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ELECTRIC RADIO

celebrating a bygone era

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ELECTRIC RADIO

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

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

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

Editor's Comments

Everyone that I've spoken with this month mentions how quickly another Christmas season has arrived. I feel the same, and I hope everyone has a Merry Christmas and a happy and prosperous 2006. Thanks to all the readers and excellent contributors, Electric Radio is doing well.

Holiday Special Event Activities

Quite a few special events are occuring during the holiday season. Please remember to send in your event notices at least two months in advance so that I can print them before the special event happens.

KØOJ reports that his Thanksgiving Day "AMI Bash" in Colorado had 48 AM checkins on 3875 kc. OJ mentions that this was an average number of participating stations.

There will be a New Year's Day AMI Bash on 3875 kc on January 1. Either KØOJ or Mike Wells, WØFD, might be the net host. Listen up starting about 6:30AM Mountain Time, January 1, to join the fun.

New Postal Rates

Electric Radio subscription prices will not be increasing, although new postal rates go into effect January 8, 2005. We will be changing our shipping rates slightly to compensate for the increased costs, said to be about 5.4 percent in all categories. I tried to contact the post office about changes in the permitted mailing costs for the monthly Electric Radio mailings, and I did not get a clear answer.

On November 14, 2005, the US Postal Service issued News Release No. 05-097. Quoting in part from "Governors Approve Change In Postal Rates," "...This rate increase...is needed to fulfill...a federal law passed in 2003. That law requires the Postal Service to establish a $3.1 billion escrow account, the use of the funds to be determined by Congress at a later date."

The rates are going up, but they don't know what the funds will be used for, and "wouldn't have been necessary without the law!"

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Cover: From the cover of Radio Magazine 80 years ago this month, "Santa" is trying out a new two-dial radio set, complete with a fancy loop antenna, while everyone else is still asleep!

Restoring Life to a Vintage Tube Tester

By Tom Marcellino, W3BYM
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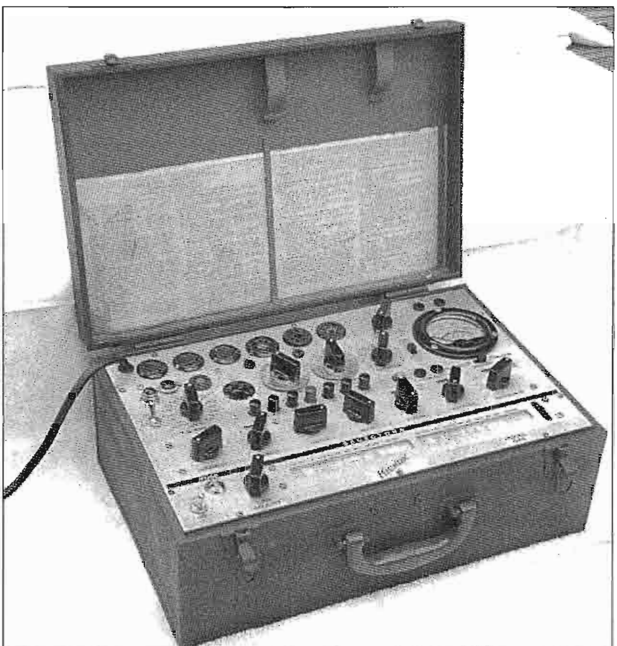
This article is about putting life back into a Hickok Model 546 tube tester. Its life began back in the last century, perhaps as early as 58 years ago. Before getting into the technical portion, I want to tell how the tester came into my possession. During one of our visits to Western PA, my wife Betty and I spent a few days with WN3B, Mike, and his wonderful wife, Patty. On this particular visit Mike's mom, Kathy, and husband, John, were in from Arizona for a summer visit.

As usual, Patty had planned some fine dinning on tube steaks, corn, and salad. The corn was a very special treat because during the course of the evening it became known as "shovel corn." Mike had built a large bonfire for the evening chat but it had one additional purpose, cooking the corn. By the time the fire had burned down to a bed of red coals it was nearly dark. The corn was placed into the coals, husks and all. Now, all this was Patty's idea as she had eaten it before, but didn't have any idea how the corn was prepared. She did know to soak it in water for at least 24 hours.

So, Mike had the chore of moving the coals with the shovel using only the light from the red coals. We all agreed that about 15 minutes should be long enough for the cooking process. By this time it was really dark, and a shovel was used to extract the finished products. Right away, John and I grabbed two ears and started peeling back the husk so it could be used as handles. We both soon found out that the corn was too hot to handle so a five minute cooling time was invoked. Now, here is the best part. Patty had melted a pound of butter and poured it into a large jar filled with hot water. The butter floated to the top where the corn cob could be inserted and removed and throughly enjoyed! Now, you can try you hand at some fine tasting "shovel corn" while spinning a few yarns around the bonfire.

Earlier that evening, Mike and I had disappeared into Studio G, aka, the garage shack. I hadn't seen his latest inventory of two additional Gates



The Hickok Model 546 has been completely restored with a fresh coat of textured green paint.

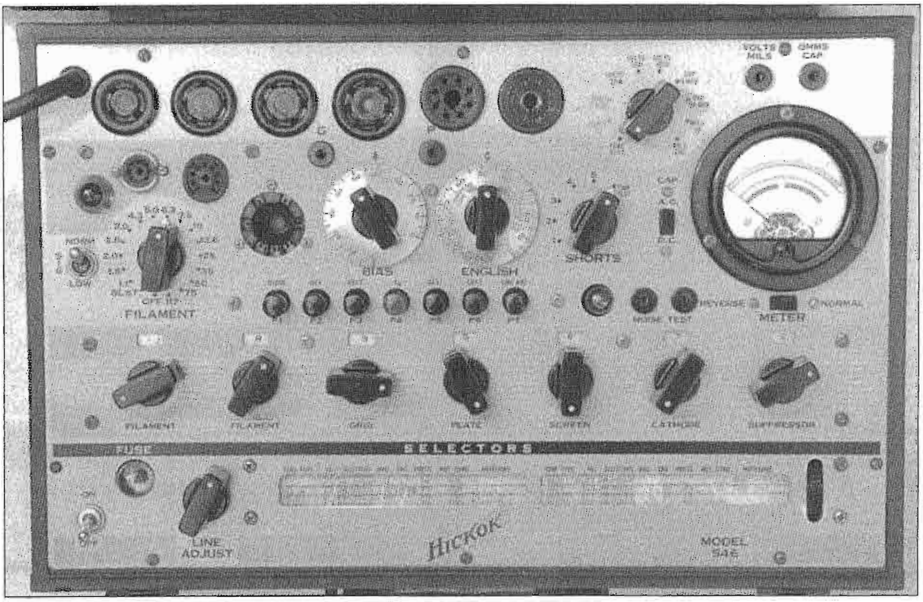


Figure 1: The instrument's front panel was in amazingly good condition and it just needed a light cleaning.

transmitters. Think I will make him a new sign for the door that reads GatesVille, because he now has four lined up in a row.

As Mike was showing me some other treasures he had in stock, he spotted a rusted looking box on the bottom shelf. He pulled it out and commented "Tom, you need this."

I replied, "OK, but what is it?"

He lifted the lid and a Hickok Model 546 tube tester appeared. He then commented that it would make a fine article for ER, but of course I would have to do a little repair work. My comment was "OK, winter is coming and I'm getting low on projects."

Mike's final words were something to the effect that if I took the tester I couldn't return it. So, he took it outside and used a large wire brush to remove some of the rust before putting it into the trunk of Betty's car.

The Model 546 is a dynamic mutual conductance multi-tester that reads directly in micromhos. It is designed to operate on 60 cycles from a 110-125 volts AC power source. It also operates on frequencies of 50-400 cycles with 110-120 volts AC.

I have two other tube testers which I've restored. One is a Hickok Model 600A and the other is a Sylvania Type 140. Neither of these testers have some of the features found on the Model 546. The Model 546 can test for noise within a tube by connecting it to the antenna terminals of a radio receiver. As mentioned before, it measures mutual conductance and it tests for shorts between tube elements. It contains VOM functions of DC voltage to 1000 volts, ohms measurements to X1000, capacity measurement to 50 µF, and DC current measurements to 200 milliamperes. Although not indicated by a meter scale, the Model 546 can measure inductance and decibels. So, you can see this was a very versatile instrument for its time.

It is not the intent of this article to go deep into the technical end of tube testers or discuss in detail all the measurement parameters or techniques, mainly because that isn't my area of expertise. However, it would be prudent to talk briefly about emission and mutual conductance testing as extracted from several references.

The three testers that I have are not emission testers. By definition, the emission test is to ensure that the cathode emission is adequate to provide the peak and average space currents for the particular application. The test is usually performed by applying a direct positive voltage to all grids connected together to the plate, and by measuring total cathode current. Thus, it is a very simple test in terms of the required circuit, but it is a static test by design and this alone may be a limitation. It is obvious that the emission test is a potentially damaging test due to the excessive cathode current resulting in excessive dissipation for the grids. There are additional concerns with emission testing. The test must be long enough to get an indication but not too long as to contaminate the emission. A duration of 3 seconds was generally accepted for this test.

On the other hand, the mutual conductance test has virtually no test time limit. The terms mutual conductance and transconductance are very close in definition with the latter having the ability to be more strictly defined as a small change in plate current divided by a small change in control-grid voltage with all other voltages remaining the same.

