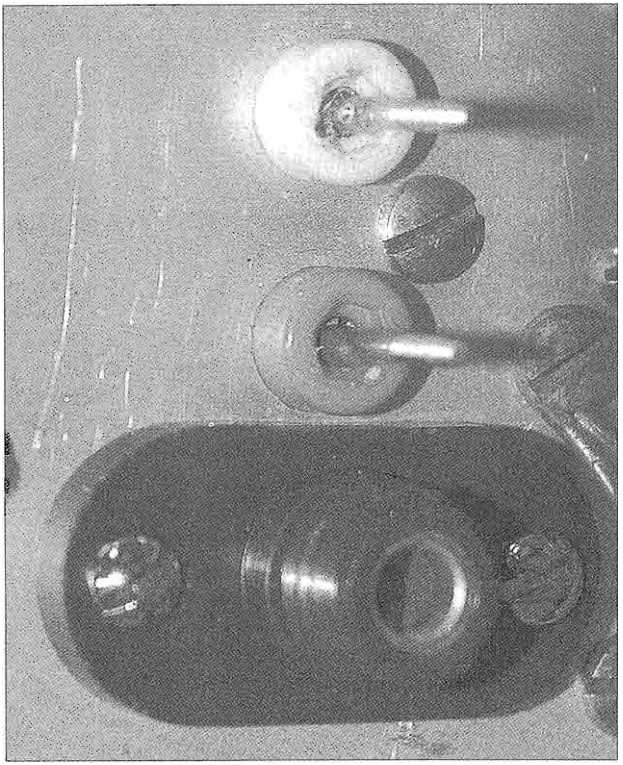
Rear view of the power supply-modulator unit with the cover off.

RF unit and the power supply unit, the modulated high voltage jacks were replaced with Millen high-voltage female connectors. The proper name for this connector is a Safety Terminal, part number 37001, per the 1958 Radio Masters catalog. These connectors can be installed after a bit of filing in the original hole. Look for them at the hamfest for a couple bucks each.

The two remaining pin jacks, on the RF unit, had their gender changed to male. This gender change was accomplished by soldering the cutoff ends of test probes



The gender-modified high-voltage cable end that mates to the RF unit.



The gender-modified high-voltage connections on the rear of the RF unit.

into the female pin jacks. The top jack (J302) carries the screen voltage (440 VDC) for the PA. The middle jack (J303) carries the unmodulated 2 kV, and does this without voltage breakdown to the chassis. Yes, I'm amazed too. This little pin jack can carry high voltage without breakdown to the chassis.

Now that the gender had been changed on the rear chassis of the RF unit, the mating connectors from the power cable had to be modified. This was a simple process, and I used two cable shells from male pin plugs. These shells fit very well by threading them onto the new female pin jacks, in lieu of the normally used chassis mounting nuts. The Millen cable end was used on both ends of the modulated high voltage cable and is a recessed male connector that reduces the exposure to high voltage. The female pin jacks were left in stock configuration on the power supply unit.

Perhaps the cable issue isn't a major concern for most users because they exercise the required precautions. Granted, once the cables are mated to the two units, there is no high voltage hazard. The small pin jacks used on the modulated high-voltage line was certainly a problem from the day the rig left the factory. This transmitter has many interlocks on both units that would additionally reduce the high voltage exposure.

I have one final comment about the Five Hundred. The PA tube can be a 4-250A or 4-400A. These tube numbers are used interchangeably throughout the documentation. My rig has the 4-400A and easily makes 300+ watts of resting AM carrier. The method for cooling the PA tube is interesting because there is no glass chimney used. The chassis has holes drilled around the base of the tube for air flow. The bottom of the chassis is fully enclosed with sheet aluminum, with one large hole directly under the tube in the bottom sheet metal. A small fan is mounted above the hole and draws air in from the bottom. The only exit for this air is up and through the chassis holes around the tube base. This air system was innovative in design, inexpensive, and very effective.

Now, besides being a great transmitter, my Viking "Five Hundred" is a much safer transmitter to repair and operate.

ER

Improving the Performance of My R-390A

Part 1, Refurbishment

By Bill Feldmann, N6PY
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This is the first of a two-part article that is about my project to refurbish and improve the performance of a Stewart Warner-built R-390A, shown in **Figure 1**. In this part, I'll mention how I repaired some of the aging problem often found in these 40-year-old receivers. Also, I'll describe a method of quickly spotting bad capacitors in the tuned RF and IF circuits. Part 2 will describe how I improved my R-390A's CW, SSB, and local audio performance.

The R-390 500 kc to 32Mc general-coverage receivers were a tremendous leap forward in receiver design and set the standard for modern HF receivers. They incorporated many unique improvements developed by Collins during and just after WWII. Collins Radio Company designed the original R-390 in 1949 as a receiver that was triple conversion from 500 kc to 8 Mc and double conversion above 8 Mc and up to 32 Mc for optimum spurious signal rejection. It had an outstanding preselector system using permeability tuned RF and IF circuits controlled by a very accurate coil slug positioning system, giving excellent unwanted signal rejection. Using crystal local oscillator signals for the first two mixers and the extremely accurate permeability-tuned master oscillator, PTO, for the 3rd mixer, this receiver had frequency stability and accuracy far ahead of other receivers of that time. After a

Figure 1: My Stewart Warner R-390A and its matching CV-979 tabletop cabinet.

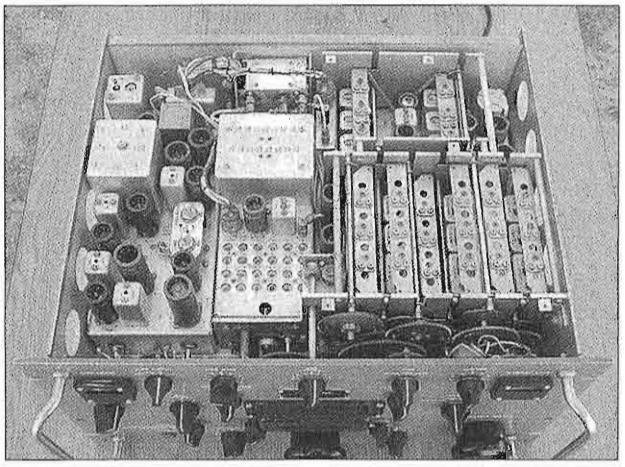

Figure 2: Top view of the R-390A out of its cabinet showing modular construction, and on the right, the slug racks and gearing system.

half-hour warm up, it's nearly equal to today's best receivers. It used very low-noise triode mixers resulting in a noise floor and intermodulation rejection far in excess of what is required on today's crowded HF bands. It had IF selectivity from 100 cycles up to 16 kc using a very expensive system of five variable-coupling IF transformers. This outstanding receiver went into production in 1951.

A "must" for R-390 enthusiasts is a copy of the R-390 Final Engineering Report that fully describes its development and is available on the Internet at http://www.r-390a.net/, click on "References".

In the mid-1950s, the original R-390 design was changed to reduce its cost, increase reliability and ease of repair, and was released as the R-390A. This was done by replacing the expensive variably-coupled IF transformers with the less expensive Collins-developed mechanical filters. The power supply was improved to generate less heat, and the design used more modern tubes such as the 6BA6 and 6DC6. The modular design was changed to make removal of the RF module easier. **Figure 2** shows my R-390A out of its cabinet and its modular construction. **Figure 6** shows how its modules are mounted to a horizontal deck for ease of removal. Looking from the front, the IF module containing the fixed 455 kc 3rd-IF circuits is on the left, the crystal oscillator module is in the center, and the RF module is on the right. The RF module has eight cam-and-gear positioned racks. The six racks in front control the RF preselector tracking and the two racks in the rear tune the 1st-and-2nd tunable-IF circuits.

While Collins originally designed the R-390A, other manufacturers built most of them. Although some object to its military battleship look, these receivers are among the best performing HF receivers ever built. Because of their excellent preselector system, the RF/IF performance of these receivers still exceeds the performance of most of today's HF receivers, as illustrated when the military put some back into service in the early 1990s during the first Iraq conflict.

If you are planning to repair or modify an R-390A you'll need a little skill in working on radios. If you have been able to understand and repair radios like the Hallicrafters SX-28s or Collins 75A-line receivers you should have no problem.

Looking at the R-390A in **Figure 2** can be a little intimidating, but because of its modular design and the excellent manuals it's much easier to work on than a Hallicrafters SX-28. You'll need the right tools, such as a good digital volt-ohmmeter and an accurate 500-kc to 32-Mc signal generator. I use an old HP-606B with a separate digital frequency meter, a tube checker that indicates transconductance, a slug-rack adjusting tool, and an insulated screwdriver to adjust the trimmer caps. You will need a set of Bristol spline tools. I use an Xcelite

Bristol spline driver set available from McMaster-Carr, 562-463-4277 or www.mcmaster.com. You'll also need a manual like the one I'll recommend below.

Last winter, my friend Wayne Spring (W6IRD) mentioned he had a very clean Stewart Warner R-390A installed in a CY-979 military cabinet for sale that just needed some electronic refurbishment. This radio would match my non-A R-390 that's in an identical cabinet. I also wanted to develop some modifications I had been thinking of to make an R-390 a more versatile receiver, but was reluctant to try these on my more-rare, non-A model that I described in ER #202 and #203. I was glad to purchase the R-390A.

Another friend, John Svoboda (W6MIT), sent me a copy of the Y2K-R2 manual on a computer disk. I highly recommend this manual. It is an edited copy of the 15 May, 1985 Navy manual with additions and corrections made by a committee of R-390A enthusiasts. (This manual is obtainable at www.r-390a.net, click on "References".) I have a slow ink jet printer with expensive cartridges so I took the disk to my local Kinko's copy center where they printed a black and white copy for around $20.

Before even turning on my new R-390A, I pulled the 455-kc IF module and replaced C553, the .01-µf blocking cap. C553 protects the mechanical filters from B+ that can destroy them if C553 is leaky. I used a .01-µF, 1000-volt disk ceramic capacitor to be absolutely safe.

After tube checking and alignment by the manual's procedures, I was disappointed in my R-390A's performance as compared to my non-A R-390. The R-390 worked perfectly after alignment. The R-390A problems were a 9-kc PTO endpoint error, poor sensitivity on some bands–mostly those under 8 megacycles, a 15-dB drop in sensitivity after warming up, and a drop in sensitivity at the higher-frequency end of all bands.

Endpoint error occurs if the PTO no longer tunes its designed frequency range in exactly 10 turns of the KC knob.

I decided to first work on the PTO endpoint error problem by using a procedure that was used on my non-A R-390, that doesn't require any special tooling. I first calibrated the KC dial at 0 kc using the crystal calibrator and BFO, and then checked the calibration at the top of the band after ten clockwise turns of the KC knob. If I had to turn the dial past 0 kc to zero beat against the calibrator, I recorded the error as "+kc". If it zeroed before 0 kc, I recorded the error as "–kc". The dial was set back at 0 kc, the radio was tipped on its side and I removed the PTO–using the procedure in the manual–while being careful not to loose the Oldham coupler's spring. In this position, the threaded plug located on the front of the PTO (which is partially covered by L702) cn be used to gain access to L701's endpoint error-adjustment screw. If the PTO has two plugs located between its tube and L702, only remove the one closest to L702, having only one adjustment screw under it. This plug can be a little tricky to remove or install, but with patience it can be done without removing L702.

I rotated the adjustment screw 1/3 turn clockwise for every +1 kc of end point error, or 1/3 turn counterclockwise for every –1kc of error. The PTO was reinstalled, but the L701 plug and the Oldham coupler spring were left off for later reinstallation. The PTO was zeroed at 0 kc against the calibrator signal by only loosing the setscrews holding the coupler to the PTO shaft and turning the PTO shaft while keeping the KC dial set on 0 kc. I rechecked for any remaining calibration error after 10 clockwise turns of the KC knob. Lastly, any remaining error was corrected for by pulling the PTO and repeating the above procedure. After this final adjustment, the plug over L701's adjustment screw was reinstalled. Also, you can more accurately determine the screw's adjustment rate for your

particular PTO by noting the error correction rate during your initial, first adjustment. Like my non-A, the one in my R-390A took about 1/3 turn per 1 kc of error, but only after finishing the repairs to its PTO, to be described below.

Unfortunately, when I initially tried to use the above procedure on my R-390A it didn't work. There was almost no change in error even after 3 clockwise turns of L701's adjustment screw. Also, the screw was very far into L701's threads, indicating that the slug was nearly out of coil L701, and that some component in the PTO had probably changed value. I opened the PTO by first removing its outer cover and carefully noting where the wires were connected. The wires for the PTO's heater circuit were unsoldered and the heater's cover was removed. By carefully unwrapping the insulation, I noted how it was installed over the inner cover. Last, the inner cover was removed by sliding it outward to expose the PTO's circuit.

My R-390A has a Cosmos PTO. I read Thomas Marcotte's (N5OFF) excellent article in ER #107. Tom suggests removing turns from the endpoint adjustment coil, L701, if the endpoint can't be adjusted. Trying to remove the right amount of very fine wire from this coil looked scary.

Noticing two small 10-pf caps on my schematic, C703 and C702, which were in parallel with the PTO's larger fixed cap, C701, I tried removing one of the 10pf caps, a method used in the past on other PTOs. After removing one capacitor, L701's slug was screwed into the coil's center as a starting point for adjustment. The PTO was reassembled and reinstalled. If C702 or C703 are marked as having a temperature compensation value, don't remove them.

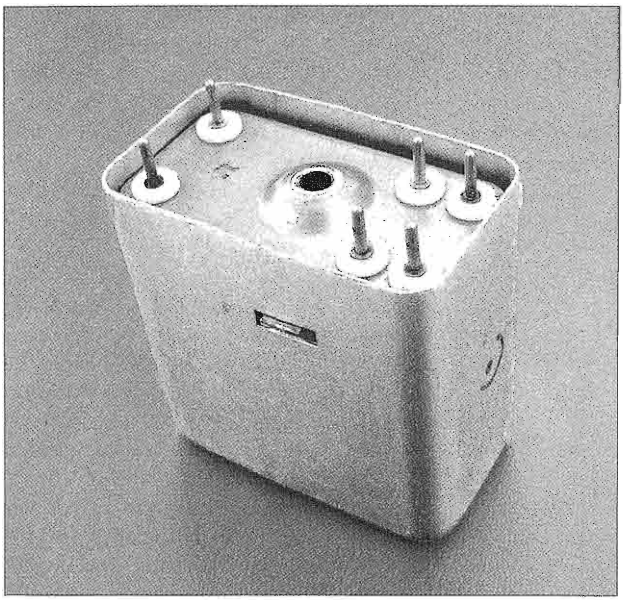

Figure 3: Normally hidden from view, this photo shows what the bottom of one of the RF transformers looks like. This one has six gold-plated contact pins that mate with matching sockets on the RF deck. The hole for the hold-down screw is in the center, in the raised area. Also visible at the side of the can is the metal tab that presses in to release the can from the inner circuit.

After a 30-minute warmup, I checked the Cosmos PTO for excessive frequency drift and didn't find any. If there had been excessive drift, or if both of the caps had been marked with temperature compensation values, it would have been necessary to remove turns from the L702 coil as recommended in ER issue #107.

Now, the PTO had a KC dial error of only –2 kc. I was able to easily correct it by again pulling the PTO and rotating L701's screw counterclockwise 2/3 of a turn. The error over 10 turns of the KC knob was now less than 400 cycles, which is more than acceptable. Before

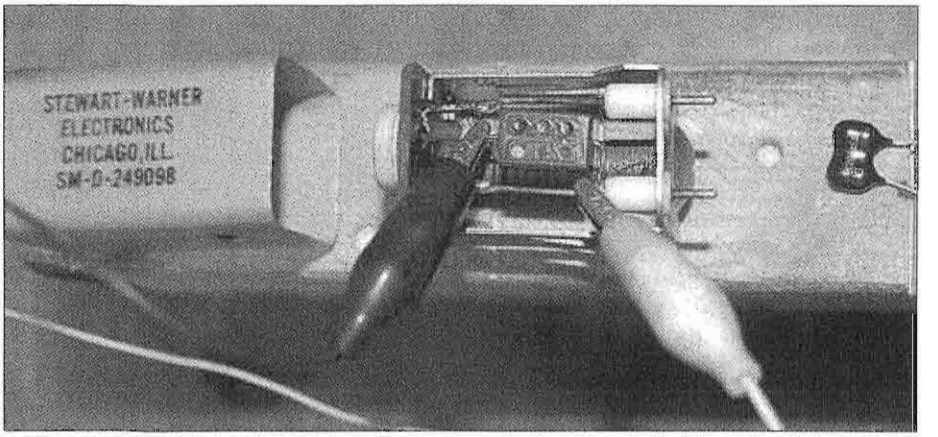

Figure 4: Checking a mica capacitor inside an RF transformer.

installing the PTO for the last time, I replaced the plug over L701's adjustment screw. After rechecking the calibration, the Oldham coupler spring was reinstalled.

It's also very important to check the frequency dial for adequate dial calibration range. This is done by first zeroing the KC dial on "0 kc" with the calibrator turned on, and then, with the ZERO ADJ knob still screwed in, check that the KC knob can be rotated a near-equal number of degrees on either side of zero. If the KC knob's free movement is not adequate you may not be able to calibrate the dial when changing bands or when using a BFO offset. I corrected this by setting the KC knob to the center of its zeroing range with the ZERO ADJ knob screwed in. The ZERO ADJ knob was turned fully counterclockwise to get out of the calibration mode. The KC dial was reset to 0 kc, and the coupler-to-PTO shaft setscrews were loosened. I rotated the PTO shaft to zero-beat the PTO against calibrator signal, and when that was done the coupler setscrews were retightened.