The symbol for mutual conductance is "Gm," expressed in µmhos. The mho is a unit of conductance and was named by spelling ohm backwards. For convenience, a millionth of a mho or "micromho" is used to express mutual conductance, or transconductance.

Now, that's enough of the technical stuff, so let's move on. When I got the 546 home I was afraid of what I would find on the inside, based on a totally rusted, all-steel outside case. But, I was pleasantly surprised to find the inside of the instrument in reasonable condition. The tester had not been immersed in water as I had originally thought.

What I found were the typical white spots, here and there, due to the high-moisture environment and also numerous spider webs. So, the first order of business was to clean up the inside with a clean paint brush.

Next came a good internal inspection. As you can see from the internal photos, the major components are switches. So, the next task was cleaning all the switch contacts and wiper arms. If you stop and think about it for a moment, tube testers in general have relatively few parts, hence the potential for failure should be low–wrong!

The main component of a tube tester is the power transformer. If it has gone West, the tester becomes a good parts donor. There are several rotary and push button switches. What could go wrong here, other than dirty contacts? You can see two vacuum tube rectifiers, but no filter caps. Yes, tubes do wear out, so here's a place for failure. Other than several feet of connecting wire, there are many resistors, a few small coupling capacitors, and an indicating meter.

The 546 had its original two-wire power cord, so the next order of business was to change it over to a three-wire grounded cable. After doing that, it was time for powering it up on a Variac. The results of this test were not good. The panel power lamp did not light and there was no filament voltage, nor did the two internal tubes show filament voltage. Did I have a parts donor, or was there a fuse problem? The fuse in the 546 is a #81 bulb that is panel mounted. It was removed and it checked OK.

Next, I tried to measure the secondary voltages from the power transformer and all terminals measured zero. Things certainly were not looking good at this point. So, the next step was to measure the 120-volt AC primary circuit. This revealed no

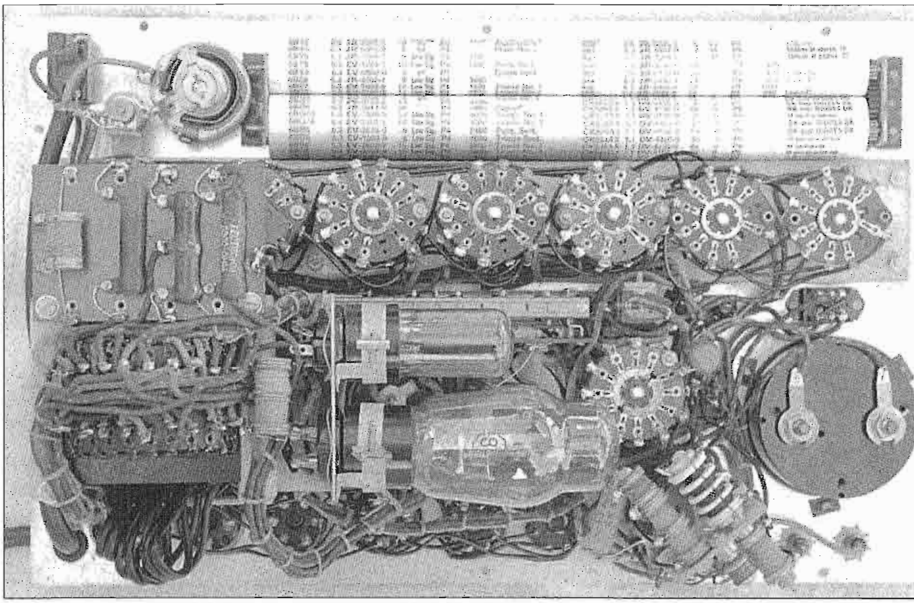


Figure 2: This internal view of the Hickok 546 shows the many wirewound resistors and the two rectifier tubes.

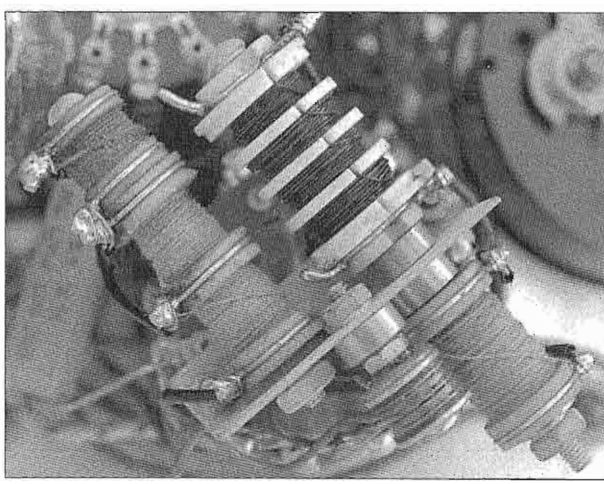
voltage on the power transformer's primary. I quickly found the culprit was the main On-Off switch. It was one of the early laminated types that seem to always have a problem.

After replacing the power switch, all filament voltages were restored but the pilot lamp still wasn't working. Inspection in that area showed a broken socket tab. The tab had pulled from the end rivet and a little soldering fixed that problem.

Now, I thought all was well and I could start testing tubes. Well, you know that wasn't the case because there was no meter indication at this point for Line Adjust or Mutual Conductance.

I mentioned earlier that the tester uses many resistors. You can see them in the internal photos. There are a couple of wirewound (WW) power resistors mounted to a board in the upper left of **Figure 2**. Also on that board is one WW resistor that is wound on a wood bobbin, see **Figure 2A**. This was the technology in the late forties to make precision resistors using cotton-

Figure 2A, below: A close-up view of some wooden-bobbin WW resistors used in the model 546.



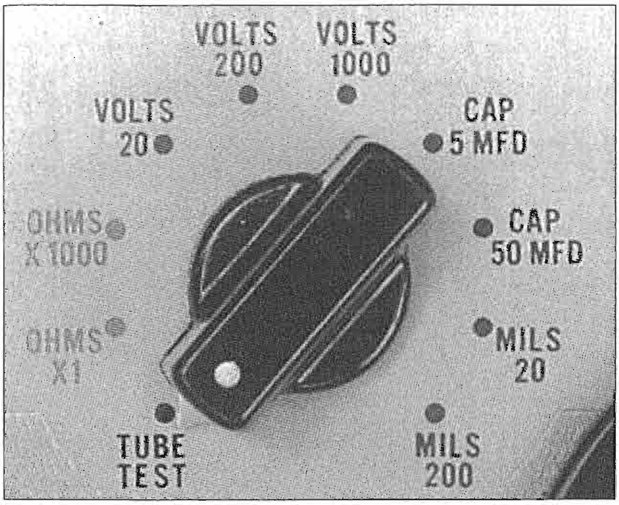


Figure 3: The tube tester's function switch has color-coded lettering that matches the meter scale colors.

covered nichrome wire, machine wound on small wood bobbins. The tester was filled with these precision type resistors that mostly used #40 wire.

Now, consider the high moisture environment combined over time with #40 cotton-covered wire and what do you get? The answer is micro corrosion that leads to open resistors. Several of the

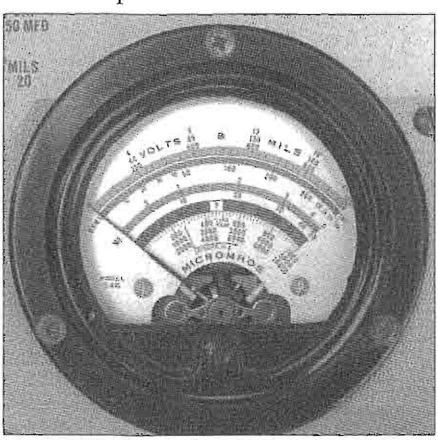


Figure 4: The meter, fortunately, showed no ill effects from the moist environment the tube tester had been stored in until disassembled.

resistors survived this environment, but about a half dozen were open. The failed units were easy to ID using a VOM.

Repairing them was another matter. First off, the #40 wire size was so small that these 66-year-old eyes had extreme difficulty seeing a single strand. Worst yet, some of the failed resistors were open at the bottom layer. Bear in mind that these machine-wound resistors had several feet of wire wound on the wood bobbin.

In the case of a bottom break, near the external solder connection, all the wire was removed and the resistor was rebuilt. Some nice person's job during manufacturing was to hand write, in black pen on the edge of the bobbin, the value of the resistor. This was an immense help during the testing phase of each resistor, whether it had failed or not.

The restoration was at the point where all components were tested and/or repaired, so the 546 should have performed well. I've been wrong before and this time was no different. There still was no indication on the meter for "line adjust" or "mutual conductance."

The last part remaining was the meter.

I was hoping the meter was OK, because they are a delicate component to repair.

But, since it hadn't been looked at as part of the total restoration it was necessary to clear it from the list. The meter was removed and its dial scale was removed, revealing yet another bobbin-wound precision resistor. Yes, you guessed it, this resistor was open. With a little effort, the open resistor was removed. The top layer was good to the end solder contact, so the only thing left to do was start removing the layers of wire. After removing several feet, I found the open spot, with several feet still remaining on the bobbin.

At this point it became a no-brainer. I wouldn't be able to make the repair with the original wire and I didn't have any resistance wire in stock. The next best thing was to come up with a combination of resistors to match the hand written value on the wood bobbin. This was done and the meter was reassembled into the panel. Power was applied to the tester and now I was in business. The meter worked–almost. It stuck half way up the scale. The pointer was rubbing on the meter glass. So, it had to be removed again from the panel and disassembled to correct the problem.