If the linearity of your Cosmos PTO is very poor between the 100-kc calibration markers, you may want to look at N5OFF's article in ER #107. If you have another brand of PTO, adjusting its linearity will be almost impossible without the proper tooling. My experience has been that undamaged and unmodified Collins PTOs usually hold their factory-set linearity very well and should only need an endpoint adjustment.

Next, I worked on the poor sensitivity problem. This is usually caused by fixed mica capacitor failures in the tuned RF/IF circuits. On all R-390s, these RF circuits are in shielded cans that are tuned by vertically-moving coil slugs. The slugs are attached to racks that are gear-and-cam controlled, see **Figure 2**. On my radio, the 1-Mc to 2-Mc band was the weakest, so I decided to look at the tuned RF circuits for this band. The shield cans were removed by first unhooking the springs on each end of their associated slug rack and lifting the rack up and out of the radio. It's extremely important to not let any dirt or oil get on these slugs. After inserting a Phillips screwdriver down into the center of the slug hole for each circuit and loosening a small screw securing the transformer can to the RF module, the can was lifted out of the module. The cans are mounted with pin plugs and jacks and are easily unplugged. It's often necessary to turn the KC knob a little to obtain clearance to get the transformer can past the adjacent band's slug rack. Also, be very careful not to

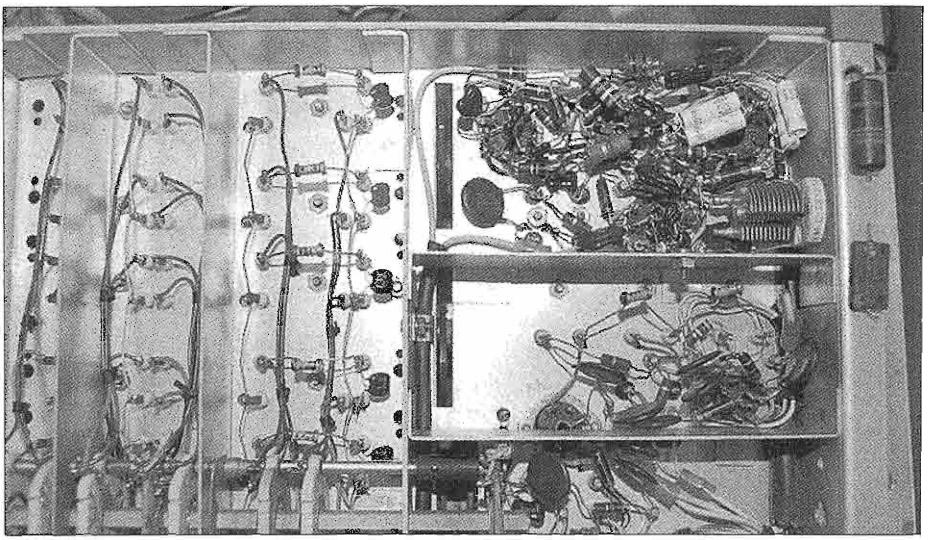

Figure 5: Underneath the RF module. Two of the capacitors I replaced are laying on the flange on the right side.

loose the securing screws after removing the transformer cans.

I removed the shield cans from each circuit by pressing the metal tabs on their sides in. Each circuit has a coil, 2 or 3 fixed mica caps, and usually one trimmer cap, but the antenna circuits will have two trimmers. I checked each mica cap on my General Radio GR-1650 impedance bridge by first cutting one lead loose. **Figure 4** shows a RF circuit's mica cap being checked with its can removed. Two of the RF circuits had bad 180-pf caps installed in parallel with a trimmer cap. Both were very low in value and showed high dissipation. When heated with a hair dryer, they changed value. I replaced them with dipped silver micas like the one shown on the right in **Figure 4**, reassembled the cans, and reinstalled them in the receiver. After realigning these circuits there was a tremendous increase in sensitivity for that band.

I made a significant breakthrough that saved lots of time and helped to find RF/IF circuits with defective caps. If an RF circuit that was under alignment had a bad cap inside the can, the adjustment slot on the trimmer ended up exactly lined up with the long dimension of the can when looking directly down on it. I also noticed the slug-adjusting screws for these circuits were screwed in much further than the others were for that same band. Often, the screw's top was well into the threads on the rack. The trimmer slot indicated the trimmer was set at its maximum value, and the position of the slug-adjusting screw indicated the inductor was at a high value to compensate for the bad cap. But, after repair and alignment of these circuits, their trimmer slots never aligned with the can's long dimension and the top of the slug adjustment screw was well above the top of the rack. Noticing other RF transformers with the same conditions, I realized these RF circuits were for the bands where I had problems with low sensitivity[1].

Only the RF circuits that had the trimmer slots and slug screws in the positions described above were removed. There were bad mica caps in them, and they were replaced. Now there was excellent sensitivity and tracking on all

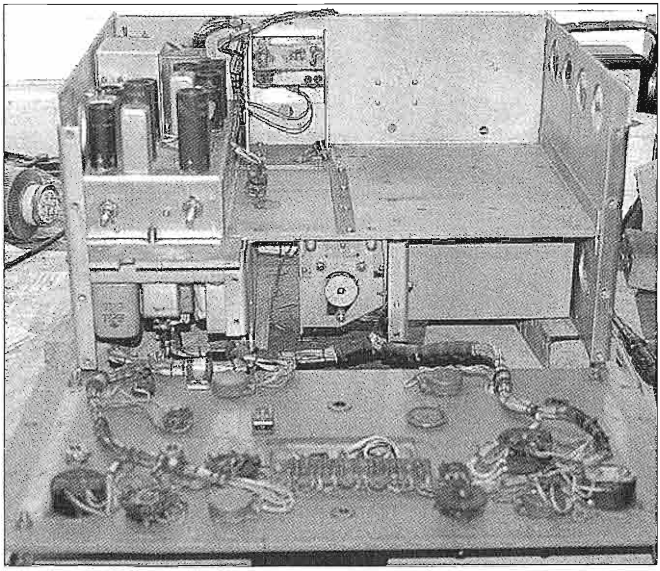

Figure 6: R-390A with the front panel lowered and the RF deck and crystal oscillator module removed. Notice the modular construction.

the previously-weak bands. However, there was still lower sensitivity at the top end of each 1-Mc bands and below 8 Mc. Looking at the three circuits for the second IF, one trimmer slot was in line with the can's long dimension, and the slug screw was far into the rack's threads. I unplugged the transformer and found another bad mica cap, which was replaced. After reinstalling this circuit and realigning the second IF, the in-band sensitivity change problem was solved. A first-IF transformer can showed the same symptoms. Unfortunately, its fixed cap was under the RF chassis. Later, I removed the RF module and replaced the bad cap.

The above repairs confirmed that just looking at transformer can is a valuable technique for judging what RF/IF circuits have bad capacitors. If you don't have access to a capacitor bridge but suspect bad mica caps, it may be best to replace all the mica caps in these circuits since they aren't very expensive and could possibly fail in the future. Many of the caps checked OK, but when heated they failed. So, I always used the hair dryer when testing suspect mica caps.

At this point, I had replaced eight of the brown "CD-TYPE 22" mica caps in the RF/IF circuits all of them between 50pf and 180pf in value, which gave me a lack of confidence in them. I also still had the problem of a sudden change in sensitivity after warm up, and low sensitivity below 8 Mc. I strongly suspected additional bad mica caps under the RF module's chassis. However, removal of this module looked real scary. My friend Foster Paulis (W4HCX), who has rebuilt many R-390As and also worked on them in the Navy, strongly urged me to remove and service this module.

Using the parts list for my RF/IF module in the manual, I ordered a complete set of 400-volt, dipped silver-mica replacement caps over the Internet from Mouser Electronics, www.mouser.com. I also ordered replacements for the IF and audio modules. For the original paper .033-µf and .1-µf bypass caps in these modules that I had very little confidence in, Mallory Mylar film replacements were ordered. I didn't replace any of the very small value mica caps in the LO module because none of the crystal trimmer caps were at maximum value and these caps seemed more reliable. I didn't replace any of the very small-value tubular ceramic caps because they usually don't fail.

By following the manual's procedure, I found removal of the RF/IF module fairly easy after removing the front panel. The hardest part is finding some green screws hidden behind the gears on the front of the module. The cables that have to be

removed are well labeled for easy reinstallation. The crystal oscillator module is attached to the RF module, and they are removed as one unt. **Figure 5** shows the underside of the RF/crystal oscillator module after replacement of the mica and paper capacitors. Some of the bad ones are shown sitting on the lip of the chassis.

With the RF deck out, it was very easy to clean and lubricate the gears and cams controlling the slug racks and check their mechanical alignment. The alignment of the band change switch for the crystal oscillator module was checked using the manual's procedure. Everything would have been easy to align with the RF module removed, but mine was still in perfect alignment. The cams and gears were fairly clean but badly in need of lubrication. I previously had used a product called Tri-Flow® with excellent results, but a mechanic at my local Trek bicycle shop recommended ProLink® chain lube because it doesn't attract dirt, cleans parts, stays on forever, and is very slippery due to its polar nature. After applying it, I was very pleased to find it worked much better than Tri-Flow®. It gave the tuning a very smooth feeling that seems to get better with time because heat helps to spread it over the metal surfaces.

Figure 6 shows my R-390A after removal of its RF module. The front panel has service loops in the wiring harness to permit removal of the RF/crystal oscillator module and the IF module. This figure shows the construction of the R-390A mainframe, which consists of a horizontal deck having vertical side panels and flanges for the front and back panels. The power supply, PTO, and audio modules are attached to the bottom of the deck. The RF deck and its attached crystal oscillator module have been removed. Normally, they are attached to the top of the deck. The antenna relay module is mounted to the back panel. This excellent design makes an R-390A very easy to service.

While recapping the modules, I replaced resistors more than 10% from their specified values. The RF amplifier screen resistor was very high in value and would cause poor performance if not replaced.

After reinstalling the RF module, I did a complete realignment of the RF and IF sections and was pleased to find my R-390A's sensitivity was excellent on all bands and there was no sensitivity change after warm up. A 100-µV antenna input resulted in the same carrier meter level, within 10db, over each band. I repeated the R-390 noise floor tests described in my previous article and found my R-390A was performing slightly better than my R-390, having a usable CW reception noise floor of –148 dBm in the 1-kc bandwidth position. Checking and paying attention to all the components in the RF and IF circuits really paid off. I suspect there are many R-390As not giving 100% performance because of bad resistors and capacitors.

Instead of using the manual's procedure for setting the 455-kc IF gain, I set it so that my carrier meter reads 50 dB for a 100-µV antenna input signal. This is equal to a S9 signal, and aids in giving signal reports. The tests I've conducted show that setting the IF gain for a meter reading between 30 dB and 60 dB for 100-µV input signal had no measurable effect on the receiver's noise floor or 3rd-order intermodulation performance.

In the second part of this article I'll be describing the changes I made to improve my R-390A's local audio, automatic gain control and detector circuits for much better SSB/CW performance.

1. Also see Ben Robson, Mechanical and Electrical Considerations for the R-390A, ER #201, page 30.

[Part 2 will be featured next month, in ER #208–Ed.]

The Hero of Hallettsville

How a QSL-40 Transmitter Helped Bring Aid to a Flooded Texas Town

By Niel Wiegand, WØVLZ
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Several years ago I acquired an ugly transmitter from a guy that said it came out of a defunct radio museum in Houston, TX. It looked like it was built from parts scrounged from a variety of places including the kitchen trash can. The broken and repaired panel, hacked tin can chassis and hasty paint job all said function before beauty. Interestingly it came with a label, "The Hero of Hallettsville". Hallettsville is about 100 miles west of Houston. The Lavaca River runs through it. Could this transmitter have belonged to some ham struggling to stay on the air as a hurricane roared around him? Perhaps he provided the only communication with the outside world as roads flooded and telephone lines went down. The true story behind this transmitter is close to exactly that.

Early Saturday morning June 29, 1940, 4 inches of rain fell at Hallettsville, Texas. A downpour of over 10 inches followed that night. In addition,16 inches of rain fell in the area up stream from Hallettsville. The Lavaca River at Hallettsville, normally crossable on foot, started to rise. By 2AM Sunday morning people living near the river were being evacuated. By 5AM the river was flooding

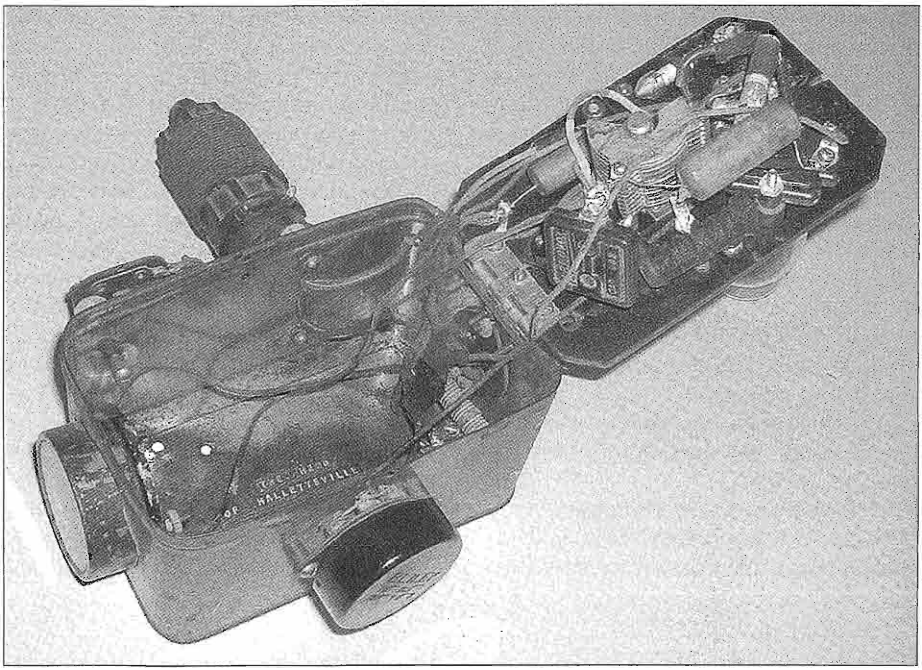
Downtown Hallettsville, Texas on Sunday, June 30, 1940

the town. Several houses were seen floating down the river beyond the reach of anyone. Cries could be heard in the darkness but nothing could be done. Shortly after 7AM water was 6 to 10 feet deep in the town square and several feet deep over the highway itself. The highway approach to the Lavaca River Bridge was washed away. Around 9AM the railroad bridge was washed out after being struck by a floating house. That day, seven people died in the Lavaca River at Hallettsville. Property and crop losses were estimated at more than $1 million.

An article in the September 1940 issue of QST (page 60) reports details from the ham perspective.

On Sunday morning, Hallettsville put out a plea to hams for help. The town was completely cut off, flooded, needed boats and doctors and had no outside communications. Houston hams responded by gathering emergency equipment and heading for Hallettsville. Along the way, water was over the running boards of their borrowed Texas Highway Department truck. At one point, the hams found the road gone. Locals attempting to cross were stranded in trees, where they stayed until the water receded. There the hams stopped and got on the air. One of their rigs was W5CVQ's 6L6 transmitter made up like a QSL-40 but with a padding condenser that could be switched in for 3.5 Mc. Eventually, the water went down enough that the Houston hams managed to get across and into Hallettsville to set up in the city hall. They were on the air for 24 hours, handling requests for help and supplies,

The Hero of Hallettsville is a crystal-controlled 6L6 oscillator. The antenna is coupled into the output tank circuit via the compression capacitor just to the right of the output coil. A crystal socket is on the side opposite the output coil. Also visible is the plate tuning adjustment, the 80-meter padding condenser switch, and a plate current meter.



The top of the Hero of Hallettsville is hinged for access. This is a minimal design. About a dozen parts make up the entire transmitter.

broadcasting flood reports and warnings, and sending "personal messages of safety to relatives of the marooned populace". The QST article reported that the little 6L6 rig proved to be a valuable help.

This ugly little transmitter is certainly that 6L6 rig that helped save Hallettsville on June 30, 1940. It is built along the lines of the QSL series of CW transmitters described in QST before WWII and has an extra padding condenser that can be switched in via a toggle switch.

The QSL-40 name comes from the transmitter size and the power. It is about the size of a QSL card and includes one tube, a crystal, plate current meter and a plug-in coil. The design claimed 40 watts from the single 6L6. The QSL series of compact 6L6 transmitter designs appeared in QST starting with the QSL 40 in February 1938 and ending with the QSL 25 in April 1941. The QSL Push-Pull (June 1940) ran 600 volts on the 6L6 plates and could light a 100-watt light bulb to full brilliance. The 5-watt version, described in December 1939, was at the other end of the spectrum. It was a transformerless design using a voltage doubler off of the 110 volt AC line to get 220 volts B+. That particular article mentions that the operator should avoid touching the metal frame of his key. The 6L6 (and its big brother the 807) appeared in transmitter article after article for two decades.

I've never tried fixing the Hero of Hallettsville and putting it on the air. Any repairs would destroy its character and some of the history behind it.

Information Sources:
- QST, Sept. 1940
- The Lavaca County Tribune, July 2, 1940
- http://pubs.usgs.gov/of/2003/ofr03-193/cd_files/USGS_Storms/counties/fayette.htm
- Thanks to Brenda Lincke-Fisseler of the Friench Simpson Memorial Library, Hallettsville, TX, for her research help.

ER

The "Little Tiger" Transmitter

By John Firey, W5ZG
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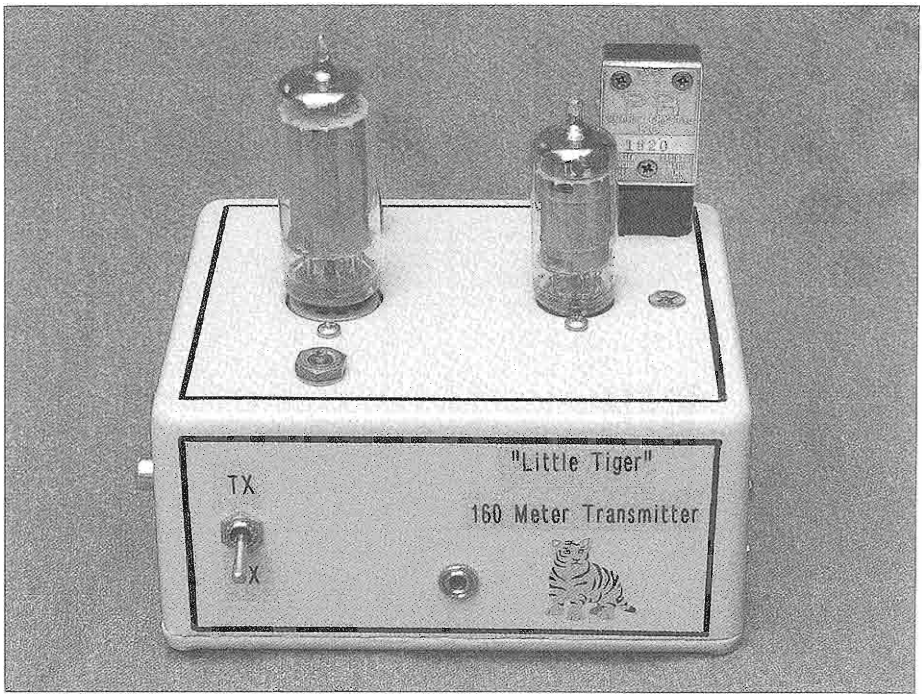
Over the years I have always had a moderate interest in QRP operating. For me, the main attraction has been twofold: First, the pleasure of making a DX contact that logically seems impossible. It's fun making that DX contact that, by all odds, shouldn't happen. Second, the basic aspects of a QRP CW transmitter allow for lots of experimenting with RF circuit design at a low level. One feels "at one" with each component he or she incorporates into the design and understands exactly what its function is.

My first QRP rigs were the Heath HW-7, 8, and 9 series. My operating success was always only moderate as I have usually been limited to moderate antennas. Several years ago, I started doing a lot of international travel and I decided that my treasured Collins rigs were not practical to take along! I purchased a modern rig to travel with; an Icom IC-703. Operating this rig planted the seeds to my "Little Tiger" transmitter project. Here's how:

I found that even with modest antennas, my success rate with contacts was far higher with the IC-703's 10-watt output than with true QRP (<5 watts). I was having much more fun! The only problem was that for years I have enjoyed the pride of running something unique or antique. It nearly always gets an interesting reaction when I say "Rig here



The complete 160-meter version of the two-tube "Little Tiger" transmitter.

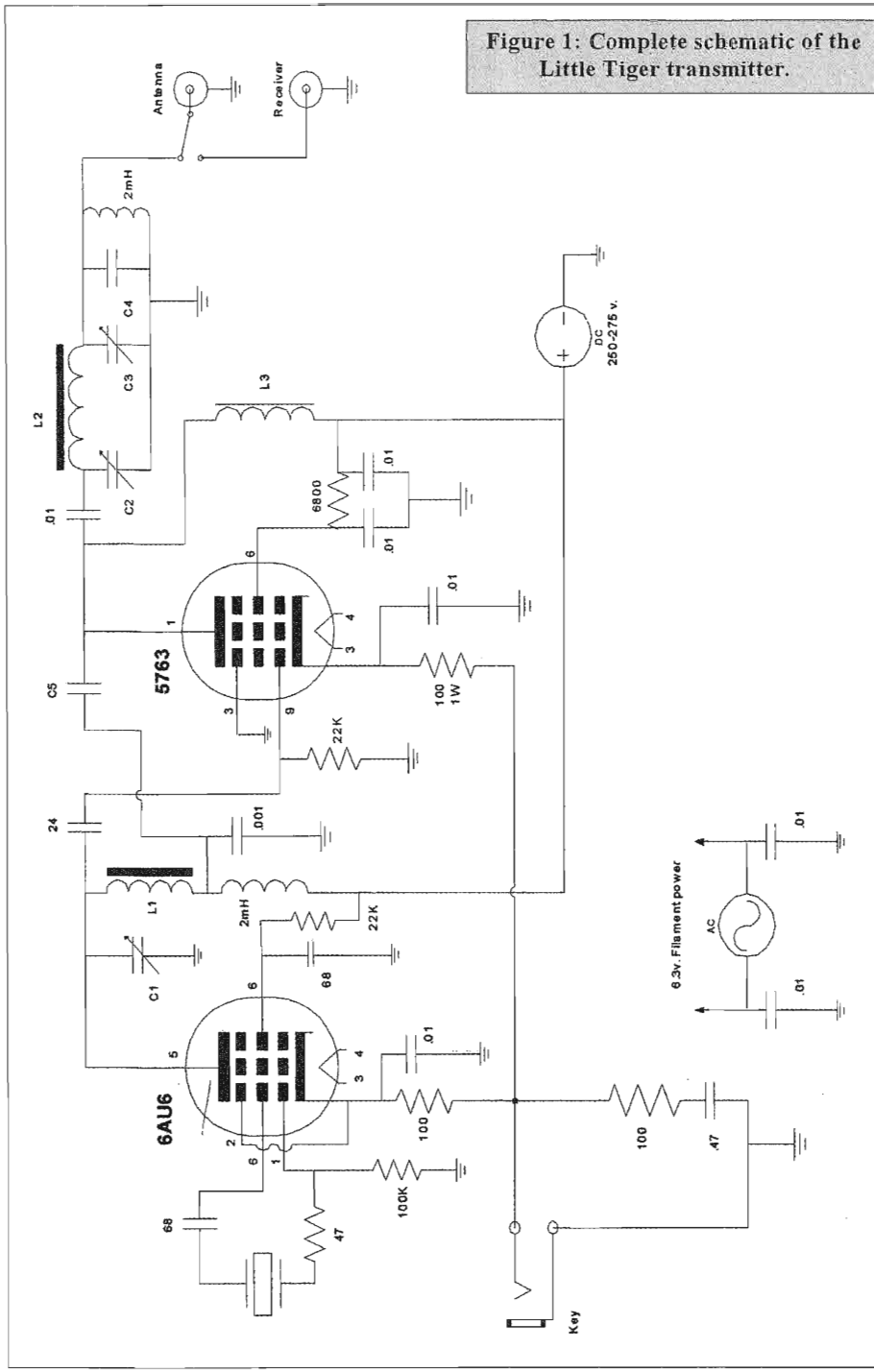


Figure 1: Complete schematic of the Little Tiger transmitter.

	L1	L2	L3	C1	C2	C3	C4	C5
160	35 uH	30 uH	5.0 mH	250	250	2500	0	0
80	20 uH	12 uH	2.5 mH	140	160	1800	0	6
40	5 uH	5.8 uH	2.5 mH	100	140	140	500	6
30	4.0 uH	4.0 uH	2.5 mH	100	75	140	360	6
20	3.0 uH	3.0 uH	2.5 mH	50	50	100	360	6
15/17	2.5 uH	2.5 uH	2.5 mH	30	30	80	360	10
10/12	1.6 uH	1.6 uH	12.0 uH	25	25	80	250	12

Table 1: Component values for seven different versions of the Little Tiger transmitter.

is a 1935 Collins model 150-C transmitter and National HRO senior receiver"! Having to say "rig is an Icom" was simply too boring and commonplace for my tastes.

I decided to design a tube transmitter to run at a similar power level to the Icom that would be in keeping with my collection of classic tube rigs and be something interesting. The popular "Tuna Tin" design intrigued me but I wanted something more solid and commercial looking. Here are my main design objectives:

- It must be of very solid, professional construction: Built in a die cast box with the tubes proudly showing and glowing on top.
- Monoband design for simplicity and small size.
- Two tubes will be used: A small 7-pin tube as the oscillator and a larger 9 pin for

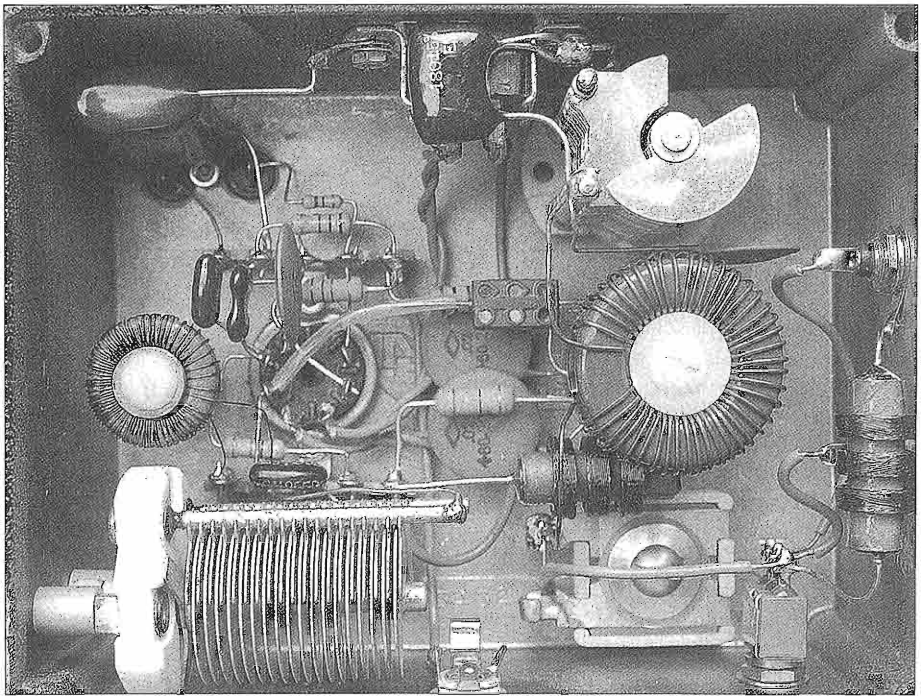
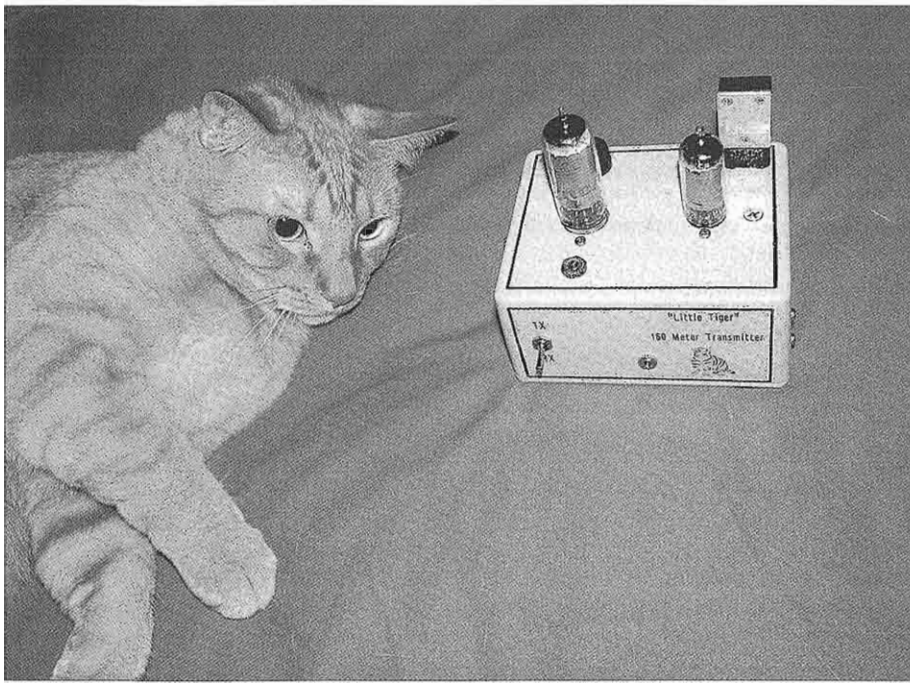


Figure 2: Component layout view of the Little Tiger. For best performance, it would be a good idea to follow the author's general parts layout.



Big Tiger, on the left, and the Little Tiger transmitter, on the right, are both orange colored.

the final. This just looks good! I chose a 6AU6 oscillator and a 5763 final.

• Design will be such that I can build one for any band I want, 160 thru 10, and only change tuned circuits. Physical layout will remain constant.

• It will require only a single "B" voltage plus filament.

• It must key cleanly and not chirp with HC/6 type crystals (not requiring large FT-243s) as it is difficult to find FT-243s in the 17 or 30 meter band. This requires an oscillator design that does not pull significant current thru the crystal, yet still provides sufficient drive for the 5763.

• I decided to use iron powder toroids for the inductor component of the tuned circuits for their space efficiency. Also, I felt that their self-shielding properties would also simplify design requirements for stability on the higher bands and minimize internal shield requirements between the two stages. I also thought this was an interesting mix of technology: Using vintage tubes with toroids that are common in solid-state design today.

Construction Notes

The die cast box is a LMB #KAB-3432, size 3.7 x 4.7 x 2". The oscillator and final tuning variable capacitors are relatively common E.F. Johnson trimmers. The final amp toroid is supported by a phenolic post screwed to the center of the 9-pin socket.

The toggle switch for T/R selection is optional: I usually use an electronic switch for full break-in keying but including this switch allows for more flexibility.

One thing I found necessary to do for complete stability on the 10, 15 and 17 meter version was to shield the coupling capacitor between the oscillator plate and final grid. A 1.5" section of brass tubing soldered to ground on each end did the trick.

For 80 and 160, I used larger value chokes but no longer needed neutralization in the final.

Operation

I use a Heathkit IP-18 power supply and run it anywhere between 100-275 volts depending on desired power. On 160 thru 40 meters, I can get a little over 8 watts out and a couple watts less on the higher bands.

Over the 2005-2006 winter season, I decided to see how many states I could work on 80 meters with this transmitter. With just a dipole at 20 feet I had complete contacts with 25 states. I was quite satisfied because 80 is not an easy QRP band. On the higher bands, I have logged dozens of DX countries. I am eager for the sunspots to improve to give my 10 meter "Little Tiger" a chance to make DXCC!

Other Possibilities

I have considered building a modulator to make these Little Tigers work AM phone. A pair of 6AQ5's would probably work well. The main change to the Little Tiger RF deck would be to feed the modulated plate voltage in separately from the oscillator.

I am also working on a matching receiver of similar construction style.

The name "Little Tiger" was chosen to satisfy my cat, "Big Tiger" who weighs 18 pounds and has quite an attitude. Both Big and Little Tigers are orange/deep yellow in color.

ER

[Comments from page 1]

taken, and the additional steps necessary to remain in compliance with the applicable FCC rules....As noted above, you were directed to take action to resolve any continuing harmful interference as alleged by Mr. Agnew to his mobile operations or reduce the emissions in that area to 20 dB below the level required for compliance with Part 15 of the Commission's rules.... This should be done as soon as practicable.....You are also directed to take the necessary actions to bring the BPL system into compliance with the applicable emission requirements....Finally, in light of the apparent ongoing interference to Mr. Agnew's authorized transmissions and the insufficiency of data reported to the Commission, you are requested to provide a description of what steps you will take to inform customers of a cessation of services, including the number of customers who would be affected by such cessation should you be directed to cease operations, either in part or system-wide...." This letter is signed by Mr. Joseph Casey, Chief of Spectrum Enforcement Division, Enforcement Bureau.

So, it looks like noisy, illegal BPL systems are not going to be allowed to continue operations. It would seem that the key is to report interference to the proper authorities as soon as it's noticed, and to then stay informed on the progress of any enforcement action that is taken.

Bob Heil Honored

The Rock and Roll Hall of Fame and Museum in Cleveland, Ohio, has recently added artifacts from the Heil Sound company to the Museum's technology and music exhibits.

Even if one does not prefer this music style, it should be realized that it's quite an honor for Bob to be recognized for his long career in the music business.

"Bob Heil is truly an innovator in the field of live sound," says Howard Kramer, the Rock and Roll Hall of Fame and Museum's curatorial director. "His contributions to the live sound industry are countless. Bob developed so many important products, including the first live mixing console, the first electronic crossover and parametric equalizer, as well as the first fiberglass speaker horns and numerous other products that have molded the industry into what it is today. These artifacts are a wonderful addition to our Museum and help expand our mission of educating about all aspects of music."

ER

The American VHF-AM Equipment Gallery

Part 6, The Hallicrafters SR-34 2-Meter Transceiver

By Jim Riff, K7SC
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I have previously mentioned, the well-known and common Gonsets were introduced in the mid-1950s. They sold quite well, establishing a new standard for compact VHF transceivers. Featuring an all-new combination of a receiver, transmitter, and power supply in one package was a new and exciting concept during that time. Of course, many manufacturers were offering 2-meter components, but as I mentioned before, Faust Gonsett's new idea of making an integrated system out of separate parts challenged the old methods. He made mobile and base-station operation possible with one compact package.

In 1958, the Hallicrafters Company challenged Gonset's established lead by offering packaged VHF equipment, a new concept. Their first model became known as the SR-34. The Hallicrafters SR-34 will be the focus of this article.

As a new concept, the SR-34 took VHF operations to new heights by offering both a 2-meter and a 6-meter transceiver in the same package. Both Heathkit and Johnson later offered dual-band transmitters, but not a complete dual-band transceiver. The SR-34 was one of the last radios produced while Hallicrafters was still under the control of Bill Halligan Sr. (W9AC, SK), prior to selling the company in 1958. (The Halligan family repurchased the company from the bankrupted owners and continued ownership until 1966.)

The SR-34 was designed in the old and heavy Hallicrafters style, much like the SX-101 of the same era. Heavy steel chassis, complex dial strings, and unique band switching operations were featured.

Figure 1: The SR-34 has many controls, as was typical of 1950s Hallicrafters' styling.