The 546 was now working for testing mutual conductance, but what about the VOM and other functions? When the function switch was placed in either the ohms X1 or the ohms X1000 position, the meter was supposed to go to full scale. The meter didn't deflect at all on the X1000 scale, and went three fourths up the scale in the X1 position.

Now, I had another problem to solve. The ohmmeter scale resistors were tucked between two wafers on the function switch. Simple VOM measurements showed another open resistor. This resistor was different than the previously repaired types. It was a spiral-cut, thin-film ceramic resistor. A look into the junk box turned up a 15-k, 2-watt carbon replacement. Looking at the front panel photo, **Figure 1**, you won't find any Ohmmeter Zero adjustment. So, how is the zero operation performed?

When all else fails read the manual! The Line Adjust pot performs the zero operation, or in this case, it adjusts the meter for full scale when the function switch is in either "Ohms" position. Then, shorting the probes will zero the meter. The Volts, Cap, and Mils scales were checked and all were perfect. Now, that was one more problem solved. The use of the 5% carbon replacement was acceptable, since the full scale is adjusted using the Line Adjust control each time the ohms function is used.

As far as calibration of the tester goes, I didn't find any internal adjustments for this purpose. There are no internal voltage regulation circuits either. When testing for mutual conduction, the only calibration is the front-panel Line Adjust. This control is connected in series with the 120-volt AC line and the primary of the power transformer. Therefore, when this control is turned all voltages will change, including filament, signal, and DC potentials on the tube elements.

The only performance test that made any sense to me was to verify the 16 switchable filament voltages with a RMS reading AC voltmeter. These measurements were made with the tester's meter set to Line Test using the Line Adjust. All readings were within very acceptable tolerance given the age of the instrument. If I'd had the design job of labeling the controls, I would have picked something other than "Line Adjust." A name like "voltage calibration" would be a more accurate title.

The Hickok manual described one interesting test that can be performed, giving an indication of a tube's reserve life. The tube is tested for mutual conductance in the normal manner. Then the English dial is turned until the meter is reading up into the green area at "700" on the 1000 scale. A tube with a nominal filament voltage of, say, 6.3 volts is then reduced to 5.0 volts. If the reading remans in the green area, this indicates a large life reserve.

In the previous paragraph I mentioned the English dial. Not until the 546 restoration did I know or understand what in the world "English" meant when used in this context. The manual gives a very confusing and somewhat contradictory explanation of this dial. Basically, "English" refers to the red and green areas on the panel meter. So, the tester can be set up like that old drug store tester to read "Red" or "Green," or in other words, "Bad" or "Good." In my opinion, the English red and green areas should have never found their way into this level of tube tester.

Like the label on the Line Adjust control, I would have assigned another name to the English dial. Forgetting the red and green nonsense, the English dial has three marked settings for changing the "μmhos" range on the meter. The meter can read either 1000, 5000 or 10,000 μmhos, full scale, by setting the English control to the proper position. These settings also are intermixed with the level of grid signal, which can be either 1 or 5 volts. I would have labeled the English dial, more accurately, "Micromhos Range."

When I first started this restoration I didn't have a manual. So, the project got shelved until a manual was purchased. But, as it turned out, the manual, and more importantly the circuit diagram, wasn't required to make the tester fully operational. The two key factors leading to rapid analysis and repair were the high moisture environment it had been stored in, and the type of construction of the precision WW resistors. Combining these with a little common sense was all that was necessary to complete the job. There was no need to do any circuit tracing or head scratching. It was just a slow, logical, and methodical process to find the bad part and make a good part.

Selected References:

1. F. Langford-Smith, Editor, Radiotron Designers Handbook, Wireless Press, 1952

2. Receiving Tube Manual, Technical Series RC-23, RCA, 1964

3. The Hickok Electrical Co., Operating Instructions for Model 546 Tube Tester

ER

Design and Build

A Simple WARC-Band Converter, Part 1

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This article presents a simple receiving converter offering techniques, design, and learning opportunities for those interested in building something useful.

Contrary to public image purveyed in many media, I am not convinced the art of home brewing our equipment is completely dead. The pulse may be weak, but at least on CW and AM, there are many home brew rigs on the air. Along with the true HB rigs are kits which frequently see modifications and improvements to meet the builder's particular interests; I find this quite encouraging. Another arena for building is vintage-type gear and vintage clones. There seem to be more vintage radios than home brew stations being used on the HF bands and I'll admit they are a kick to use, but home brew is special, and from the other end of the QSO, a well built home brew transmitter can not be identified from store-bought.

Many of the older transmitters have wide range transmitting abilities, some using heterodyne oscillators which will allow transmission anywhere between three and 30 MHz, while others only need a crystal or to have a tank circuit tricked-out to cover just about any frequency you want.

Receivers, however, are a different story. Many of the older receivers cover more than just the Ham bands, but I can't identify one which will properly hit the WARC bands. Sure, the general coverage/Ham band receivers will hit the WARC bands, but the band spread is usually narrow, and with the new bands

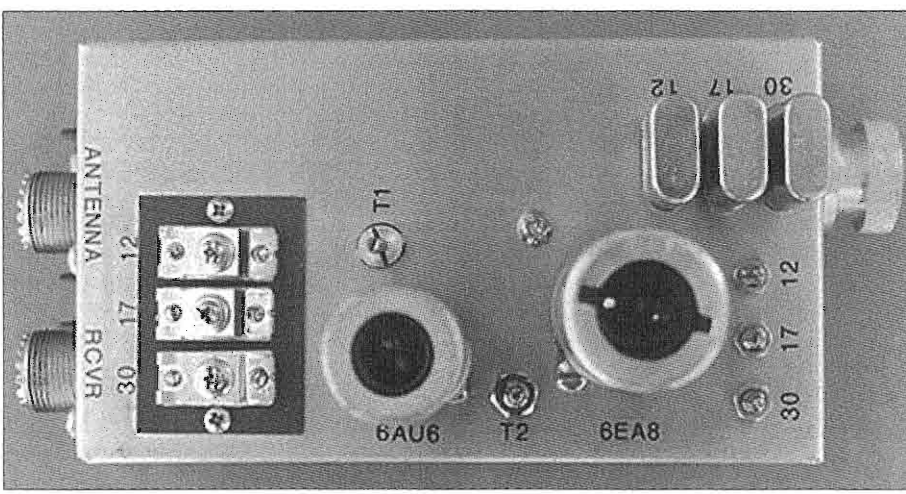


Figure 1: Clean, easy-to-read decals mark all adjustments and removable components. A Brother P-Touch® labeler was used, black ink on clear background. Trimming the finished decal to close tolerance on the lettering and manipulation by tweezers gives clean lines, and until the light hits it just right, can not be told from ink on metal.

being so minuscule, it's only a fraction of a knob tweak and you are out of the band.

Although my own home brew all-band transmitter has been my primary rig for a few years, I've not been able to enjoy the WARC bands as I haven't owned a suitable receiver. OK, my SX-101A will hit 30 meters in the WWV position, but the band spread is miserable and the tuning so non-linear it is hard to tell where I am. Additionally, the 101's particular habit of lighting up the entire dial on 10 MHz it is a bit daunting. I wanted to be able to use both my 75A-4 and the '101A on the WARC bands.

In my youth, the standard approach to covering bands you wanted but did not have was with a converter. From mobile rigs which used a converter ahead of the car radio for reception (OK, that was AM only, I know) to VHF bands which were converted down to some lower frequency and used your station HF receiver as a tunable IF (Intermediate Frequency), converters work! The basic operation of a converter is exactly the same as the front end of a brand new transceiver from Japan. In fact, the entire superhetrodyne or super-het principal is buried within converter circuitry.

It would be in poor taste for me to show pictures of my little converter, print a schematic, and wish you "good luck." I believe those days are gone. For those interested in rolling your own, and for those who have not found a local Elmer, I am offering encouragement. Although you can't purchase necessary parts new, quite likely you will be able to make some of the parts you need. Be flexible in your design and don't be intimidated, it ain't brain surgery, it's Ham radio. I can't resist suggesting this is an ideal project if you want to start building RF circuits, even if you don't need a WARC band converter, perhaps you would like 160 meters or 60 meters. This simple circuit will expose you to basic theory and construction of just about anything you will ever want to do. Oscillation, tuned circuits, amplifiers, impedance matching, mixing, switching, and if you build an outboard power supply rather than steal power from your existing receiver, you may pick up another talent or two. This project is simple enough so you should succeed, but is also sophisticated enough that you can easily see your failures and quickly determine the corrections required. Also, if you have been wondering how to use that scope you bought at Dayton three years ago; this will be a good exercise in developing trouble-shooting habits.

The point of a converter is to move one frequency to another. Simply put, the RF signal you want to receive is mixed with a LO (Local Oscillator) and the result, the IF, places the desired signal at the frequency you select. In reality, there are at least four signals within the mixer, the original RF, the original LO, the sum of the RF and the LO, and the difference between the RF and the LO. The four different products (and there may be many more) should stay within the mixer, and by selective filtering only the desired product exits. Some consideration must be given to the individual frequencies involved to assure enough separation of the component signals so you can selectively filter the one you want to use while discarding the others, as well as what else may be on that frequency which could cause interference. Placement of the LO will also determine if the receiver tunes conventionally or backwards. We've all seen receivers which, on a particular band, tune from the low frequency on the right, to the high frequency on the left. That is upside down, and is a product of the relationship of RF to the LO. Sometimes it is a wise choice considering cost or complexity. I view it only as an unnatural inconvenience. Most mixers have loss, meaning the desired IF output signal is less than the original RF input level. Conversion gain exists in some circuits, but don't count on it. To keep from losing signal through the mixing process, an input tuned circuit or even a preamp is common, boosting the input signal so after some loss in the mixer you still have your original signal, just on a different frequency. Additionally, the tuned input and/or preamp prevents the LO and mix products from being connected directly to the antenna, which can radiate what you thought to be internal signals. In summary, to make the whole converter work you need a tuned input stage to filter out unwanted signals and offer some gain, perhaps a preamp stage, a local oscillator to generate the specific mix frequency you need, and a tuned output tank in the mixer to amplify the desired IF and perhaps offer just a bit of gain. Simple!