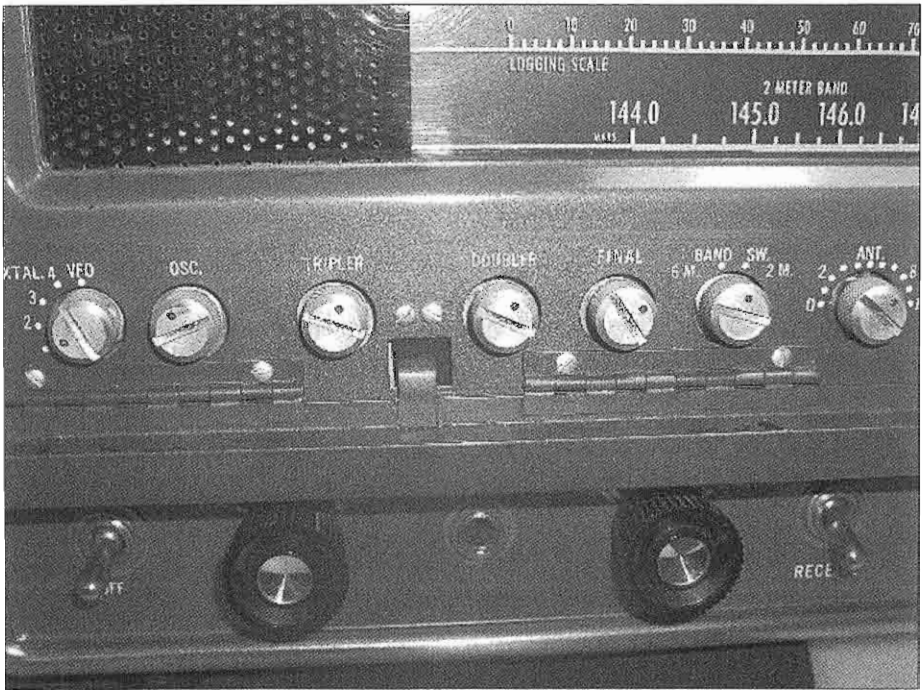

Figure 2: Many transmitter controls are hidden underneath a flip-down cover on the front panel of the SR-34.

Figure 1 shows the typical looking Hallicrafters front panel.

There are 18 controls, and the SR-34 has a complex band-change system. It is easy to understand after it has been learned. To change bands, both the receiver band switch on the front panel and the transmitter band switch located behind the flip-out cover need to be turned, see **Figure 2**. This dual-control ability allows the SR-34 to operate cross band. Only one coax connector was provided, and if a dual-band antenna was not used, the coax cable also had to be changed.

An interesting concept was used in the dual-band receiver section; two complete front-end tuning assemblies were provided. Separate tuning capacitors, RF amplifiers, mixers, and filters were switched for each band as I have shown in **Figure 3**.

A mixture of old and new tubes were used in the design of the transceiver. A prewar 6N7 dual triode is used as the push-pull plate modulator, but newer 6BK7B color TV tuner tubes were used in the receiver's RF amplifiers. A then-modern 6360A dual tetrode served as the push-pull RF output tube. The 6360A was common to both bands.

Some trouble spots to watch out for include an unsealed open frame TR relay that collects dust and can become intermittent. Those 16 tubes run quite warm, and the excess heat can be a hindrance. The tuning calibration is quirky because the dial markings are spaced at an unusual 25 kHz, and the tuning ratio is quite slow. See **Figure 4**. The dual-conversion receiver sensitivity is about 1µv on both bands, but drift is minimal after about 10 minutes.

Full CW operation is available with a

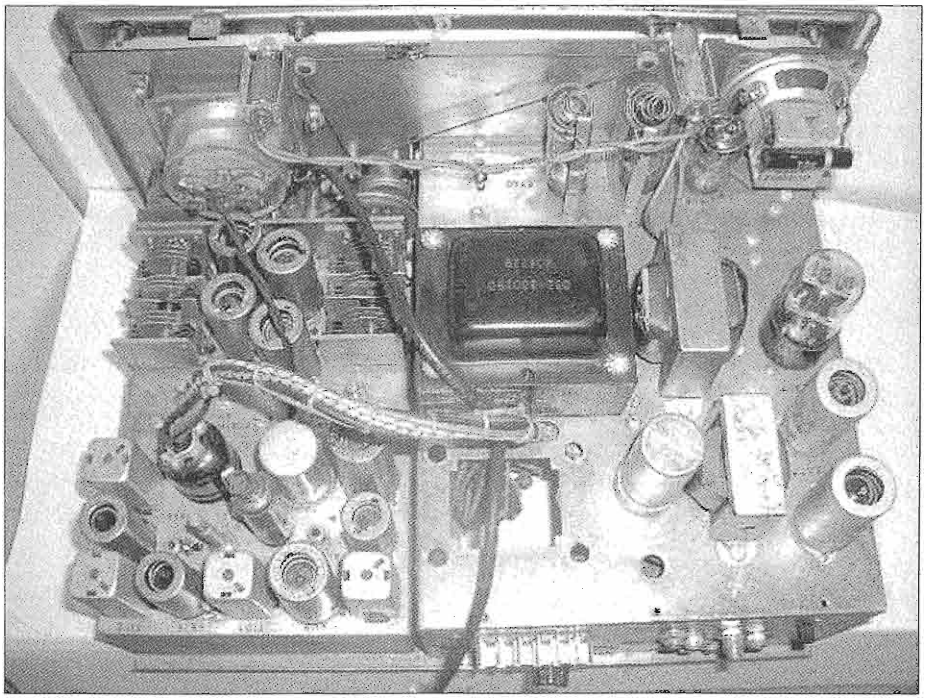

Figure 3: A top view of the SR-34 with the cabinet removed. Note the two separate tuning capacitors, one for each band, at the top left. This is the chassis of an SR-34AC, the AC-only version. At the lower center, notice the cutout and mounting holes for a 12-volt transformer. The chassis was common to the 12-volt and AC-powered versions.

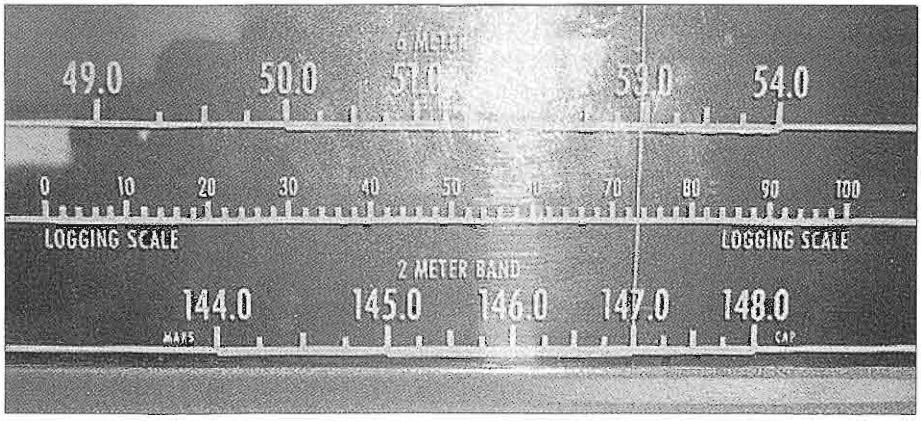

Figure 4: The dial scale uses only 3.5 inches to cover the entire 4 Mc of the 2-meter band, and it has not much more for the 6-meter band, 4 inches.

NEW SR-34 TRANSMITTER/RECEIVER

Complete AM-CW 2 and 6-meter amateur station in one compact unit. Exceptionally stable and sensitive, it combines all the functions of both receiver and transmitter. Perfect for fixed, portable or mobile use.

FEATURES. Operates from either 115 v. AC, or 6 or 12-v. storage battery with efficient, dual-transistor power supply. Receiver is dual-conversion with crystal controlled 2nd oscillator; separate RF and oscillator sections for each band. Has "S" meter, BFO, ANL, squelch. Sensitivity averages under 1μv for 10 db S/N ratio on 2 and 6 meters. Transmitter is crystal controlled—up to 4 crystals may be switch-selected. May be used for "crossbanding"—transmitter may be tuned to 6 and receiver to 2, or the opposite. *Output:* 6-7½ watts on 2 meters; 7-10 watts on 6 meters. Collapsible antenna; built-in speaker. 8½x14⅞x13⅝". Less crystals and mike. Shpg. wt., 33 lbs.

92 SU 396. NET.....495.00

SR-34—AC ONLY. As above, but for 110-120 v. 50-60 cycle AC only.

92 SU 397. NET.....395.00

Figure 5: The 1959 Allied Radio catalog featured the SR-34, selling alongside the SX-100.

tunable BFO and buffer-cathode keying. In **Figure 5**, two models were offered. The SR-34AC was an AC-only version that sold for $395. The SR-34 added an additional transistor power supply for 12-volt operation, but was considerably more expensive at $495. The dual-powered SR-34 featured a snap-on cover and an accessory telescoping antenna. In today's money, these rigs would sell new for over $5,000.

• **Pros:** The SR-34 was a pleasant Hallicrafters design offering dual-band 6-meter and 2-meter operation, high level push-pull Class-B AM plate modulation using a 6N7, adequate 6-10 watt RF output power from a 6360A dual tetrode, and a crossband compatible, dual-conversion receiver that has a respectable 1μV sensitivity. There is a standard PL-68 microphone connector, making it easy to use a wide variety of mics.

• **Cons:** It is very heavy, and it runs very warm in operation. It has a complex band-changing operation. There are some Sprague "Black Beauty" capacitors in the receiver, and these are known to be troublesome. The SR-24 is becoming expensive due to collector interest.

• **Specifications:** The SR-24 was available in dual-voltage, 120V/12V models, and 120V-only power supply models, with a reasonable 6-10 watt RF output. There are 4 selectable crystal positions. AM and CW modes were provided for. Its dimensions are 8.5" X 15" X 13.6" inches and the SR-34 weighs in at 33 pounds.

• **Conclusions:** The transmitter is fun to operate, has good audio, and it matches other older Hallicrafters equipment of the era. It is an ideal old boatanchor to use on the 144.450 MHz AM calling frequency.

[Editor's note: Save those clipped-out junk Black Beauty capacitors. Readers have reported them selling on that Internet eBay site for $25 each!]

ER

Help For 160 and 80

A High Performance High-Pass Filter

By Walter Lindenbach
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What Brought This On?

Here's some gossip. There's a good guy at Fair Radio in Lima, Ohio, who said there was an AM radio station "so close to their premises (and his workbench) that I could hit the tower with a baseball" He probably had something else in mind to throw!

That means the induction field would go beyond their building: the signal strength would be way over 1 volt/meter! Ugh! How do you set up radios for guys like us who have ordered them with an AM signal smeared all over everything, much less work a 160-meter or 80-meter QSO, or even some modest DX? Gary has been good to me (you should see my R-390A, S/N 3301), and it seemed some reciprocation was in order, so a HPF (high-pass filter) was cooked up, gunning mainly for 1150 kHz, the frequency of the station supplying him with all the free energy. Now, with a well-shielded radio and the filter in the antenna connection, the station can barely be heard. This was very satisfying. And also, the idea was to pass everything in the 160-meter band, and up, while stopping all the stuff at 1700 kHz, and down.

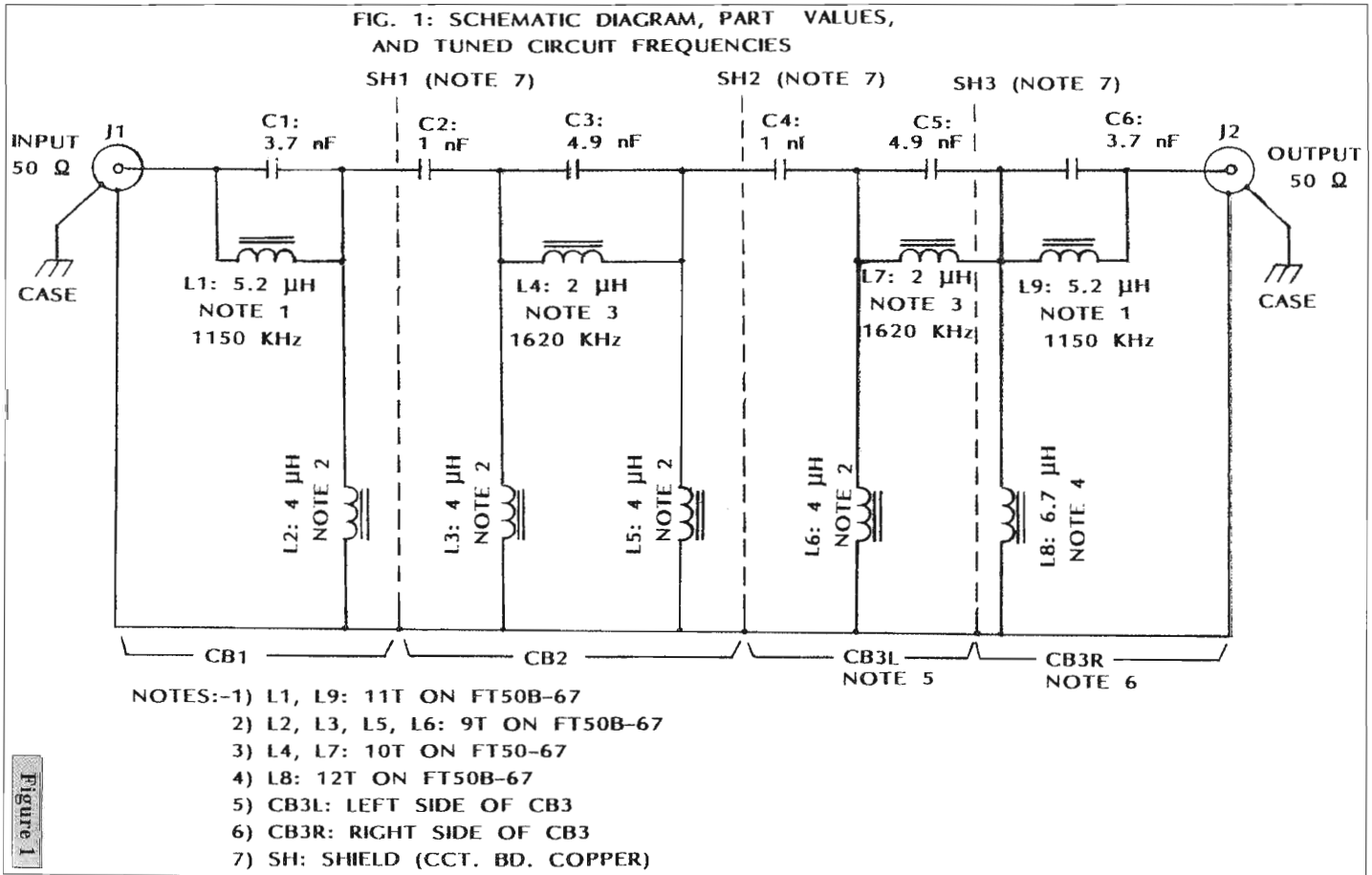
Sounds Useful; How Do I Get One?

Well, ya kinda' build it like, ya know? So this will tell you how I did it, and then you can decide how you want to do it. The schematic is shown in **Figure 1**. Looks simple doesn't it? 'Tis. There are just a few things to watch out for, and then "Bye-Bye, AM band!"

Ferrite cores need careful handling. They don't look or feel fragile (the material is very hard and brittle) but if you treat them like tubes, things will go better. If a ferrite core, especially of a high-Q, high-frequency material (like Type 67, which is specified) is dropped on a hard surface, it might shatter but, even if it doesn't, it will be changed. Ironically, the A_L factor doesn't change much (nanohenries per turn of wire: $L = A_L N^2$, where "L" is in Henries, A_L is Henries/turn, and "N" is the number of turns). But, the Q does change; it goes down, especially at frequencies above 5 or 10 MHz. That means that tuned circuits made with "bounced" ferrites will tune sloppily. Heat can have this effect too, so they shouldn't get near a soldering iron.

Oh, there's more! Ferrite-core coil performance isn't free. Next: Don't use glue. Not even rubber cement, let alone two-part epoxy. Very bad! And, the ends of a winding should not be wound around each other to keep them in place; this arrangement makes more stray capacitance (very bad stuff). Masking tape can be used to hold wire in place, but not wire ties! They exert too much pressure on the core. And that means that wire as thick as No. 22 has to be wound carefully: it must not be just pulled through a toroid; rather it should be pushed from one side and pulled from the other. Sounding tiresome, huh?

This is one reason for the choice of Litz Wire: ease of winding without pressure on the ferrite core. Ordinary stranded wire could be wound easily, but it's no good for high frequencies. What's the difference? Litz Wire strands are all insulated from each other, and that's not



NOTES:-1) L1, L9: 11T ON FT50B-67
2) L2, L3, L5, L6: 9T ON FT50B-67
3) L4, L7: 10T ON FT50-67
4) L8: 12T ON FT50B-67
5) CB3L: LEFT SIDE OF CB3
6) CB3R: RIGHT SIDE OF CB3
7) SH: SHIELD (CCT. BD. COPPER)

Figure 1

true of stranded wire. Insulated strands are important for high-frequency operation because of something called "skin effect", but Litz Wire is not better at frequencies above 2 MHz, and that's due to something called "proximity effect", all of which makes another story.

All the little strands of the Litz wire have to be soldered at the ends. No, they don't have to be individually scraped clean of insulation, the insulation disintegrates at soldering temperature. This might seem pretty obvious, but we had to learn it once upon a time, and the thought of someone trying to scrape all those little No. 38 strands—yipe, horrible!

Smaller magnet wire like number 30 could be used, but there will be a compromise in cutoff depth at the low end of the 160-meter band.

The cores can be mounted to the circuit board with nylon screws (just slight pressure; use locknuts to keep them firm), and there should be no conducting surface near the winding. That includes the copper surface of the circuit board, so a fiber washer or two between the coil and the circuit board is a good idea. Theoretically, this shouldn't be necessary with toroids, but it is. Sorry.

Assembly is Easier if You Get the Parts First!

(Oh, profound! Where did he get that idea?) First, where do you get these precious ferrite toroids? Here's the information:

Amidon Associates Inc.
240 Briggs Avenue
Costa Mesa, CA, 92626
714-850-1163, or 800-898-1883

The Internet address is: www.amidon-inductive.com.

Ask them for their catalog when you call; it is full of good stuff about magnetic materials. Oh, and if you're worried about the price, don't be: the FT50-67 is 75 cents and the FT50B-67 is 95 cents.

Now for the box–er–the case, I mean. Such language! A Bud box, Type CU471 is 4.33 inches long by 2.5 inches wide by 1.75 inches high will work. You might prefer a bigger box–case, but it should be metal, not plastic, for shielding and grounding reasons. And, use one with the interlocking lip around the top plate, and at least four screws holding the top on. It should be as nearly RF-tight as possible, so no extra holes are wanted.

Now for Litz wire:

Antique Electronic Supply[1]
6221 S. Maple Ave.
Tempe, Arizona, 85283
480-820-5411 or 800-706-6789

The Litz Wire part number is S-W106 and their Internet address is: www.tubesandmore.com

All nine coils in this thing can be wound with less than 12 feet of wire. The turns should be spread over the whole core as evenly as possible. This is because the farther the wires are apart, the lower is the stray capacitance, and the proximity effect does not increase the resistance as much.

Figure 2 is the assembly diagram, but there's a bit more to do before putting the thing together.

Take Aim

Is there a particular AM "free energy source" you're gunning for? The tuned sections of the filter can be tuned to different frequencies within limits. The characteristic impedance will change, but not seriously, and if the end sections (L1-C1 and L9-C6) are tuned higher than 1150 kHz, the cutoff will be shallower, and if lower than 1150 kHz, it will be deeper.

It is probably best to leave L4-C3 and L7-C5 tuned to 1620 kHz if there is a serious interference source above 1200 kHz. If there is nothing to be filtered out between 1200 kHz and the top of the AM band, these 1620-kHz resonant circuits can be tuned lower for a deeper cutoff, but not below 1150 kHz; the Q of the

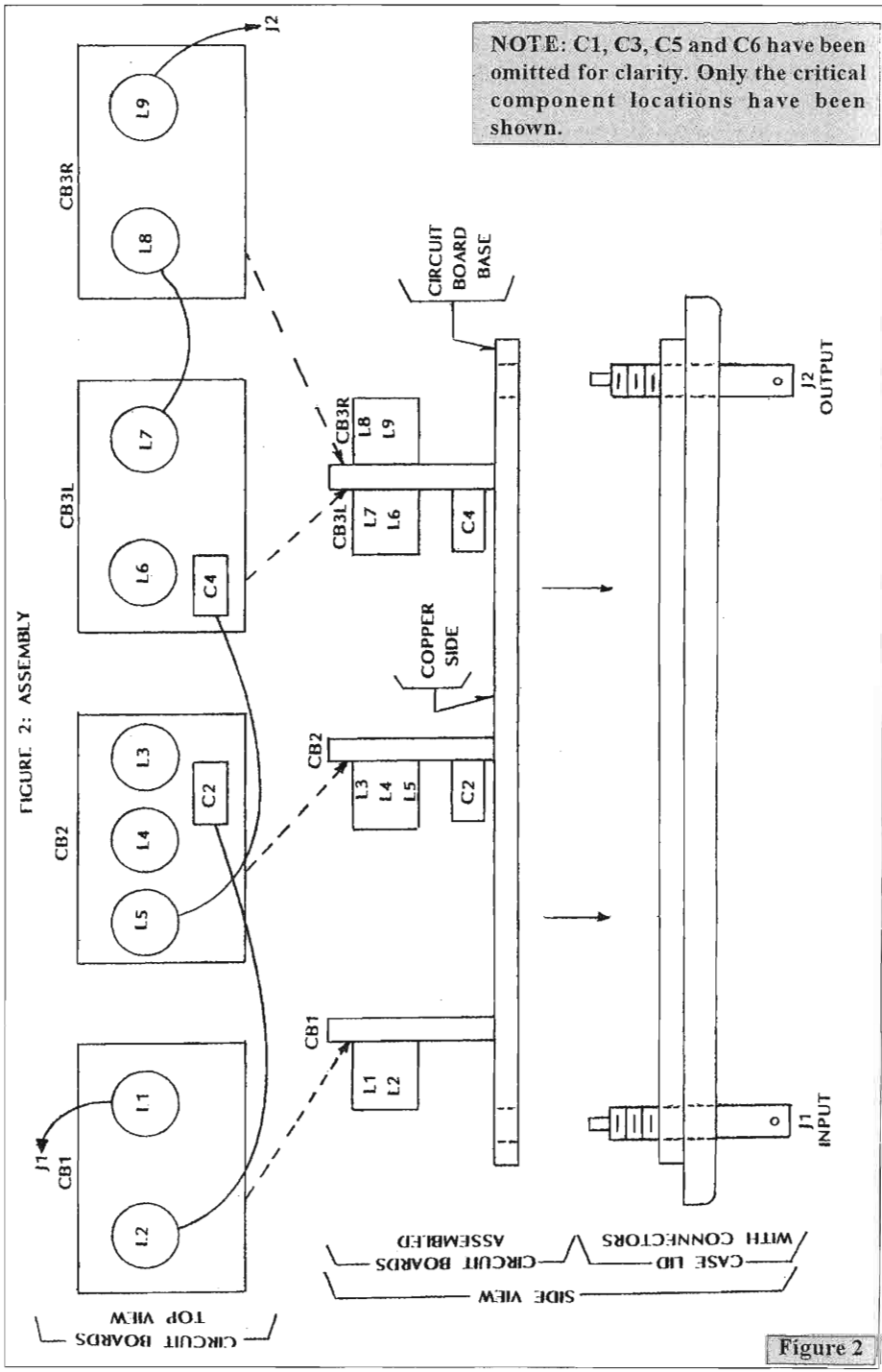

NOTE: C1, C3, C5 and C6 have been omitted for clarity. Only the critical component locations have been shown.
FIGURE 2: ASSEMBLY
CB3R
L8
L9
J2
CB3L
L7
L6
C4
CB2
L3
L4
L5
C2
CB1
L1
L2
J1
CIRCUIT BOARDS TOP VIEW
CIRCUIT BOARD BASE
COPPER SIDE
J2 OUTPUT
J1 INPUT
SIDE VIEW
CIRCUIT BOARDS ASSEMBLED
CASE LID WITH CONNECTORS

Figure 2

tuned circuit will be too much compromised. Still, try the filter with the resonant frequencies shown; it will probably be quite adequate.

How Do I Tune Up This Here Riggin'?

First, you'll be wondering about the capacitor values on the schematic diagram, **Figure 1**; they sure aren't standard values, huh? And, they have to be pretty accurate too, so capacitors are put in parallel to get the right values. Now, the capacitors have to be good for use in tuned circuits, and mica is pretty good. Ordinary B+ bypass capacitors are not good–too much series resistance. To get the Q values at which these tuned circuits are to operate, the series resistance is less than 0.22 ohms, and for L7, it is 0.098 ohms. No, 98 milliohms is not a typo! So, the capacitors have to be good.

Putting capacitors in parallel is a good procedure for this application; the internal series resistances are in parallel too and the total resistance for the parallel group is lower, just as with parallel resistors.

A grid-dip meter is just perfect for this job, except for one little detail: they don't tune this low. Mine goes down to about 1900 kHz, and if you try to use one down there, it's pretty clear why they don't go lower. So, we'll have to arrange a pretend-grid-dip meter.

It can be done as shown in **Figure 4**. It produces a peak at the resonant frequency, not a dip. With a 10-k resistor, the peak is pretty sharp. It can be made sharper with a larger resistor, or broader with a smaller one.

The tuned circuits to be adjusted are L1-C1, L4-C3, L7-C5, and L9-C5, and they are to be tuned to the frequencies shown in **Figure 1** or to the frequencies you have chosen for your targets. Put one of the LC pairs in parallel as shown in **Figure 4** and tune the "sig gennie" until there is a peak response on the 'scope. If the capacitor value is lower than required, the frequency will be higher than required, and another small capacitor can be bridged across it. If the resonant frequency is still high, the bridged capacitor can be changed for a larger one, or another smaller one can be bridged across the first two.

The resonant frequencies can be within 5% on the low side, but should not be higher than shown in **Figure 1**.

The remaining parts are not so critical; standard-value, 1-nF (1000 pF), 5% capacitors will do for C2 and C4. Capacitors for RF use can be measured on a standard 1-kHz RCL measurement bridge, and the result will be quite accurate at RF.

Inductors in the range needed will not be measured accurately at 1 kHz, but they can be checked with the pretend-grid-dip (that doesn't dip) meter shown in **Figure 4**. Capacitors can be measured and used to resonate the inductors to find the inductance value. The equation is:

$$L = \frac{1}{(2\pi Fr)^2 C}$$

Where "L" is inductance in Henries, "F_r" is the resonant frequency in Hz, and "C" is capacitance in Farads.

Now, if you would rather leave the calculations for another time, the table below has the capacitance values that can be used to measure the inductors. These resonant frequencies can be measured with a standard grid-dip meter if you can measure the dip frequency on

INDUCTOR	PARALLEL CAPACITOR	RESONANT FREQUENCY
L2, L3, L5, and L6 (all 4 µH)	470 pF	3670 KHz
	OR	
	270 pF	4840 KHz
L8: 6.7 µH	470 pF	2840 KHz
	OR:	
	270 pF	3740 KHz

a counter.

Time to Stick the Bits Together

Figure 2 shows a suggested assembly arrangement. The idea is to separate the input of each section as much as possible from it's output. Single-sided copper-clad circuit board material is good; double-sided copper-dad is very good; just be sure both sides are very thoroughly grounded to the base circuit board. The dotted lines labeled "SH1, SH2, and SH3" mean "shields 1, 2 or 3", and refer to the circuit-board copper.

But, that comes later. First, mount steel L-brackets on the circuit boards with metal screws, and then solder the bracket edges to the copper surface. Then, parts can be mounted on each of the boards marked CB1, CB2, and CB3. Parts were mounted on both sides of CB3, but another board can be used if you prefer. Capacitors can be mounted with terminal strips soldered to the copper board surface. Soldering them on is best because ground resistance is lower.

Then the boards are mounted to the base board, first with screws, and then the bracket edges are soldered to the copper surface. *Very good grounds are very important*. The lines on **Figure 2** between the boards are suggested interconnection arrangements. The whole assembly can be supported by the BNC connector shafts. Biting lockwashers at the circuit board surfaces and the case lid will assure good grounds. There, now.

What Does It Do?

Figure 3 shows the response of my unit using the resonant frequencies shown in **Figure 1.** The deepest loss was at 1150 kHz (my main target) and was -113 dB. That's quite a ways down and was quite satisfying, but the measurement setup has to be special to get down that far. It is also shown in **Figure 3.**

Low-pass filters are much easier to test than high-pass, and that's because the high-pass stops the fundamental test frequency but (by definition of its response) not the harmonics. There isn't a sig gennie in captivity that can put out a signal with harmonic content more than 60 dB down from the fundamental. So, if we want to measure a response from the filter that is deeper than that, we have to get the harmonics out. That's what the receiver is there for.[2]

First, receiver gain (from antenna input to IF output) must be measured. Connect the signal generator to the antenna input. It should be terminated in 50 ohms. Just put a 47-ohm or 51-ohm resistor across the antenna terminals; the match is not perfect and depends on the antenna trimmer setting but, using the same termination (and antenna trimmer setting) for the filter when it is connected will provide pretty good numbers.

Now, set the generator and the receiver to the frequencies at which you want to test the filter, and note the gain. The receiver that was used for these measurements had a consistent +80 dB level from the 10-meter band right down to 100 kHz.

But, just as a guide, here are the gain readings on my R-390 with the RF Gain at maximum, the Limiter turned off, MVC, the Antenna Trimmer set for maximum response, and the Bandwidth at 8 kHz. The measurement is corrected for antenna input impedance, and the output measured across 50 ohms at the IF output:

f, MHz	Gain (dB) from Unbalanced Ant. Input	Gain (dB) from Balanced 125 Ω Input
0.5	92	110
1.0	99	102
2.0	100	102
5.0	103	102
10.0	100	102
15.0	102	102
20.0	110	105
25.0	72	68*
30.0	86	103

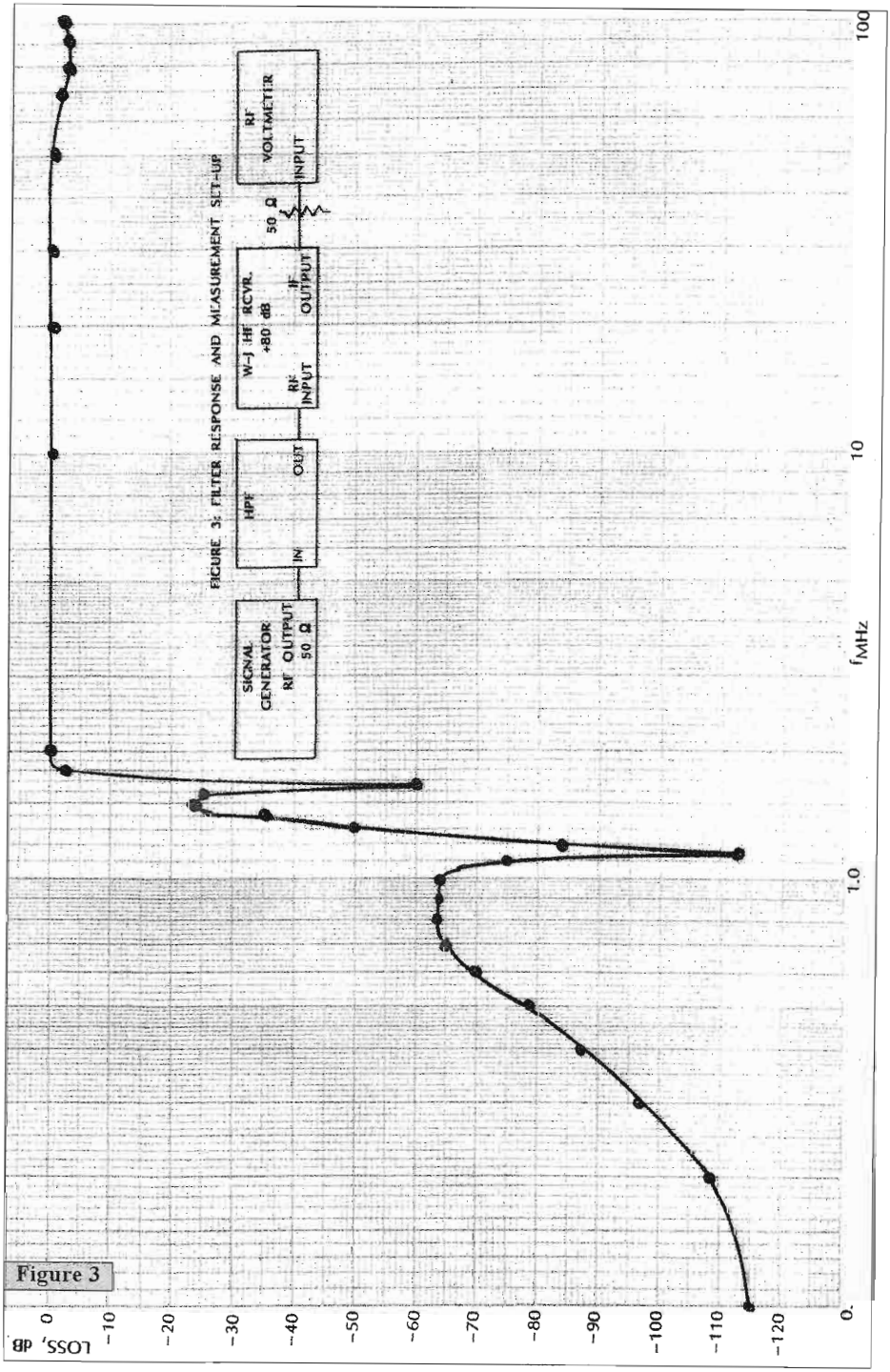
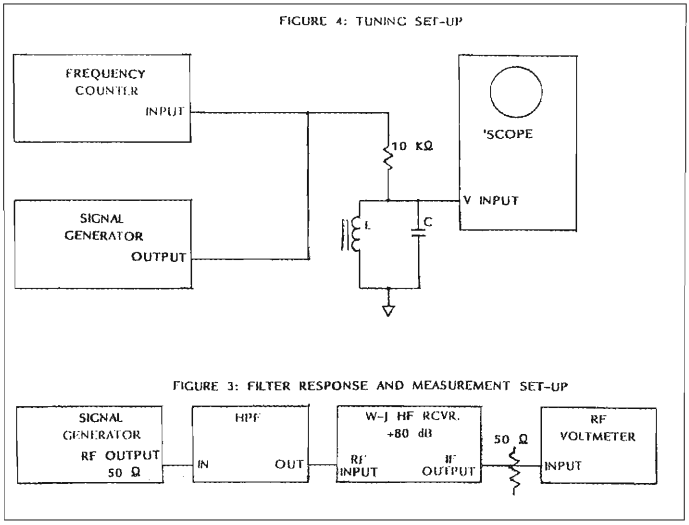


FIGURE 3: FILTER RESPONSE AND MEASUREMENT SET-UP
SIGNAL GENERATOR RF OUTPUT 50 Ω
IN
HPF
OUT
RF INPUT
W-J HF RCVR. +80 dB
IF OUTPUT
50 Ω
INPUT
RF VOLTMETER
LOSS, dB
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
0.
1.0
10
100
f MHz

Figure 3



(* Does your R-390 have a gain dip like this at around 25 MHz, and do you know why? I'd sure like to know.)[3]

OK, now that the gain is known at the measurement frequencies, the filter can be placed between the signal generator and the receiver antenna input terminals, and the output difference measured. The generator output signal will have to be increased as the frequency is lowered to keep the IF output at the voltmeter at about –20 dBm. Receiver IF outputs shouldn't go much above that if they are to stay linear.