Defining the Project

For my own reasons, I imposed two limitations on this project: It would use vacuum tubes and the entire project would be built with parts on hand, not one cent would be spent on it. The basis was, I hadn't built a tube mixer in years or financially recovered from my transmitter yet, and the radio budget is tight!

For me, the first logical output for the converter is the ten-meter band. Every Ham receiver has ten meters. Additionally, being such a wide band, although the band spread may be less than on a smaller band such as 40 meters, the band spread seems adequate and 28 MHz solved other problems. It would be nice to keep all converter outputs, 30,17 and 12 meters, on one band of my receiver, therefore less band switching. The ten-meter band is frequently not busy, so feedthrough problems are also negated. Band layout is still another benefit for this choice. For 30 meters, which begins at 10.1 MHz, if the converter produces 28 MHz output for 10 MHz input, it will automatically offer WWV for calibration and propagation checks at 10 MHz, and the true band spread would align perfectly with 10.1 MHz showing as 28.1 MHz. All I have to do is remember what band I am on and the logging/band spread scale on my tunable IF will be accurate. For 17 Meters, which begins at 18.060, I would again use 28 MHz as 18 MHz giving the same accuracy in tuning and tracking. For 12 Meters, the band would begin at 28.5 MHz, equating to 24.5 MHz, again offering accurate dial readings.

Not trusting my arithmetical talents when it comes to mixers, many years ago I made an Excel® computerized spread sheet to do all of the hard stuff for me. In this case, I entered the lowest frequency I want to cover, and the frequency I want it to appear on. The spread sheet then calculates the LO frequency, all mix products and by default, only accepted "right side up" tuning. The resultant spread sheet indicates the specific crystals I would need to achieve my desired ends. Now, this may seem incredibly simple, but by the time I finished this project I again appreciated the "facts only" spread sheet. If you think about this conversion scheme, 10 MHz is converted with an 18 MHz crystal, (10MHz signal + 18 MHz LO = 28 MHz IF out) and 17 meters, which just happens to be 18 MHz, is converted with a 10-MHz crystal. When working with crystals, tank circuits and band switch positions it is easy to nonchalantly interchange megahertz with meters, I still have problems with it! As a well stocked parts box would have it, I had all necessary crystals on hand!

This converter is to be used in front of a vintage receiver, and although performance must be good enough I never need to offer excuses. The goal was not to outperform a 21st-century transceiver. There are no contests on the WARC bands, but they are a great place to go hide during contests. When a pile-up appears on a rare DX station, well, the old 'A4 even with outboard DSP shows her age, and I just move up the band, no roofing filters here!

A Good Plan Goes a Long Way

I am unable to begin any project without a good plan. I've found that paper is not only cheap, but convenient. I can doodle with a block diagram while waiting for an appointment, downloading from my dial-up ISP, or during other non- productive time. I can move stages or switching and power requirements around at no cost and little obligation. Such diagrams also offer me the chance to see where I've led myself astray. Rethinking switching and interfacing with other equipment on paper has been a great help in finishing a project and not needing to modify it. This basic converter uses only two tubes, a band switch tuned-input preamp stage, band switch selected LO, and a common IF output. This is certainly not a circuit for which I or anyone else can take credit. The basic scheme is simple, so there are limited variations. Reviewing older literature such as the Radio Amateur's Handbook by the ARRL, Radio Handbook from Editors and Engineers, and of course the Radio Engineer's Handbook by Terman, you can see what others have done and read their observations on performance and complications.

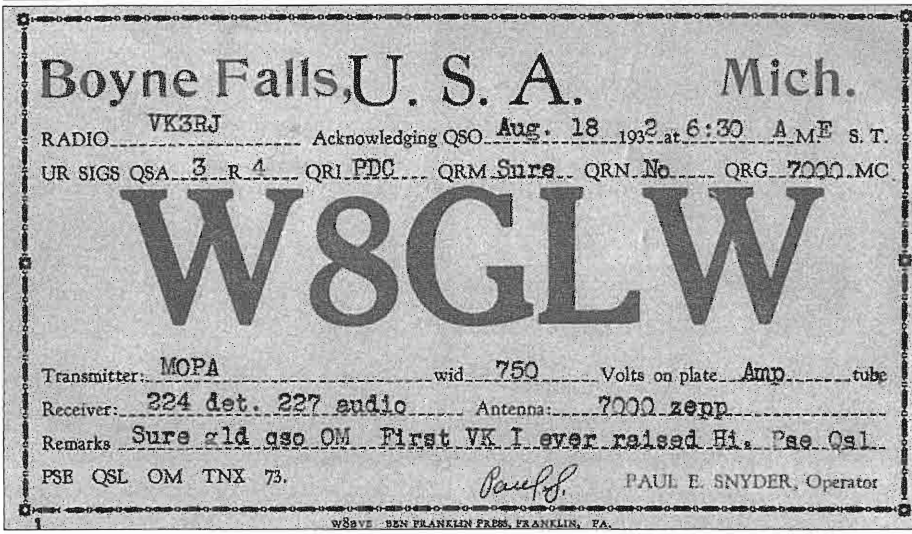
When you have established a plan, which may well be different from mine, you will still need to get individual stages perking. For even a simple project like this, I trust you have a reasonable signal generator, oscilloscope and hopefully a bench power supply. If you are "doing RF" work, and don't have something like the Almost All Digital Electronics (AADE) LC-IIB meter, you are missing the boat. I can't say enough good things about this meter. The RF world is just chock-full of inductance (L) and capacitance (C). I consider C the easy part, but L is a different story. Inductors are seldom marked, and more times than not, you will need to make your own. I've made hundreds of inductors, but only two capacitors come to mind. The AADE unit is unique, as it is made only for RF, it is accurate and incredibly easy to use. The meter facilitates winding your own inductors to make exactly what you want. If you have coil stock, you can just slide the probe along the coil and cut off exactly what you need. It works at least as well on capacitors. Other items you should have, hopefully in your library, are a couple of good reference works. Although "real hams" can recite necessary formulas for determining the values of components for tuned circuits, it is too tedious for me to perform the math. None of my calculators can handle the leading zeros, and I never properly learned how to use scientific notation. Every answer I determine is wrong! The reactance tables the ARRL and Editors and Engineers publish are just black ink on paper to me. My bedside companion since the late 60s has been the Handbook Of Electronic Tables and Formulas from Howard W. Sams. My old copy is a hard cover, but the book is still in print, paperback of course, and the current edition is still jam packed with information that should make your jaw drop. The great news is this book contains nomographs for everything you could want. Just place a straight edge through the two things you know (or think you know), and it will tell you the other one or two things you need to know. Literally, you can find the L, C and Z (impedance, expressed in ohms) for any frequency in less than five seconds. Or, if you have an old coil assembly, you can use the L and C you have to determine the impedance and frequency just as quickly. Buy the book, you'll thank me later.

To meet my previous conditions, I decided to use a 6AU6 for the input amplifier. It is a great tube, however, if you have a 6BA6, 6BH6, or the ilk, it will be just as good, perhaps better. I selected a 6EA8 for the oscillator/mixer, a 6U8 would be better, but not being on hand, it wasn't part of the project. Also needed are three oscillator coil forms, and two transformer forms. Yes, a shiny new slug-tuned coil form with the proper core material would be nice, but since we don't get to order them from Allied anymore, use what you have. This is HF, not VHF, nearly anything will work, and if it doesn't, you'll find out soon enough.

[Continued next month..Ed]

ER

PHOTOS



Boyne Falls, U. S. A. Mich.

RADIO VK3RJ Acknowledging QSO Aug. 18 1932 at 6:30 A.M.E S.T.

UR SIGS QSA 3 R 4 QRI PDC QRM Sure QRN No QRG 7000 MC

W8GLW

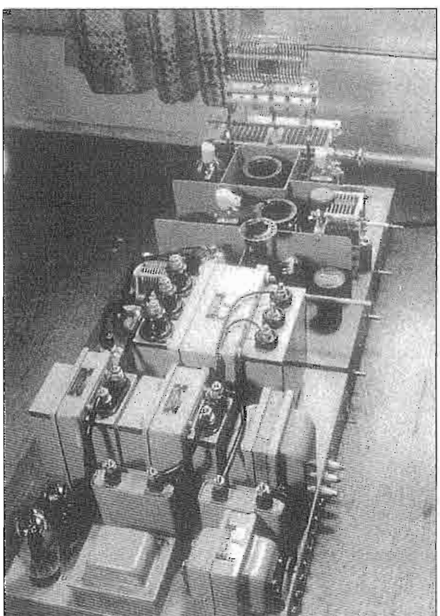
Transmitter: MOPA wid 750 Volts on plate Amp tube

Receiver: 224 det. 227 audio Antenna: 7000 zepp

Remarks Sure gld qso OM First VK I ever raised Hi. Pse Qsl

PSE QSL OM TNX 73. Paul E. S. PAUL E. SNYDER, Operator

W8AVE BEN FRANKLIN PRESS, FRANKLIN, PA.