Each dB increase in level to keep the voltmeter at -20 dBm is a dB loss in the filter. For example, the response curve (**Figure 3**) shows a loss of 63 dB at 1 MHz. For this measurement, the generator output would have been set at (–100 dBm + 63 dB) –37 dBm to keep the voltmeter at –20 dBm. Where'd all this come from? See **Table 3**.

Generator Output	–37 dBm
Receiver Gain	+80 dB
Level at voltmeter without filter (which, of course, is impossible, but..)	+43 dBm
actual voltmeter reading with filter	–20 dBm
so, the filter loss is	63 dB

Table 3: Filter loss measurement.

Happy Ending

But of course, you don't have to go through all these performance measurements. If your AM band "free energy" source is gone and 160-meter reception is good, what else matters?

73, Walter

[1][Antique only has one type of Litz wire. Most Litz wire comes from Kerrigan-Lewis Wire Products, 4421 West Rice Street, Chicago, IL 60651, 773-772-7208. They make an extensive line of Litz wire styles. They are friendly folks, but don't have a web site.–Ed.]

[2][Hewlett Packard HP-8640B signal generators have the 2nd harmonic at least 65 dB below the fundamental.–Ed.]

[3][It's likely this problem is caused by a bad mica capacitor in one of the RF transformers. It might be in T206, Z206-1, or Z206-2. See N6PY's article in this issue, page 11.–Ed]

ER

The AM Broadcast Transmitter Log
Part 13, Special:
Solid-State Rectifier Replacements for BC and ham Rigs

By David Kuraner, K2DK
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Haymarket, VA 20169
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One of the issues, which has created a quite a bit of correspondence with ER readers, has been that of replacing hollow state with solid-state rectifiers. This issue is simply whether or not to modify equipment to more modern standards. As always, there are two diverse opinions.

The pros insist that the units must be brought up to modern safety and reliability standards. In the case of mercury rectifiers, the tremendous increase in reliability is hard to ignore. Less heat is generated with all solid-state and less demand is placed on the power transformers. This is beneficial for equipment longevity.

The cons insist that the equipment be kept original. No real increase in safety is gained if the equipment chassis is properly grounded. The glow of mercury vapor rectifiers is truly beautiful and should be retained. And, when power supplies are converted, if precautions are not taken equipment could be damaged. The equipment is designed for the inherent voltage drop across the rectifiers. Going solid-state would increase the supply voltage placing much higher voltages on tubes and components.

In part 11 (ER #205, June 2006) of this series, we discussed various modifications to the DX-100. The solid-state rectifier conversion was the last one mentioned. Since this was just a small part of that article, we could not have gone into great detail. Also, in part 8 (ER #201, February 2006), solid-state replacement rectifiers were shown for the Collins 20V series transmitters.

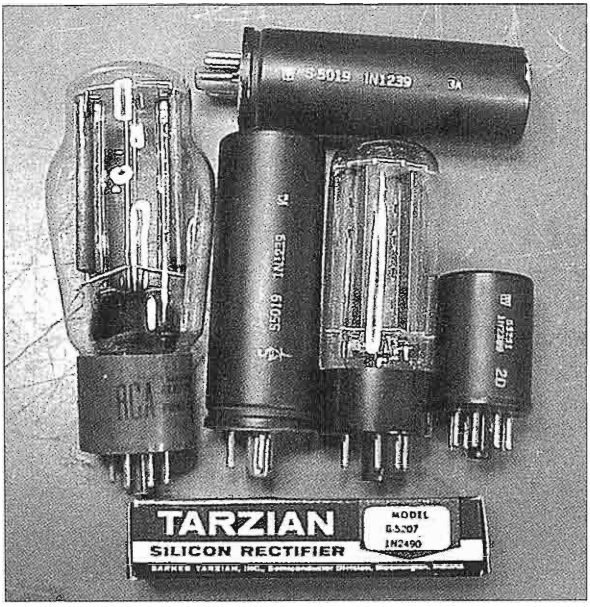
There are valid reasons to make the conversion. We will now get into the details for both broadcast and classic ham rigs. So, assuming you have made the decision to do it, here are your options.

Mercury Vapor Rectifier Replacement

The large high-voltage ones in the Collins 20V series are the 575A mercury rectifier. The ones in my rig are the RCC HVK1115/575A solid-state replacements. The medium voltage supply was using the SEM CO 1N2037 instead of the 866A mercury rectifiers. The bias supply retained the 5U4 vacuum tube. At one point, I substituted the 5R4 because I had one handy. The rig did not like it for this particular application. The 5R4 has a higher internal voltage drop. That is a maximum of 67 volts compared to 50 volts for the 5U4. I will have more on this later. Going solid-state will save 15 watts of filament power for the 5U4. But, this saving seems ludicrous in a 1-kW BC rig.

The excellent rectifier blocks sold by K2AW Silicon Alley can be adapted and should work well for any broadcast rig. Internet research revealed several sources for the direct plug-in replacements, including Penta Labs, Peter Dahl and many other Internet sources. The Dahl replacement for the 3B28/575 is $65 and the 866A replacement is $30. Penta Labs sells their 8008 replacements for about $50 each. [Radio Daze offers an extensive line of solid-state rectifiers, request their latest catalog for details–Ed.]

Should you wish to make your own, use at least 10 diodes with 1000-V peak inverse voltage (PIV) rated at 2.5 amps in a series string for the HV rectifiers. The 1N5408 is 1250 PIV @ 6 amps, at $1.50 from Peter Dahl. Also available is a rectifier board of these diodes rated at 10 kV @ 6 amps for $35.



A collection of vacuum rectifiers and their solid-state replacements.

The diodes can have different back resistances when at the cutoff state. Each one needs an equalizing resistor across it to insure equal distribution of reverse voltage across the entire chain. A rule of thumb is to multiply the PIV by 500. Thus, the 1000-PIV diodes need 500-k resistors. (Standard values are 470k and 510k.) Also, the switch from forward conducting to cutoff in a diode is not instantaneous. Some can be faster than others. To protect the faster diodes until all are cutoff, a .01-µF capacitor is also placed across each diode. Half-watt resistors should be adequate and the voltage rating of the capacitors should match the diode's PIV. This is exactly what the K2AW rectifier blocks do. Perhaps by the time you have purchased the parts and fabricated the assembly, it would be more economical to simply purchase the blocks or the direct plug-in commercial devices.

The characteristics of the gas rectifiers are more like solid-state rectifiers. The internal voltage drop is limited to about 15 volts, which is the ionization level of the gas. This permits a high-current device with a low voltage drop. And, like solid state, the current surge needs to be limited. So, often some resistance is placed in the circuit. Going solid state is much easier with circuits designed for mercury vapor rectifiers.

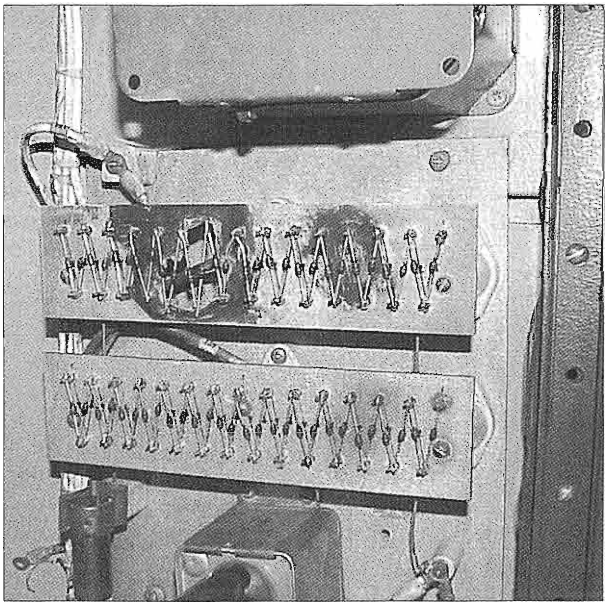
One BC transmitter I am restoring uses this type. It seems to be a HB diode string in a bridge-rectifier circuit. It was indeed originally designed for a solid-state bridge rectifier. There is plenty of evidence that several diodes, at some point, went up in smoke. If it should need replacing, I intend to use the K2AW blocks. I would rather have the fireworks in the air on July 4th—not in the rig.

Also, rectifier diodes can be placed in parallel to increase the current-handling ability if needed. Resistors should be placed in series with each diode to insure equal currents. They should be selected to provide about a one-volt drop at peak current. And, of course, do the calculation for power dissipation for these resistors.

5U4/5R4 Replacements

One company brought to my attention by Bill Tipton (K5JRI) is Weber. They cater to audiophiles with speakers, components, transformers, metal chassis, and many items that could be of use to hams building their own rigs. For $20 plus shipping you can purchase the 5R4 or 5U4 plug-in replacement called a "Copper Cap" rectifier[1] by the company. Two 5R4s are used in parallel for the Heath and E.F. Johnson equipment. Also, for the DX-100's low-voltage supply, the 5V4 plug-in is available at the same price. The 6AL5 bias rectifier replacement is available for $10. Peter Dahl sells the 5R4/5U4 replacement for $7.95.

I discovered that I had direct



French fried Bauer diode chain "a la cart?" Note the absence of the protective resistors and capacitors. Perhaps this is the reason for the fireworks!

replacements sitting in the tube caddy for over 25 years. A company called Sarkes Tarzian made a line of plug-in rectifiers. They are no longer in that business. They apparently preferred to buy and operate broadcast stations instead. Because of this knowledge, I assumed incorrectly that similar devices were no longer being manufactured. A bit of Internet snooping confirmed that I had replacements for the 5R4s and the 5V4. The 5R4/5U4 replacement is the 1N1239 and the 5V4 replacement is the 1N2389.

Homebrew replacements can certainly be made using your own components. You can use a string of at least two 1N4007 diodes, which are rated at 1000 PIV, 1 amp. You must still compensate for the inherent voltage drop within the tube rectifier. The logical thing to use would be a power resistor somewhere in series with the diodes. For the 5U4, shoot for about a 50-volt drop at 275 mA. And for the 5R4, the target is 67 volts with 250 mA. (Remember Ohm's Law, E= IR) Since 200 ohms will drop 50 volts at 250 mA, this should be a good starting point to obtain the correct voltage. And, use at least 20-watt power resistors. (P=EI) Perhaps two of the Radio Shack 100-ohm, 10-watt resistors in series would work here.

It would appear that in the case of parallel vacuum tube rectifiers only one solid-state replacement would be needed if it could handle the current requirements. This would be best as current equalization between the two rectifiers becomes an issue. (Even the commercial solid-state replacements are not exact replicas of the tube's electrical characteristics and could be damaged when in parallel.) The dropping resistor would need to be about half of the value needed for a single tube replacement. Thus, 100 ohms at twice the power rating would be about right. A little experimenting should yield satisfactory results. Four of the 100-ohm, 10-watt resistors in series/parallel should work. Don't forget the equalizing resistors and protective capacitors in the diode string.

When selecting the dropping resistor value, bear two things in mind. First, you may have to experiment with these values under average current draw. The second thing really relates to the first. The voltage drops given are derived from the maximum values stated by manufactures of solid-state replacement rectifiers. I have found no documentation that specifically suggests that voltage drop is linear with current. However, in a solid-state replacement it would have to be linear.

In researching the voltage sag, the various handbooks and engineering texts just note its existence but offer no specific

design guidance. Most often, this information is not published in the RCA tube manuals. However, in the "Interpretation of Tube Data" section, there is a discussion of the voltage drop relating it to perveance and a nomograph relating perveance to diode voltages and current. Quoting RCA Tube Manual, TC-27, 1966, "Perveance can be considered a figure of merit for diodes; high-perveance units have lower voltage drop at a fixed current level." **Table 1** provides more readily usable information from various sources for common rectifier tubes.

When electrons evaporate or bubble off the heated cathode, they form a cloud surrounding the element. This cloud forms a negative space charge which repels further electrons as they emit from the heated cathode. A simplified explanation of the voltage drop within the vacuum diode is that the electrons must overcome this space charge to reach the anode.

It was always common practice with a solid-state rectifier to use inrush limiting resistors. For lower voltage applications, just a few ohms of resistance are placed in series with the diodes. With large, high-voltage circuits such as found in the newer 1-kW broadcast boxes, about 25 ohms are used. With several hundred ohms compensating for the inherent voltage drop in series with the silicon, the inrush issue is covered. Also, the back EMF from the choke input filter on shutdown is dampened.

Vacuum Tube Rectifier Voltage Drop

Tube	Mils.	Volts
6AL5	9	2
6X4	70	22
6X5	70	22
5Y3	125	50
6AX5	125	50
6CA4	150	28
EZ81	150	28
5V3	350	42
5V	175	25
5Z3	225	58
80	125	60
5R4	250	67
5U4	275	50

Table 1: Maximum voltage drop at max-load design for solid-state replacement.

Now let's assume that you still have too much voltage on the plates. The 6146s and 807/1625s can tolerate plate voltages above 750 volts. However in a DX-100, Viking II or similar transmitter, the screen grids of the modulators are fed from the center-tapped power supply bleeder resistor chain. The screens will not be happy. The RF stage won't like that extra screen voltage either. The screen grids want to see about 300 volts. For the RF stage, just a bit more resistance in the screen circuit should do it. For the modulators, it will depend on how the screen voltage is derived. If the HV bleeder resistor chain has a slider tap, such as the in a Viking II, a readjustment of that slider should do it. If it's a fixed position on the bleeder chain, like the DX-100, then use a dropping resistor in conjunction with voltage regulators. The circuit in **Figure 1** can be applied to any modulator for improved screen voltage regulation. It was originally developed to reduce distortion in the Heath DX-100 and Johnson Viking rigs. Its origins have been lost with time.

Unfortunately, in the case of the DX-100, the modulator screens as originally designed are receiving much more voltage than they should. The screen current is constantly changing, as mentioned in Part 11 of this series. Therefore, just adding resistance in series with the screen grids will have the voltage swinging and inducing further distortion. This totally defeats the purpose of reducing the screen voltage. The screen voltage regulation modification was developed to address this issue.

One last thing casually mentioned in

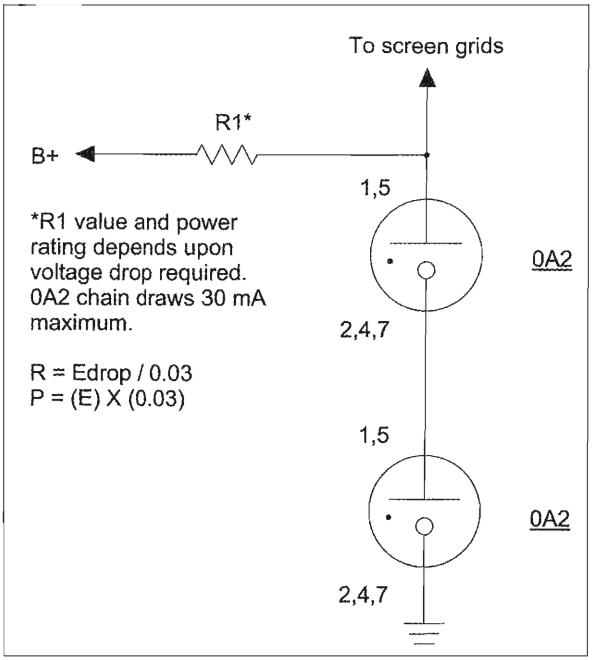


Figure 1: Screen grid voltage regulation circuit.

Part 11 was the modification of increasing the HV filter capacitor values. This gives better voltage regulation under modulation swings. The voltage sag, as the transmitter approaches 100% modulation, is called carrier shift. In an AM broadcast transmitter it is normally about 2% or so. It tends to be a bit more in a ham rig. By increasing the filter capacitor values, you have more voltage reserve during modulation peaks and therefore less distortion. The down side of this is that you have more inrush current charging those larger capacitors. While great in theory and good in practice, this modification may well be one of those in the diminishing returns zone.

Conclusion

Going solid state with rectifiers could become pricey for the convenience of just popping in a plug-in. Similarly, for homebrew, it could be expensive and time consuming depending on what you are dealing with. But, as we get further into the 21st Century, many of the common vacuum tube rectifiers are becoming less readily available and prices are always increasing. Trying to protect equipment by drawing less heat and current is always a good thing. It can be thought of as an investment in equipment longevity. DX-100 kits, Viking IIs and the like have not been manufactured in almost 50 years! We need to protect them. Don't rule out receivers and other equipment with vacuum rectifiers.

For a transmitter such as the DX-100 or Viking rigs, it may well be worth the expense and effort, especially if this is your primary rig and heavily used. For broadcast rigs, many have already been converted for reliability in a 24/7 commercial operation. If you have one working and using mercury vapor bottles, unless you are still operating it in commercial 24/7 service, why go through the expense? Just enjoy the glow!

73, Dave, K2DK

References:

1) Terman, Radio Engineering, 2nd ed., 1937
2) Nilson & Hornung, Practical Radio Communication, 2nd ed. 1943
3) Editors & Engineers, Radio Handbook, 10th edition, 1946
4) ARRL, ARRL Handbook, 1975
5) RCA Receiving Tube Manual, 1966

[1]See ER #190, March 2005, for a review of Weber Copper Cap rectifiers. Contact information is:
WeberVST
329 E Firmin St.
Kokomo, IN 46902
Phone: 765-452-1249
http://www.webervst.com/ccap.html

ER

Milestones in the History of Amateur Radio

The Crystal Set: A Centennial Commemoration

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Marconi secluded himself in his laboratory, following his triumphant one-way transatlantic transmission in December, 1901. He aimed to develop a replacement for the "filings" coherer (Grinder, 2002). The latter was an erratic and insensitive wireless receiver. Its filings had to be tapped back into operation each time an impulse was received, and at best an operator could copy code at agonizingly slow speeds. The future of wireless telegraphy depended at the time on a more effective method of reception.

Marconi thus produced in 1902, amidst considerable proprietary controversy, a "magnetic" detector, but it, too, was unstable and relatively insensitive. Subsequently, in 1903, Reginald Fessenden patented a receiver based on suspension of a fine platinum wire filament in a hydrogen-filled container. It became popularly known as a "liquid" or "electrolytic barretter" receiver, and it proved to be fairly sensitive. Fessenden's success prompted two benefactors to establish the National Electric Signaling Company in part as a laboratory for Fessenden and in part as a vehicle for marketing his receiver to the U. S. military services (MacLaurin, 1949).

However, in 1903, a venture capitalist incorporated the American deForest Wireless Telegraphy Company, ostensibly to enable deForest to establish wireless stations throughout the United States and to market deForest's apparatus to the Signal Corps, the U. S. Navy, and the United Fruit Company. deForest then proceeded to shamelessly pirate Fessenden's electrolytic detector and underbid him in competition for lucrative contracts. Fessenden protested furiously to the War Department that deForest had infringed upon his patents. The Secretary of the Navy ignored his complaints, and in turn, Fessenden wrote to President Theodore Roosevelt in an unsuccessful attempt to get the Secretary fired.

Colonel Henry H. C. Dunwoody, after a distinguished 40-year career in the Signal Corps, joined American deForest Wireless as Vice-President at its outset. His military contacts doubtless greased access to contracts. Fessenden was moving through the courts, however, to obtain an injunction that would prohibit deForest from manufacturing and selling electrolytic receivers. Financial catastrophe loomed imminently. Dunwoody was thereby inspired to conceptualize an alternative detector. His research, which began presumably during his career in the Signal Corps, produced a "[radio] wave response device". It consisted of a crystal of Carborundum clamped between two electrodes. He patented his invention (#837,616) in mid-December, 1906.

Virtually simultaneously, another American inventor, Greenleaf Whittier Pickard, patented a silicon crystal detector. He worked for the American Wireless Telephone and Telegraph Company, and he was a grand nephew of the famous poet for whom he was named. Pickard's patent was issued on November 20, 1906. It was assigned #836,531. The record shows that Pickard's patent preceded that of Dunwoody by perhaps

only a few weeks—by 1,085 patents. The two men, however, apparently never collaborated and may have been unaware of the other's endeavors.

Ferdinand Braun, in 1874, observed in several natural minerals the phenomenon of "unilateral conductivity". He revealed that a battery current flowed through the minerals readily in one direction and hardly at all in the other. The discovery of asymmetrical resistance had no practical application in the nineteenth century. Dunwoody and Pickard, as they struggled independently to develop a new detector of radio waves, discovered specifically that the phenomenon enabled an alternating radio-frequency current to pass through particular minerals and produce a pulsating direct current that caused the diaphragm of a telephone receiver to be alternately attracted and released, which in turn, gave rise to an audible buzzing sound. Professor George W. Pierce (1907) of Harvard described the essence of the process to be that of a "crystal rectifier".

Pickard invested particularly a great deal of his career in systematic research, and his contributions to the invention of a crystal detector warrant comment. His efforts began at the American Wireless and Telephone Company in 1898. He had advanced by 1902 to using several fine sewing needles, laid lightly across a pair of carbon blocks in series with three dry cells and a headphone. To his great surprise, he found that the energy of the received signals alone would operate the receiver diaphragm. Pickard was astonished! The serendipitous experience was wholly beyond the realm of his expectations. Consequently, during the next four years, from 1902 to 1906, Pickard experimented with "some two hundred and fifty minerals and furnace products which make operative detectors, either against metallic contacts, or in combination with other minerals. The possible combinations of these two hundred and fifty substances, amounting to some 31,250 pairs, have all been tested by me, or by my assistants, and many hundred useful pairs have been found" (Pickard, 1919 p. 2). After Pickard had exhausted the possibilities, he chose to describe in his 1906 patent a detector that utilized a short piece of wire, similar to a "catwhisker", in contact with a crystal of fused silicon.

Pickard and two associates organized the Wireless Specialty Apparatus Company in 1907 to develop and market his detectors. Refinements within a few years led to six additional patents. An early product carried the trade name "Perikon"—an acronym derived from "perfect Pickard contact." It consisted of a bornite (copper and iron) catwhisker in contact with zincite, a natural redish outcome of oxidized zinc.

Pickard and Dunwoody were very much aware that different detectors required different "catwhisker" contacts. Silicon, for example, worked best with a "catwhisker", but also yielded satisfactory results in contact under pressure at the end of a tapered machine screw. Good specimens of fused metallic silicon usually possessed sensitive contact spots all over their surface. Carborundum worked best when contact occurred across an appreciable area of the crystal. Galena, a lead sulfide, proved eventually to be one of the least expensive minerals and, importantly, the most sensitive. Very good results were obtained when a fine wire "catwhisker" made light contact with a very small area on its surface. However, galena contacts were relatively difficult to adjust and often lost sensitivity in a given spot if acted upon by strong signals or static (Signal Corps, 1922).

The crystal set proved, early in the twentieth century, to be a godsend to both commercial enterprises and amateur operators, for it was vastly more effective

than any of the receivers that preceded it and it was easy to build. Indeed, Sleeper (1920, p. 50) put it this way: "The pleasure of having made a receiving set and, when the instruments are connected to have signals come buzzing in at the phones, is an experience which the experimenter never forgets". DeSoto (1936, p. 20) declared, too, that the crystal detector had been "a distinct and revolutionary departure from all other reception methods.... Its simplicity, its cheapness, and above all its sensitivity caused it to reach a high degree of perfection very quickly, and in a relatively short while it was in use at nearly every amateur station".

Amateurs operated spark transmitters almost universally before WWI. A prominent reason for the instantaneous acceptance among them of crystal detectors stemmed from the fact that the latter were admirably suited for copying the buzzing sound of radio-frequency energy that emanated from these transmitters. A spark transmitter emits high-frequency waves that fade and die out; accordingly, they are described as 'damped". They occur and decrease as a condenser discharges across a "spark gap" when the supply voltage applied to the condenser is high enough to break it down, and they are transmitted when the output of the spark-gap is connected to an antenna. An operator of a telegraph key produced a "dot" by sending the diminishing oscillations for a relatively short time; a "dash" was made by sending them for a slightly longer time. The "dots" and "dashes" produced an audible sound after signal rectification.

Amateurs and commercial operators swiftly improved the effectiveness of a simple crystal detector by adding adjunct devices to assist them (1) in adjusting the "catwhisker" should it be jarred or saturated by either strong signals or static, and (2) in tuning signals for maximum sensitivity and selectivity.

First, a crystal detector can be neither protected wholly from being jarred nor shielded from a spark transmitter operating in near proximity. Thus a means had to be at hand to readjust it periodically for maximum sensitivity, especially at the close of a transmission. A test buzzer was employed to facilitate this task. When the buzzer was energized, its RF energy was rectified, permitting the crystal to be adjusted quickly to hear the buzzer tone in a headphone, and concurrently, to maximize the amplitude of an incoming signal. A buzzer assembly usually consisted of a high-frequency buzzer, a dry cell, a push-button, and a wire connecting it either to the ground lead of an antenna tuning coil, or alternatively, to the antenna input with a few turns of wire.

Second, many amateurs chose to use an inexpensive, easily constructed, "autotransformer" or "mono-coil" transformer as a tuning device, in order to improved both sensitivity and selectivity. It consisted of a single coil that was equipped with an "antenna slider" and a "detector slider"; one end of the coil was connected to the antenna and the other end to ground. The autotransformer served as a step-up transformer –whenever the sliders were adjusted so that the detector slider covered more turns than the antenna slider. The autotransformer provided some gain in sensitivity and a degree of selectivity. Although antenna coupling and receiver frequency could be changed semi-independently, interaction inevitably occurred between the sliders, which tended to attenuate acquisition of optimum balance between sensitivity and selectivity.

The auto-transformer improved crystal-set efficiency. Amateur operators soon recognized, however, that greater sensitivity, selectivity and balance

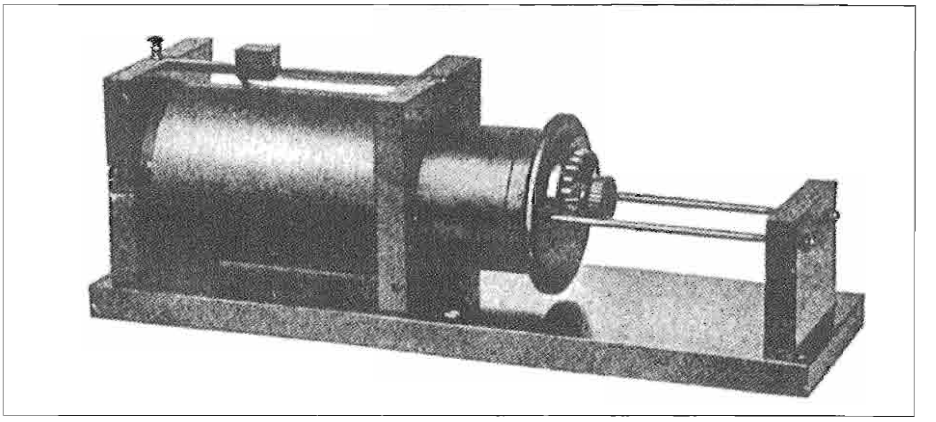

Figure 1: The Frost long-range loose coupler. From the Robertson-Cataract catalogue #22, 1922, Buffalo, N Y, p. 36.

between the two parameters could be attained when the primary and secondary sections of the transformer were two separate coils, so arranged that they could be closely or loosely coupled inductively. Such a device was aptly named a "loose coupler". It was usually designed so that a smaller-in-diameter, secondary coil slid inside a larger diameter fixed primary coil. **Figure 1** shows a loose-coupler, which was manufactured by the Frost Company, with a remarkable tuning range of 200 to 4000 meters. Both primary and secondary windings were wound with green silk covered magnet wire. The primary was controlled by a slider mounted on ¼ inch rod. The secondary inductance was varied by means of a 12 point switch so that different segments of the coil could be utilized for tuning in signals, see **Figure 1**.

The major advantage of the loose coupler over the autotransformer was significantly improved selectivity. It has been said that the primary and secondary coils are analogous to two water filters. While some impurities may flow past the first, few if any pass the second ("Grid," 1922, p. 350). However, as loose-coupler selectivity was enhanced, sensitivity was diminished. Amateurs, therefore, adjusted a loose coupler carefully. First, the secondary coil was set to the wavelength of an incoming signal. Second, with a partial, inductive relationship established, the point of the crystal rectifier and the sliding contact on the primary coil were adjusted to increase the signal strength. Third, coupling between the primary and secondary coils was adjusted for maximum signal strength commensurate with satisfactory selectivity. Thereby, the best possible balance between selectivity and sensitivity was attained.

Adjusting a loose coupler was somewhat tedious, and many amateurs welcomed the advent of versions of the "variometer," which A. Meissner, at the Telefunken Wireless Company, Berlin, invented shortly after the crystal set attained widespread usage. The variometer was produced initially in two styles. In the first, the two coils were internally connected in series to create analogously an autotransformer. In the second, the two coils were unconnected to create analogously a loose coupler. For a time, the term "variometer" served generically as a name for both styles. The custom generated a great deal of misunderstanding while the term was

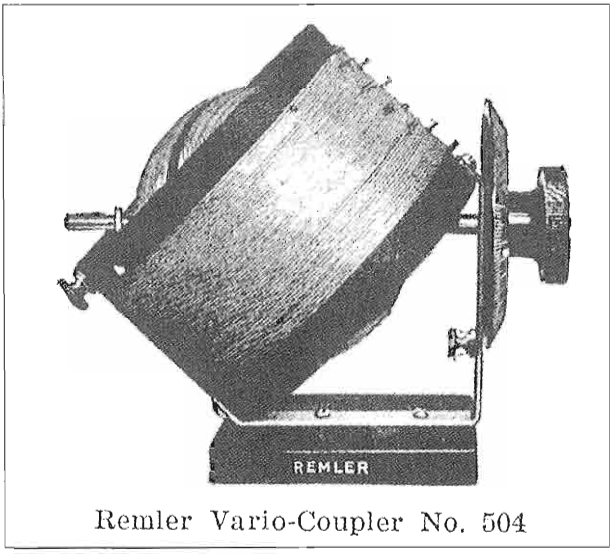

Figure 2: The Remler variocoupler. This image is reproduced from the Robertson-Cataract catalogue #22, 1922, Buffalo, NY, p. 33.

used indiscriminately. Eventually, the term "variometer" came to depict solely the "autotransformer" style and the term "variocoupler" evolved to describe the "loose coupler" style.

Thus, mainly as a matter of convenience, the "variometer" supplanted the autotransformer and the "variocoupler," the loose coupler. Each instrument consisted of two coils in the form of balls; an inner, secondary coil rotated within the body of a fixed, primary coil. When the axes of the two coils were parallel, they were tightly coupled for maximum inductance; when the axes were at right angles, they were loosely coupled for minimum inductance. Each occupied less space than, respectively, an autotransformer or a loose coupler. The secondary of each was tuned with a single knob, which made it an easily adjusted variable inductance. Variocouplers, like loose couplers earlier, became the device of choice for matching an antenna to a crystal set. Its primary or stator coil was usually provided with taps, rather than a slider, for making relatively exacting antenna adjustments. The knob on the secondary or rotor coil allowed for easy frequency adjustments. Sometimes a variable capacitor was wired in parallel with the secondary coil in order to augment the bandwidth of the variocoupler. **Figure 2** illustrates an inexpensive variocoupler that was manufactured by the Remler Company. Ten taps are provided on the primary coil; the instrument is mounted on a 4 by 3 inches base.

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DeSoto, C. B. (1936). Two Hundred Meters and Down: The Story of Amateur Radio.

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Pickard, G. W. (1919). How I Invented the Crystal Detector, Radio Age, (1976, December). 2, 1-4. Reprinted from the Electrical Experimenter (1919).

Signal Corps, U. S. Army. (1922). The Principles Underlying Radio Communication, 2nd. Ed, Washington, D. C.: Government Printing Office.

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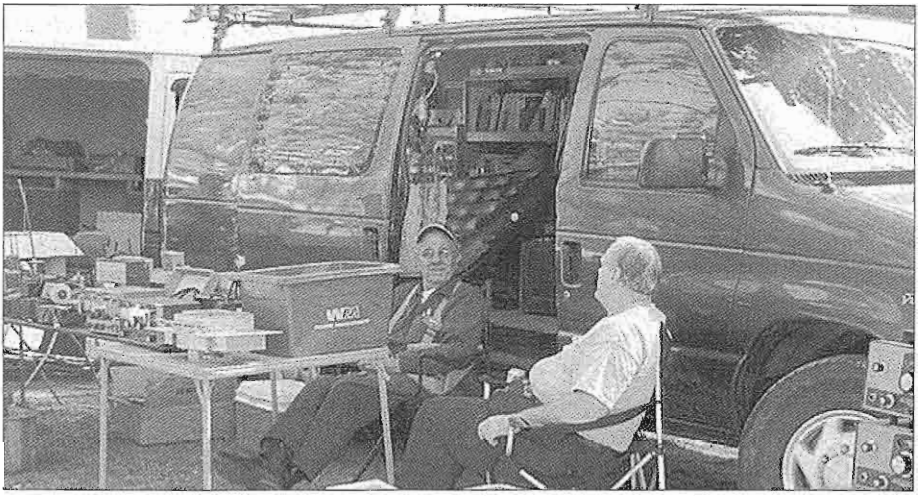
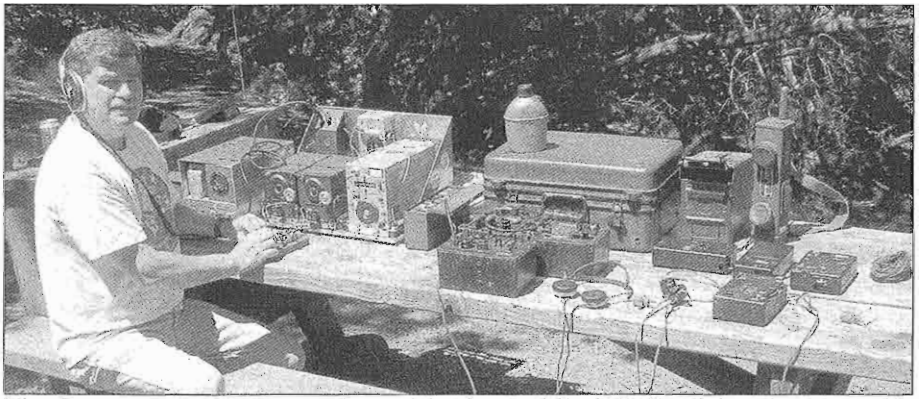
PHOTOS



George Rancort (K1ANX) sent me photos from Hosstrader's hamfest, May 5 and 6 this year. Looks like these fellows have lots of goodies in boxes around the table!



Tim Sammons (N6CC) teamed up with Alex Seddio (KB6IDO) for Electric Radio Vintage Field Day, operating from Mt. Diablo in California. Tim is pictured above with the overall setup, including a GRC-109 and RS-6 stations. Alex is operating an SCR-274N station, lower right. "We had a great day but the Honda generator ignition noise made it hard to dig some signals out. Next time I will revert back to the PU-181—its suppression is superb! We worked some of the HF Pack guys with a PRC-47 USB but the AM Gods were not favorable to the GRC-9 station this time."