The September 2005 edition of Electric Radio had Mike Monnier's (W8BAC) article about Paul Snyder's (W8GLW) shack that was closed for 43 years after W8GLW became SK. Mike sent in many great photos that we didn't have space to print at that time. This edition of the photo section features some of these pictures.

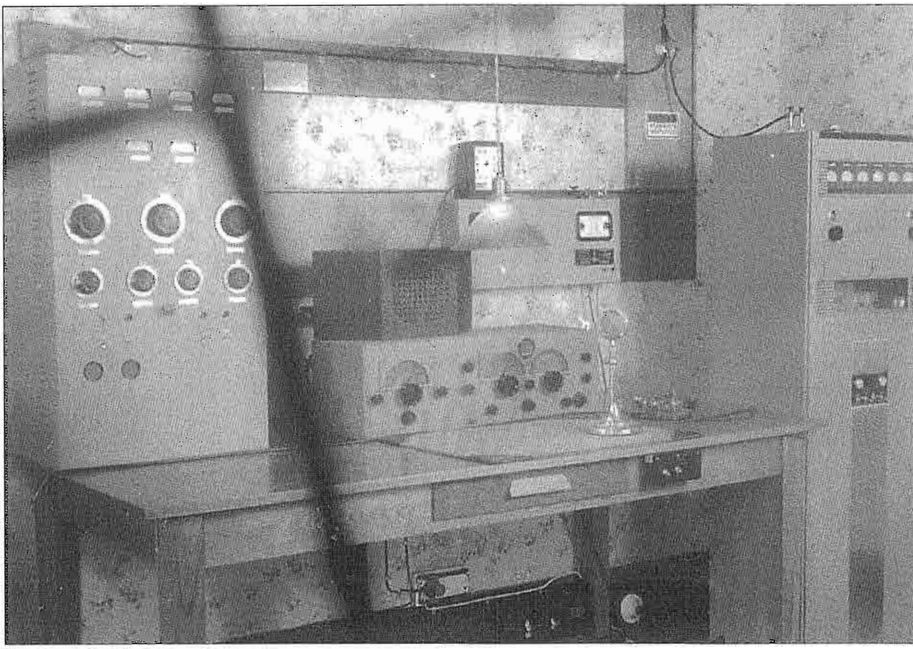
The QSL card above is from 1932, and was found in Paul's files. He had worked VK3RJ that summer with a MOPA transmitter and a 2-tube receiver, quite an accomplishment with rather simple homebrew equipment.

The photo to the left shows one of Paul's early heavy-metal transmitters. There was no caption on the original photo, but the layout uses Thordarson iron, and has a link-coupled output with large-sized coils in the intermediate stages. Perhaps an ER reader will recognize this design.

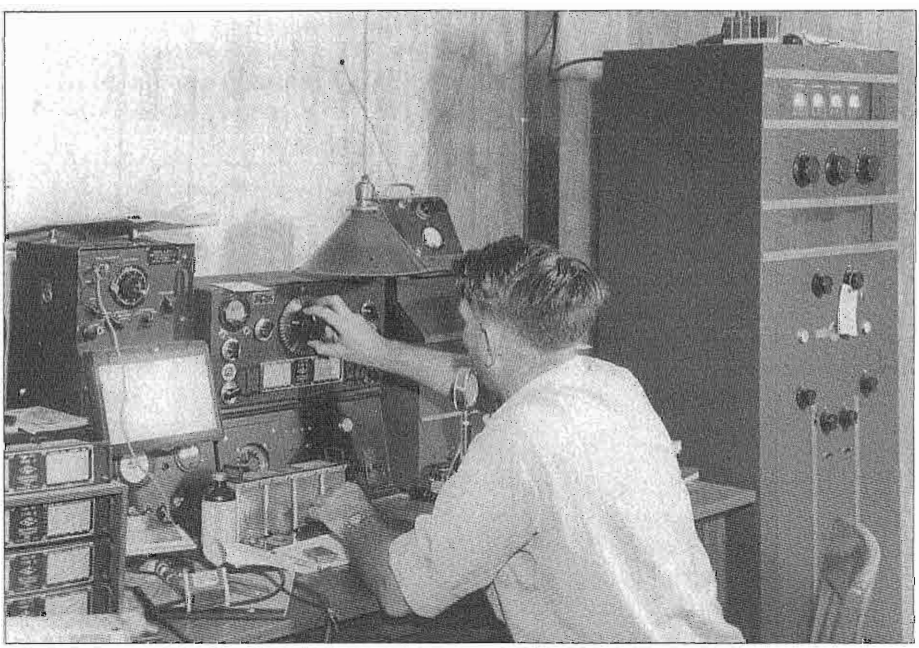
Above: Unfortunately, none of these old photos from W8GLW's files had captions and we can only speculate about them in 2005. The man above is unknown. From his style of dress, this photo was probably taken in the early 1930s, and might have been a friend of Paul's. The knobs and meters on the equipment he is holding also date the photo to this period. The rig is obviously an elaborate, well-built piece that used expensive parts; matched meters, engraved labels, and large, matched control knobs that have engraved scales. One wonders if this might have been commercial equipment of some kind.

Above right: An early view of Paul's shack shows that he was using a combination of homebrew and commercial equipment, but that his shack was in the same location as always. The unit on the left looks like a homebrew transmitter. In the center of W8GLW's operating position, we see that he was using an RME-69 receiver in combination with what is probably an RME ME-14 preselector. I think the ME-14 was only made during 1939, so that helps to date this photo. The RME-69 was a favorite receiver with phone ops for many years. I am nearly sure that the Collins transmitter on the right is one of the beautiful 30J rigs, and this means that his 30K that was pictured on the cover of ER #196 was not his first Collins rig.

Lower Right: This photo was labeled simply "Paul at Ham station" and was probably taken in 1947 or sometime later. He had probably just taken delivery of the 30K transmitter on the right, as the inspection tag is still on one of the control knobs. He has also upgraded to a new National HRO-5A1, which was produced during 1946 and 1947. The 310A exciter for the 30K is on the right side of his table. The necessary military surplus frequency meter is ready to go, and is on top of some homebrew equipment built into a small desktop console.



W8GLW's shack as it looked during 1939 or shortly afterwards.



About 10 years later, Paul Snyder is at the controls of a National HRO.

Above is one of the photos taken by Mike Monnier in early 2005 after W8GLW's time-capsule shack had been opened. In 1962, W8GLW still had the big 30K transmitter. A rather rare Mars linear amplifier is shown on the right of the operating table. He was probably using it with the modern Central Electronics 100V transmitter that is second from the left. The receiver shown here, third from the left, is a now-rare TMC GPR-90RX that had provisions for 10 crystal-controlled receive frequencies and an input for an external frequency synthesizer. **ER**

Article Corrections

Several corrections are necessary to update past articles. The cover caption for ER #196 should say that W8GLW was operating an Eddystone S-888A Ham-band only receiver, not a 680 series. Just to the left of the round Eddystone speaker is a model S-669 S-meter that wasn't used with the 680-series receivers. The round Eddystone speaker is aparently quite collectable in the UK. Thanks to G3UUR for these corrections.

In ER #197, "The DX-60: It Works CW Too," had three errors. On page 12, the new choke replaces R35, not R34. R35 was a 2-watt, 270 ohm resistor, not 100 ohm, 7 watt. R34, the 100-ohm, 7-watt HV filter should be moved back to between the positive terminals of C39 and C41 on the schematic. The screen dropping resistors R28 and R27 on the schematic, page 13, were reversed. The 68k should be in the AM position and the 10k is used at the CW position.

Also in ER #197, "AGC Modifications for the R390A and R-725" has some errors. On page 27, the zener diode at the cathode, pin 3, should be a 1N4738 for 8.2 volts. (1N4733 is a 5.1-volt diode.) On page 29, the parts list should show a 15-ohm, 1/2-watt resistor, not 5 ohms.

73, Ray, NØDMS

The AM Broadcast Transmitter Log

Part 6, Broadcast Audio Equipment

By David Kuraner, K2DK
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Thus far we have presented the RF and control side of broadcast transmitter conversion. For the nonbroadcast or nonprofessional audio experienced amateur, this aspect of employing audio broadcast equipment can be just as intimidating. As I suggested at the beginning of this series, it is not simply plugging in a D-104 and talking. Many books have been written and many fine articles appeared in ER over the years on this subject. What I will be presenting here is the condensed version of the subject, which, by necessity, covers some of the information presented in those original articles. Additional material is derived from original equipment manuals and my own experiences. Audio processing and monitoring will be addressed in sufficient detail for the inexperienced to understand and confidently implement them. The options can be overwhelming, but most of the time it becomes budget and opportunity directing this path. The subject will be presented in two parts.

The Broadcast Transmitter Audio Section

In the typical broadcast transmitter audio section, almost invariably, push-pull stages are used for their advantages. An AM broadcast transmitter of the period normally available to Hams needs to have noise and hum 45 dB below full modulation at a minimum. Also, the distortion needs to be low, typically less than 2%, and the frequency response needs to be flat. Ideally, it would be +/- 1.5 dB maximum at full modulation between 30 Hz and 12 kHz for really good audio response. In fact, an audio proof-of-performance test was performed each year to insure that these criteria were still met. The test included all equipment from the mike input at the mixing console to the output of the station's modulation monitor.

In addition to the push-pull stages, degenerative feedback is employed from the plates of the final modulators to the audio input so all stages are included in the feedback loop. A transmitter of that era might start out with a transformer input to the grids of push-pull 6SJ7s which are resistance coupled to the modulator tubes, either 4-400s or 833As. The feedback is accomplished with something like a 5-Meg, 5-watt resistor from each final modulator's plate, phased correctly, back to the grid circuit of the 6SJ7s. Feedback varies in models from about 8 to 12 dB. See **Figure 1**.

The input is designed to be fed with at least 1 milliwatt of audio into a 600-ohm load. This is the definition of "0 dBm" and it produces 0.775 volts of audio. It is commonly called "line level" and is considerably greater that the output of a typical Ham mike, either dynamic or crystal. Often, the audio input requirement is +10 dBm. The input is balanced, meaning that the audio is carried on a shielded cable (referenced to chassis ground) with two conductors inside for audio positive and negative phasing to the transmitter input. I will have more on this later. Included in the circuitry is often hum and noise canceling adjustment pots and bias adjustments to set the idling modulator plate current. This last adjustment is nothing more complicated than adjusting the PA idling current in a vintage SSB transmitter as you are dealing with a similar linear amplifier stage, only at audio frequencies.

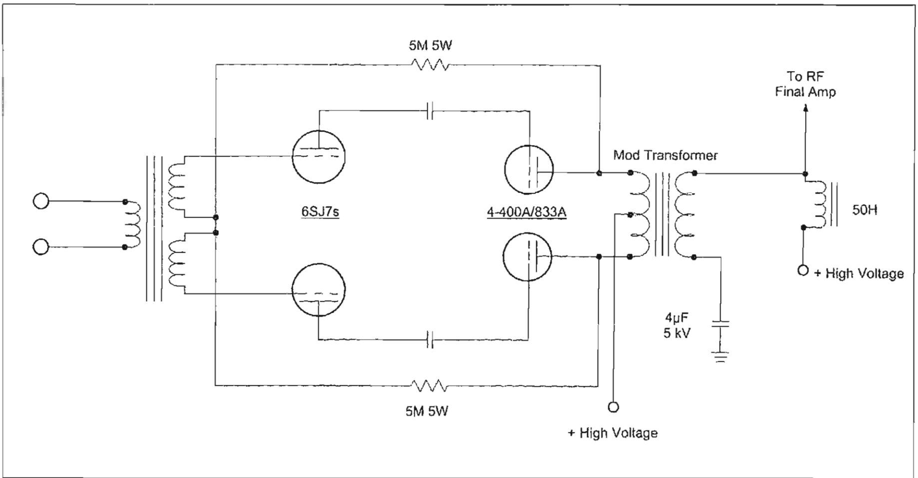


Figure 1: Simplified, partial schematic of audio stages showing the feedback path and a Heising reactor choke.

In a standard plate-modulated Ham transmitter, the final RF plate current runs through the modulation transformer secondary winding. The audio power from the primary is induced into the secondary, adding to or subtracting from the final RF DC input power to produce AM. The standard broadcast plate-modulated transmitter will not have the DC current running through its secondary. Instead, it is bypassed via a 50-H reactance choke, as is used in Heising modulator circuits. (The Heising circuit is one of the earliest forms of plate modulation.) Power is added between the top of this Heising choke and chassis ground through an oil-filled capacitor of about 4 µf from the modulation transformer secondary. This is all about not letting the modulation transformer saturate from both DC and audio currents, which would cause distortion.

The Broadcast Audio Chain

The typical AM Ham transmitter employing the ubiquitous D-104 crystal mike sounds nice. The mike has a natural equalization (EQ), which is perfect for communications, and if the transmitter can pass the full audio spectrum it really sounds good. The only thing that would aid here is a peak limiter to insure that 100% negative modulation is not exceeded. The reason that the series-cathode modulator I described in the April 2005 Electric Radio (#191) holds its own next to my big broadcast equipment is because it has an inherent limiter function. With no transformers in the circuit, it passes the full audio spectrum with no restrictions. The negative peaks can never exceed 90%. This is the epitome of the KISS (keep it simple, stupid) principle for audio processing equipment.

Since broadcast transmitters can not accept the D-104 directly, and they have no inherent negative peak limiter, external equipment is required to achieve this goal as an absolute minimum audio processing requirement. When I first started using my Collins 20V-2, I had no professional audio processing equipment and I had to make do with what I did have. And yes, it is possible to use a D-104 and here is how it can be done. This is the teenager-in-poverty method.

Connect your D-104 or other crystal mike to the Radio Shack 200-milliwatt audio amplifier (p/n 277-1008) which sells for about $11.95. This unit operates off a 9-volt battery and has an internal speaker. Connect the headphone output to a graphic equalizer with a 600-ohm impedance output and adjust the amplifier's volume control as needed for close to 100% modulation. A 600-to-600 ohm transformer should be used between the equalizer and transmitter input to convert from unbalanced to balanced audio. No, you don't have a limiter, but you do get balanced line level audio or more, which is what the broadcast transmitter wants to see. I know all the professionals are horrified by this lash up, but it does work and I had to employ it until I acquired the proper audio equipment. This audio system did the job, although not very elegantly, and hardly sounded like a broadcast station.

A broadcast station's product is sound and they want to maximize that product. So, to make the sound louder they compress it as well as limit the negative modulation peaks. Often a station will intentionally run over 100% positive peaks, which is perfectly acceptable in AM broadcast service. To do this, compressors, AGC audio amplifiers, equalizers and limiters are used before the audio is fed to the input of the transmitter. And, they don't use D-104s at the beginning of all this equipment. Modern processing equipment is digital. Fortunately for the amateur AM community, the older analog equipment is being replaced and has been showing up at Hamfests and on eBay. But, even new modern digital equipment can be very inexpensive.

Before getting into what's available, an understanding of the functions of each piece of audio processing equipment is appropriate. Starting with the microphone, if a professional condenser microphone is used, a 48-VDC phantom voltage is required to power it. Either a condenser or dynamic microphone will need a preamplifier to bring the audio up to line level. The mike level is typically minus 55 dBm. Next, a compressor will maximize the audio power. Then, an equalizer tailors the sound as required. Finally, the peak limiter comes just before the audio chain feeds the transmitter. The individual units can be combined in some rather inexpensive new digital equipment. Some pricey analog equipment combines many of the functions as well.

Microphones suitable for broadcast equipment can be had for $1 up to over $600 from various catalog and eBay vendors. Yes, I did buy a new "Hi-Ball" dynamic mike for $1 at a Hamfest; it is used on a Karaoke machine. It doesn't sound bad but there are no bragging rights. The top end is the Electro Voice RE-20 or RE -27 and similar microphones which are broadcast radio standards. Unless you want the bragging rights, something a bit less expensive will do for amateur use. There are plenty of microphones available from these catalog and eBay vendors. One mike often used is the Behringer B-1 condenser mike, at a street cost of $99. A much less expensive one would work just as well and probably sound about the same with EQ. The common thought is that the B-1 is a poor man's RE-20. But, I must emphasis that there are plenty out there that will do perfectly well for amateur use for much less money.

The microphone preamplifier can be a separate unit, a microphone mixer for multiple mikes or one of the modern multi-function audio processing devices. Economics and space should dictate which way to go. Even the phantom power supply can be discrete but why, if the function can be incorporated with another box? Many people use the Behringer VX-2000 Ultravoice Pro. It has all the functions needed except the limiter. Unfortunately, this unit doesn't seem to be available as new equipment. It recently sold for $89 refurbished from an Internet vendor. Similar devices are the VX-2426, DSP-1424P and DSP-9024 but might not have all the features. Alesis makes a dual-channel unit (MDX-4600) available for $99 with a compressor, lim-

Figure 2: In front of the my SX-101 receiver is the "Hy-ball" (right) and B-1 (left) mikes. Between the receiver and an Optimod 9000A is the CBS Labs Volumax 4000. Sitting on top of the Ultra-Voice VX-2000 is the Aphex DA and Monitor scope. The little Behringer Shark is beside the field intensity meter.

iter and noise gate. (The noise gate effectively turns off the audio during pauses in speech. It may not be desirable if you have a steady background noise which comes through as you speak; the constant noise may be preferable than the interrupted background noise created by the noise gate.) Look over those catalogs and the Internet vendors, as the market place seems to change constantly with new and even less expensive equipment.

A device, whose primary function is really not needed, (like the Behringer Shark DSP-110) can economically provide some of the required functions. The Shark is a device with a preamp, phantom supply, compressor, 12 filters designed to eliminate acoustical feedback and up to a 2.5 second time delay. It is available at this writing for a street price of $79.99. I purchased it for $50 including shipping. Look around, as inexpensive audio equipment is plentiful. And, there is no reason that this type of audio compressor could not augment a nonbroadcast AM transmitter. The high-impedance input, as used with a DX-100 or Viking II, can be bridged across the 600-ohm output with excellent results, although the audio level will be very high and an attenuator pad would be appropriate. (More on the attenuation pad next month.) And, in case you are wondering, time delay is used in PA systems so that the sound coming from a set of speakers at the front of an auditorium arrives in phase with the speakers in the rear.