During ARRL Field Day, from Santa Barbara, CA, Bill Feldmann (N6PY) worked the West Coast Military Net on 3983 kc and got an extra 100 bonus points for his club as a man-powered station. With his BC-1306—the one discussed in his ER #200 article—official field day contacts were obtained for the club, K6OX, to W7QHO in Glendale, CA. Bill mentions, "It took a team of three guys to crank the GN-58 generator because they also had to crank during receive. It was very hot and humid and the poor guy cranking really took a beating. Those Army Signal Corps guys must have really been big strong guys!"

Alex Seddio (KB6IDO) is at the SCR-274N equipment during Vintage Field Day.

Ward Kremer (KI4JHA) recently came across some brand new WWII surplus radio equipment and has added it to his shack. Here is Ward's description of this new equipment: "Top to bottom in the picture to the left is a DU-2 loop antenna and loop amplifier from the F4F fighter. It's rigged to the BC-348Q, which is also new. Immediately underneath the DU-2 is a Collins 212-Y microphone preamp from the 1940s. It's feeding the BC-375's mic input a nice, fat signal. I use a blocking cap to eliminate the DC bias a carbon mic needs. The audio input is at least 0 db, perhaps as much as +4, I haven't measured it. I just set it up with cans on, listened to the side tone and biased accordingly. The BC-375 was new in the box when I found it, and worked perfectly right away. To its left is a matching Army Signal Corp Vibroplex key. In the middle is a dandy and somewhat perfectly matched microphone. Of course, it's a Shure S-55, the large shell model. The curious part is that it has a "General Electric" tag at its base. This tag has ID numbers similar to the transmitter gear and was probably used with the ground version outfit of the BC-375. Although it did not come with the transmitter, the mic was also NIB. To the right of the transmitter table is a sound proofed wooden box that holds the dynamotor. I didn't have the heart to put it outside, being new/old stock also. There is an HP frequency counter atop the BC-348Q. To the left is my visitor, Arnie the alien. I am Elmering him. He just showed up one day and said that his people picked up an SSTV transmission that had a moving box with four wheels and a message on the back reading "real radios glow in the dark". Arnie came all the way from Alpha Centuri (next sun over to ours) to learn what this meant! Evidently there were similar scribblings on an old shack at the home planet that were over 2 million years old and no one could figure it out. Arnie's been here quite awhile and has been learning how to tune up on top band. Actually, aliens are no trouble at all to have around."

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VINTAGE NETS

<u>AM Carrier Net: Sunday mornings, 8:30AM local Eastern time, 3835 kc. QSX W2DAP. Friendly format.</u>

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

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

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

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

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

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

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

Gulf Coast Mullet Society: Thu. @ 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: Sat. mornings, 7143 kc, 10:00 Eastern time. QSX op Steve (WA3JJT) or Ron (W8KYD).

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

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

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

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

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

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

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

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

Swan Nets: User 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), Bill (N6PY) & Vic (KF6RIP)

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

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

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FOR SALE: Collins 75A-4, NSN, bulletproof, every option, $1,400 split shipping or trade for 75S3-C. Parts and/or service for 51J-/75A-. Very 73, Abe, W3DA, 302-349-5389.

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FOR SALE: Hammarlund SP600, recapped, panel done, works good, $375. BC-348Q, works, $65, modified. Pick up only in So. Cal. 661-718-8885

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

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FOR SALE: Dismantling Hammarlund BC-1004 Super Pro, homebrew PS. What do you need? Joel, W1UGX, Box 20887, Sedona, AZ 86341, 928-284-5419

FOR SALE: Working Heath Apache. $200. Try before buy, cash and carry. NO SHIPPING. Brian Roberts, K9VKY, 130 Tara Drive, Fombell, PA 16123. 724-758-2688. k9vky@verizon.net

FOR SALE: Three bar National speaker and transformer $75, SX-130 $150. All plus shipping. Ed Sauer, 787N. Peterman Rd., Greenwood, IN 46142, 317-881-1483.

FOR SALE: CLEGG: Interceptor, looks and works great, $300. Zeus, good receive, needs TX work, 2 supplies, 1 working & 1 parts unit, $300. Venus, complete, not checked, $100. Prices FOB Houston. Don, K5AAD, 713-942-9747

FOR SALE: HQ-180, HRO-50, HQ-145XC, Valiant I, parts SX-101, 5 element 10 meter beam. Priced to sell, pickup only. Herb, K9GTB, 618-274-0740; Cell: 217-851-2585

FOR SALE: Transformers, chokes, meters, tubes, (other parts, ask), consider offers plus shipping. E.F. Hayes, WØJFN, 3109 N. Douglas Ave, Loveland, CO 80538-2548

FOR SALE: Heath sale: HD-15 hybrid phone patch. HA201 2M RF amplifier. QF1 Q-multiplier. $18 ea. + shpg. Henry Mohr, 1005 W. Wyoming, Allentown, PA 18103-3131

FOR SALE: Tektronix service note copy: AM Broadcast Measurements Using the Spectrum Analyzer, 20 pgs $15. Shipping and mailer extra. Ross Wollrab, 229 N. Oakcrest Ave, Decatur, IL 62527. 217-428-7385. REWollrab@aol.com

FOR SALE: BC454B, AC supply, others. Collins exciter plug-in coils, Crystal filter. Fluke digital counter, 1980A acting up. Bill Coolahan, 1450 Miami Dr NE, Cedar Rapids, IA 52402, 1-319-393-8075

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

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

FORSALE: 1940s Millen Model 90800 exciter without coils $65 +UPS. Robert Baumann, 1985 S. Cape Way, Lakewood, CO 80227. 303-988-2089 rgbdenver@att.net

FOR SALE: Leader Model LBO-50I scope as new with original manual $75 plus shipping. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Precision Series 10-12 tube and battery tester with B-16 socket adapter for later new tubes and all manuals exc cond $125 plus shipping. John Snow 1910 Remington Ct. Andover, KS 67002 316-733-1856

FOR SALE: Leader Model LAG-26 Audio Generator as new, $35 plus shipping. John Snow 1910 Remington Ct. Andover, KS 67002 316-733-1856

FOR SALE: B&K 600 Dyna-Quick tube tester with manual and one TC-63 adapter exc cond $55 plus shipping. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Galena crystal radios and/or parts to make your own. Also radio tubes. Len Gardner, 458 Two Mile Creek Rd, Tonawanda, NY 14150, radiolen@att.net

FOR SALE: MFJ Model 901-B Versa Tuner 200 watt PEP as new $50 plus shipping: John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: B&K Model 162 Transistor/FET tester, all leads with manual, $45 plus shipping. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: B&K Model 960 Transistor Radio Analyst with manual exc cond $45 plus shipping. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Military whip antennas, NOS, $45 ea. plus shipping. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777, 989-595-6483

FOR SALE: Make offer: 1 radio tower 97 feet high base 12 feet, ladder all way to top with platform heavy duty. Need sell at once. Frank Bridges Maple Street Brevard, NC 828-885-2470

FOR SALE: Viking Invader 2000 transmitter in good shape, 80 thru 10 meters, 2kw filter type SSB/CW/AM. With supply. You ship. $750. Ken Sands, K8TFD, ken.sands@juno.com, 505 Parkview Drive, Plymouth, MI 48170. 734-453-7658 734-564-0316 313-917-0144

FOR SALE: Collins 32V-3. QSTs: 1923-1991, 1993-6/94, 7/97 to 5/2005. All items pickup only. Rudy, W2ZIA, 716-937-9279.

FOR SALE: Tubes, transformers, receivers cabinets, more. LSASE w/2 stamps or email for list. WA7HDL, 167 Highway 93 south, Salmon, Idaho 83467 gbabits@salmoninternet.com

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

FOR SALE: ARRL books:1930 7th Ed. 1935 12th Ed. Both fair, $25.00 w/shpg included, will send pic's if needed. Bernie Samek, 113 Old Palmer RD. Brimfield, MA. 01010, 413-245-7174, bernies@samnet.net

FOR SALE: Knight KN-4550 cardioid dynamic mic (similar EV-672, made by EV) Circ 1960, 60-13,000 HZ, 57 DB, scratch free, 150 ohm or HI-Z, $50.+ u-ship, Bob, KD9GI@MSN.COM 815-332-9520

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. $63.85 includes postage. See http://pweb.amerion.com/~w7avk, Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net, 509-766-7277.

FOR SALE/TRADE: Manuals: HQ180, HQ100, HQ180A, 75A4, 51S1, DX20, SB634, SB320, SB650, NC240D, DR30, 51J3. NI4Q, POB 690098, Orlando, F1 32869 407-351-5536 ni4q@juno.com

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

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

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

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

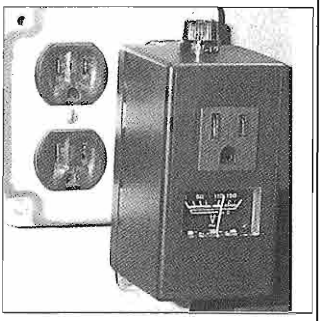
JOHNSON PARTS: EFJ replacement parts: Valiant tie bolts-4 for $18.50. Ranger tie bolts-3 for $17. 80-2CM mic connector (also for Heath/Collins/others) $10 All ppd. Contact Cal Eustaquio, N6KYR/8, 823 W. Shiawasee St, Lansing, MI 48915, catman351@yahoo.com

ZIM ELECTRONICS INRUSH CURRENT LIMITERS

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

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

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



Model AB1-M

Electric Radio Store
720-924-0171

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

FOR SALE: 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

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

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

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

WANTED: Elmac PMR-7 or PMR-8 receiver parts unit. Jerry Gold, K2SCI@aol.com or 718-472-8439.

FOR SALE: Tubes tested good globe 224 $6, 226 $8, 227 $9. Write or e-mail: tubes@qwestnet 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

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

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

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, PO Box 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

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

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

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

WANTED: Eico Model 320-322 basket case only signal generator. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

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: Triplett meter Model 327T. This is 0-500 mA movement, and 3X3 inches square. Bob, WBØDMC, 1-507-331-5103. I am ok in QRZ.

WANTED: All four knobs for National Select-o-Ject. W5SUM, Ronnie, w5sum@glowbugs.com or 318-688-1389

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

WANTED: Manuals, copies or operating instructions for Farnell PSG-1000 RF Signal Generator.Kirk Ellis, KI4RK, 203 Edgebrook Drive, Pikeville NC 27863. 919-242-6000, e.kirkellis@netzero.com

WANTED: A WIRE RECORDER? 1'm looking for a Crescent type (Not Webster Chicago) Wire Recorder Transport Mechanisms. Complete units OK. I need the Record/playback head, P/N WR37-C, for a restoration project. WIQWW, 207-427-3770. arnie@midmaine.com

WANTED: QSL cards from W6JYS, Carl Lunghart. Clayton Vedder, 1037 Route 23A, Catskill, NY 12414

WANTED: Bezel and push buttons for a Philco model 42-395 console radio. Finder's premium paid. Ed Allen, 17677 Stonewall Rd, Prairie Grove, AR 72753, 479-846-2442

WANTED: Black wrinkle cabinet for older HRO or junker for cabinet and parts. Jim, K7BTB, 928-635-2117 jeldgl@aol.com

WANTED: Low voltage power transformer for Heathkit Apache TX-1, P/N 54-65. Bob, KL7HDY, 907-346-1044

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: Bias and filament transformer from HT-33A or B, also HT32B transmitter parts unit. John, W8JKS, 740 998 4518

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

WANTED: Hallicrafters SX-73/R-274D junker with good main tuning capacitor. Tom, W4PG, wtw@rti.org, 919-382-3409.

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: Altec Lansing horns: 811B, 511B. Drivers 808-8A, 806-8A. Ron, 262-673-9211, karenson87@yahoo.com

WANTED: Zenith chassis with speaker, model # 12S-232 or near equivalent for Walton cabinet. Please contact: Mike Grimes, K5MLG; 5306 Creekside Ct.; Plano, Texas, 75094, 972-384-1133. k5mlg@verizon.net

WANTED: National NC-183DTS speaker, NFM-83-50 adaptor and SOJ-3 Selectojet. Contact Ric at C6ANI@arrl.net

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

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

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

WANTED: Any TMC equipment or manuals, what have you? Will buy or trade. Brent Bailey,109 Belcourt Dr., Greenwood, 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: 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: 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: Postcards of old wireless stations; QSL cards showing pre-WWII ham shacks/equip. George, W2KRM, NY, 631-360-9011, w2krm@optonline.net

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

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

The Caps Are Back!

By popular request, we are offering another run of the popular Electric Radio baseball caps. These new caps are a nice 5-panel all-cotton style with an adjustable rear headband and a 3-inch front brim. The background color is light tan, and the ER logo is embroidered in 3 colors, not printed. These hats will hold up for a long time.

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720-924-0171
Or on-line: www.ermag.com

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

WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI 16 Carly Drive Highland NY 12528. 895-691-6247

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

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

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

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

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

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

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

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

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

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: 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

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

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

WANTED: JB-49 Junction Box, BC-731 Control Box, DY-17 Dynamotor. Rick Brashear, K5IZ, rickbras@airmail.net or 214-742-1800

DONATIONS WANTED: Southern Appalachian Radio Museum, Asheville, NC, where others can view your radio treasures. For general information or donations call Clinton Gorman, Curator, 828-299-1276

WANTED: WW-2 IFF Equip FM-80 rack BC-126F RA-105A 1-221, BC-1293. Will pay top dollar. Steve Bartkowski, 1-708-430-5080, 7702 Austin Ave, Burkank, IL 60459

WANTED: Info on Jerrold 704B calibrated field strength meter. Any info at all. Ed Kalow, 612-788-7976, 712 36TH Ave NE, Minneapolis, MN 55418

WANTED: After many years of faithful CW service the power transformer in my DX-20 has given up the ghost. Anyone have a junker DX-20 or the power transformer out of one? Heath P/N 54-54. Ron, W6OM, Cell:949-533-7958, QTH: 949-559-6209

WANTED: Jackson Brothers ball drive dial. **FOR SALE:** Portacab cabinet, 8x12x9, Bud #1541, NOS, $20 postpaid. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

WANTED: R-388 in good condition, please contact Mike, VE7MMH, at mike46@shaw.ca

WANTED: Manual and/or schematic for Conar Model 452 two meter FM transceiver. Kirk Ellis, KI4RK, 203 Edgebrook Drive, Pikeville NC 27863. 919-242-6000, ki4rk@arrl.net

HUGE VINTAGE ESTATE SALE: SASE for complete list of rare transmitters, receivers, accessories. David, POB 323, Metamora, MI 48455

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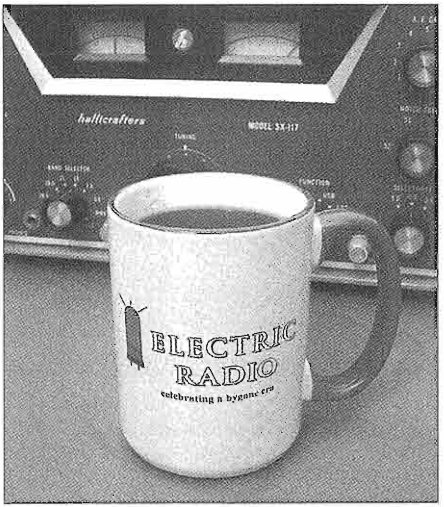
Fairchild 1N4938 switching diodes are still available in packs of 20 for $10.
See Ordering Info, page 63

Electric Radio T-Shirts

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



Electric Radio Coffee Mugs!

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

$13.99, including priority shipping within the US.

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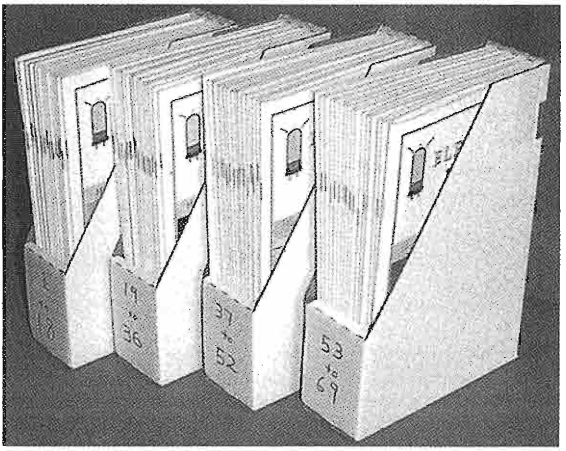

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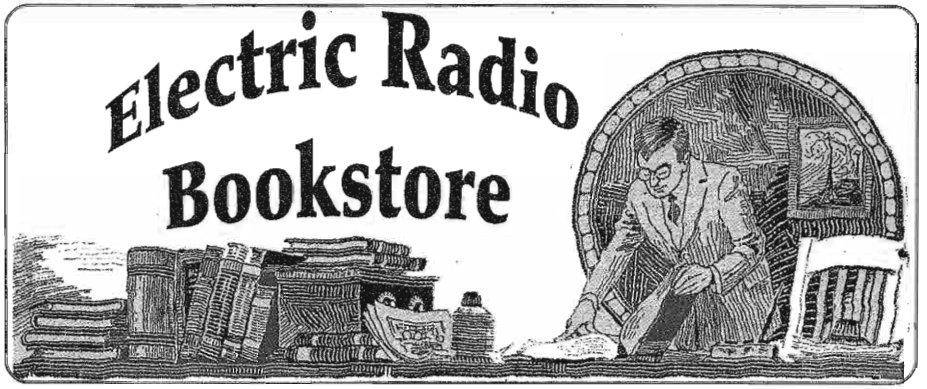
Set of 20: $22.75 + $7.45 S&H

ER Bookstore, 720-924-0171
PO Box 242, Bailey Colorado, 80421-0242
Or order on-line at WWW.ERMAG.COM



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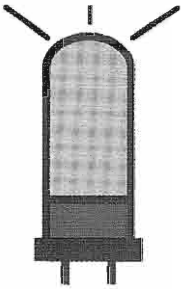

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