Some of the discrete compressor type processing equipment available at Hamfests or eBay includes the Harris Solid Statesman AGC, CBS Audiomax and DAP-310 multiband processors. The first two are examples of AGC action on the entire audio spectrum. The multiband processor operates on a portion of the audio spectrum in each AGC section and combines the output. A major advantage to this system is found in music. A heavy thumping bass rhythm will capture the AGC, reduce the gain, and "punch holes" in the rest of the programming as the gain recovers. By processing the different parts of the spectrum individually, the effect is eliminated. The DAP-310 (Discriminate Audio Processor), and later version DAP-610, are made by Dorrough Electronics. The name should be familiar to ER readers because Mike Dorrough, KO6NM, is a frequent ER contributor.

A common limiter seems to be the CBS Labs Volumax. The standard audio chain of the 1960s and early 70s seemed to include the Audiomax and Volumax, or the Harris versions with their Statesman products. As the 1970s continued, the Dap 310 was developed and Orban Associates came out with their Optimod series. The Optimod included a broadband compressor, multi-band limiter, EQ, and something called a "Smart Clipper." This device permitted the station to eliminate all other audio processing with a feature that allowed positive peaks to reach to 150%, while most others capped them at 125%. The Optimod and the DAP are analog devices still found in broadcast plants and still command several thousand dollars.

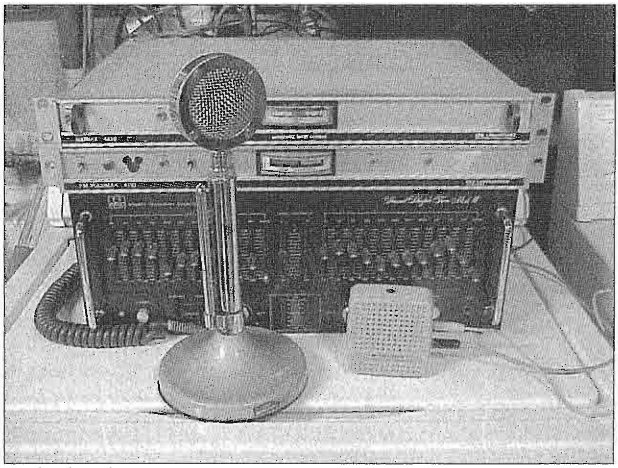
Some consider the Optimod to be the ultimate processor. I know of several amateurs using them, including myself. I consider myself very fortunate to have stumbled on to one at an almost "need-a-license-to-steal" price. However, there is a down side. Many people hearing an A/B comparison between the Optimod and the Volumax prefer the softer sound of the CBS Volumax limiter. Also, the EQ control functions are very limited and don't give you enough control over the voice tailoring that is needed.

Most amateur stations include some EQ in the audio processing chain. You can use a home entertainment device, but you risk getting RF into it because most of them do not use balanced audio inputs and outputs. Or, you can go to a 31-band device that controls lots of small segments of the audio spectrum individually. A device such as the Behringer VX-2000 includes the EQ. How the EQ is set is a matter of personal preference. Some like to have the bass end of their voice shake the walls at the other guy's receiver. If you do this, most likely you will be sounding very unpleasant. You need to notch out the audio spectrum at 250 Hz. It seems that this part of the spectrum makes the male voice "boomy" and difficult to understand. Leave the rest of the low end in and just attenuate that part of the spectrum at 250 Hz. You can boost the high end as well, but don't go above 7 or 8 kHz. You want the presence or mid range to come through at about 5 kHz. Professional audio equipment refers to warmth (bass), presence (mid range) and breath (high end).

Next month's installment will be devoted to the magic of audio processing, the implementation and monitoring.

73, Dave, K2DK

ER



The teenage-in-poverty audio chain with the "dreamed about" broadcast standards of 25 years ago, the CBS Labs Audiomax/Volumax processors. Obsolete EQ cost: $5 at a Hamfest. Radio Shack amplifier, $11.95. Experience with using it: Priceless!

The Drake AC-4 Power Supply Upgrade

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History

The Drake AC-4 power supply has been around since 1965. The AC-4 was used to power the TR-4, TR-4C, TR-4CW series of transceivers, and all the transmitters such as the T-4, T-4X, T-4XB and T-4XC. Well, after all of those 40 years, the AC-4 has seen some aging like all of our other older gear. The electrolytic caps are drying out, some are shorting and some just opening up and causing hum and no regulation at all. The one part of the supply that has caused problems is the "bias" –45 to –65 volts for the final tubes. When the "bias" caps decide to start going, the supply will not be able to keep the final tubes "cut off" and we all know what happens then! The finals start to conduct at full throttle and the finals have a nice "red glow" to them causing the 6JB6's to burn up. I like to see the glow of the tubes, but this is not the time for admiration. At the cost of 6JB6's today ($20 to $30 each) this could be a costly problem. One of the other problems is that the +700 volt supply has been known to lose one of the filter caps, causing the power output to be around 50 watts, which should be 200 watts in a TR-4 series transceiver. All these problems have just recently started to occur, not bad for a power supply that has really been reliable for all these years.

Rescue

Another ham has come to the rescue to the AC-4 dilemma. Mike Bryce[1] (WB8VGE) has come up with a circuit board that will replace all the chassis mounted components except the power transformer and bias control for a fraction of the cost of replacing everything separately. Mike also has a web site called the Heathkitshop.com and now you're wondering why a fella would be making Drake replacement parts. Well, he started this project by building a circuit board for the Heathkit HP-23 and it worked great

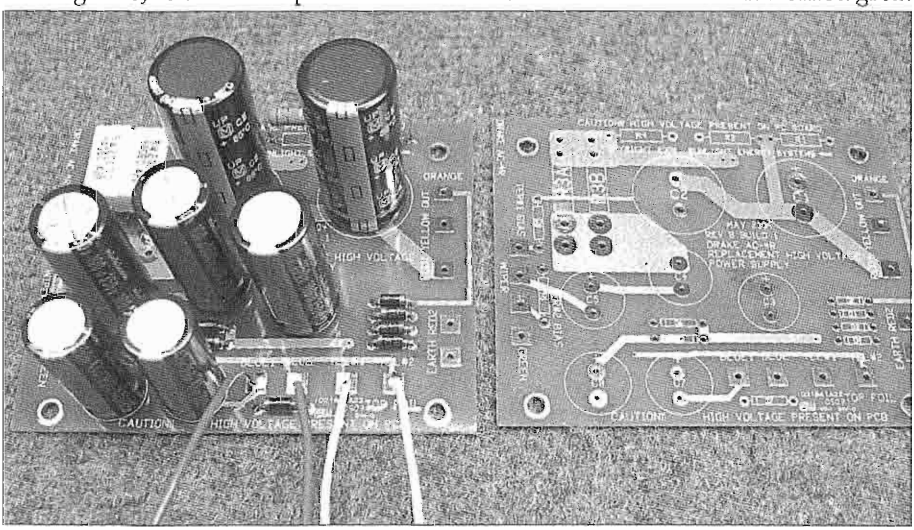

Figure 1: Left, the AC-4R board has all the components mounted and is ready to go. The board on the right is how it looked before the parts were installed.

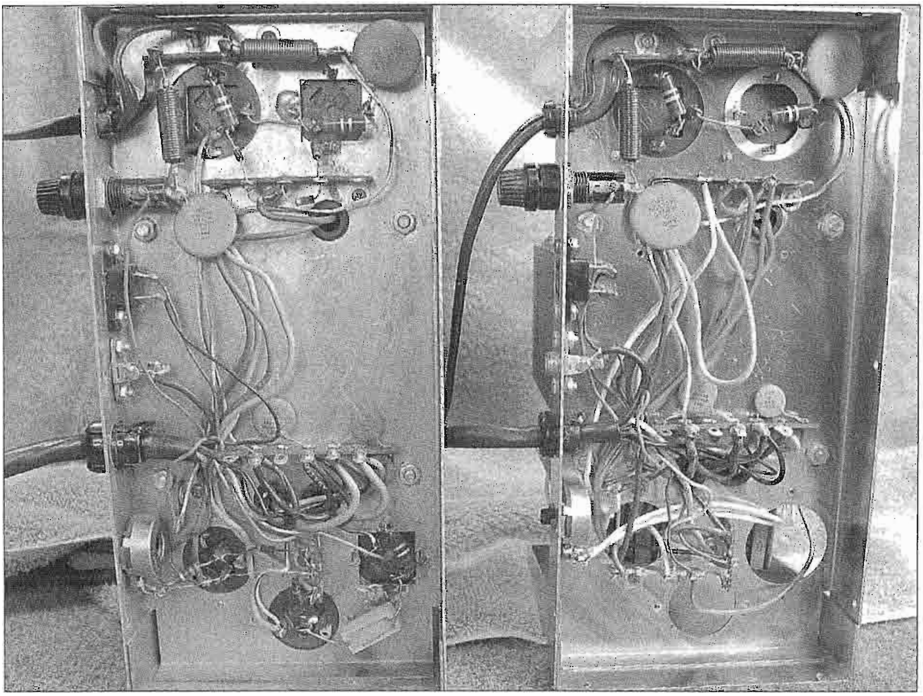

Figure 2: The chassis on the left is the original wiring, and note how most of the components are on the bottom of the chassis. In the right picture, the smaller capacitors are removed to allow room for the board tobe mounted on top and wiring on the bottom.

for all those Heathkits. I contacted Mike, along with many other hams having the same problems with the aging AC-4, and with a little convincing he said "why not," since the Heathkit circuit board worked so well, another one with the layout for the Drake AC-4 might just work.

Well, I can tell you it has. I have installed over 20 of these and they work very well. The new circuit board is called the AC-4R replacement PCB.

Getting started

When you get the box full of parts, Mike cautions you on the fact that you are working with high voltage and to be very careful! The instructions are good and to the point. The box comes complete with all the filter caps, diodes, resistors, colored wires, and hardware. To start, you end up removing most of the parts on the side where the smaller capacitors are. Then, you have to assemble the circuit board with the new components, and they are very good quality and much smaller in size than the originals. The AC-4R actually has some upgraded components, compared to the original parts in the AC-4 supply. The high voltage filter caps have been increased to 150 μfd compared to the 125 μfd for the originals, and the bias supply caps are 47 μfd compared to the original 22 μfd. There is a 100-ohm resistor at 5 watts that has been replaced with two 200-ohm resistors in parallel at 10 watts. The original 100-ohm resistor used to open up in the screen supply, so this should eliminate that problem.

There are some slight variations of the AC-4 that can cause a little frustration, and one is the power transformer. Some

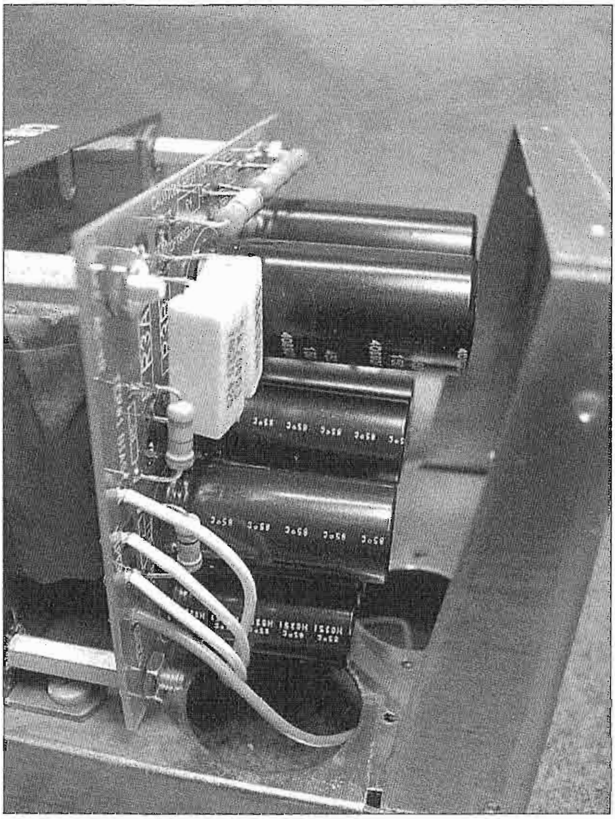

Figure 3: The AC-4R board has been installed using mounting studs and hardware supplied with the kit. Note the holes remaining after the old small caps were removed.

have the mounting screws opposite from where they should be, so you only have to remove them and reinstall them the way the instructions show.

By the way, the new AC-4R board mounts on top of the chassis compared to having all the parts on the bottom of the chassis.

The other transformer change is, some have tar on the older AC-4's, so I have mounted the board as instructed with two angle brackets and using the bottom screws of the transformer to hold them perfectly. Once all the wiring is done, you are ready to fire up the renewed AC-4. I have a mating connector I use for turning on the AC-4 without using a radio. I like this approach, that way you are not harming the radio if you made a big mistake. You can short out pins 1 and 2 of the power plug and this will do the same thing as having the radio hooked up. I use a Variac to bring up the AC-4 slowly, then check the high voltage (+700v) first, then screen supply (+250v), the bias (-65v) and filament supply (12.6 vac).

A side note to the AC-4 upgrade, the later AC-4 supplies have a 6.25 amp slo-blo fuse compared to the original 5-amp standard fuse. The reason for the upgrade is that the inrush current, when turned on, would cause the 5 amp to blow once in a while and the 6.25 amp will help this problem.

It Works

As I said earlier, I have done 20 or so of the AC-4R rebuild kits and they all worked very well after wiring as per the instructions. I noticed that the transmitters have better voltage regulation due to the improved filtering, and the scope also looks cleaner when keyed at full power (200 watts output on a TR-4). With the advent of collecting Drake and other older tube gear, this is a great help for the folks that want to keep the Drakes running for many years down the road. I hope to hear more of the revived Drake gear on the air soon.

73, Jeff Covelli, WA8SAJ

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ER

DC-to-Light

A Drake C-Line General Coverage Add-On

By Doran "Jeep" Platt, K3HVG
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Monrovia, MD 21770

General-coverage capability in most current amateur HF equipment is all but a given. This is not the case with many vintage receivers, transmitters, and transceivers. By design and/or happenstance, however, many vintage sets lend themselves readily to the addition of an external source to extend VFO or LO/mixer range(s). Examples would be the Collins S-Line and KWM-2 and the Drake C-Line (or earlier). This article provides an application note, of sorts, to facilitate an economical substitute for the rare and costly FS-4 synthesizer for the Drake C-line equipment. This adjunct will also work with earlier Drake equipment of the same series and provide full[1] 1.5-30 MHz coverage.

This article discusses the use of an S&S Engineering[2] HF digital variable frequency oscillator module, Model DVFO-II. The DVFO-II operates up to about 54 MHz and can be tuned in steps of 1 Hz up to 10 MHz. The DVFO-II comes either as a kit or factory wired and tested. Because this module employs surface mount components, I elected to purchase wired units, versus kits. The unit comes with the module, a manual, and a 9-volt battery cable. The DVFO-II has the capability of

Figure 1: The version 1 project box is shown to the lower left, and the version 2 project is on the lower right.

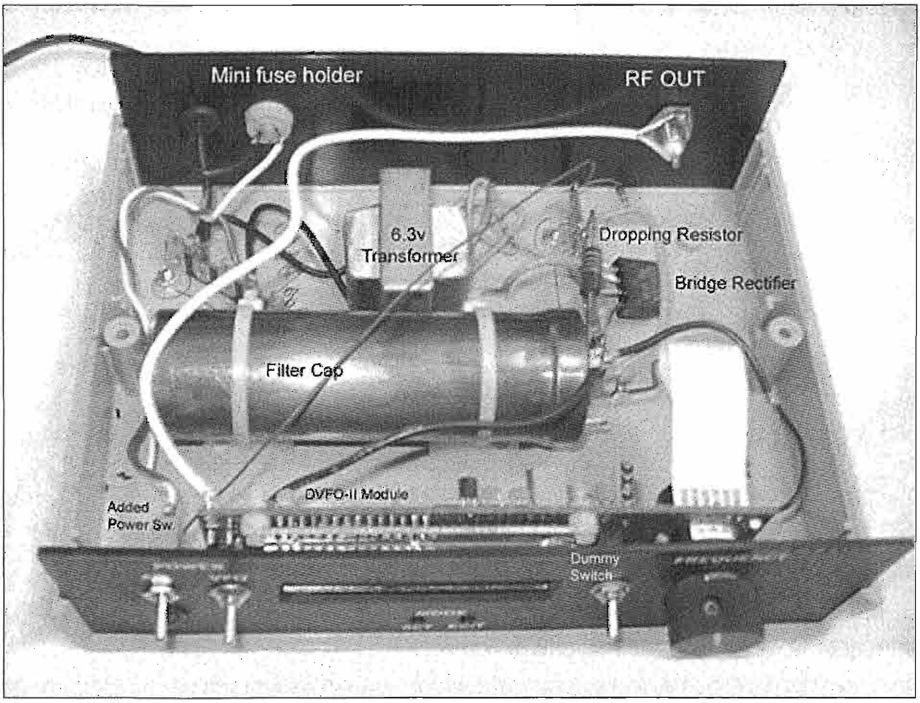

Figure 2: Top view of the second version with an internal AC power supply. Locations of the major components are labeled in the photo.

programming and storing a number of offset frequencies and could be used with more complex or band-dependent mixing schemes, like the KWM-2. Changing to different offsets from band to band on rigs like the KWM-2 requires a few additional front-panel button pushes. The DVFO-II provides a special offset channel used for precise calibration, in lieu of tweaking a cap, or the like. I found this feature particularly neat in that one can calibrate to WWV via front-panel settings, in real-time, after everything's been installed and working.

Conveniently, the Drake C-Line uses a single mixing formula for frequency determination. This makes life easy in that once the correct offset is factored in to the frequency source; the desired frequency may be simply "dialed in" no matter what the band. The Drake equipment requires crystals to be 11.1 MHz above the operating frequency. Thus, the DVFO-II would operate from 12.6 MHz to 40.6 MHz. The dial of the DVFO, however, would be programmed to indicate 1.5 to 29.5 MHz. In normal fashion, the receiver PTO would provide the mixing frequency (upward) to tune within the selected band.

In operation, the DVFO provides a bit more flexibility than would be available with either the Drake synthesizer or individual band crystals. Here's what happens: To operate on any given 500-kHz segment, the receiver bandswitch is set to the range that covers the desired frequency, or frequencies, as it normally would. The DVFO would be set to the bottom of the particular 500-kHz segment desired. For example, if one wanted to receive a frequency of 8290 kHz, the

DVFO would be set to 8.0 MHz. As you'd expect, the receiver VFO dial would then be set to 290. Recall that the DVFO dial cursor can be readily set from any step from 10 MHz down to as little as 1Hz. Thus, after setting the DVFO to the required 500 kHz segment, the DVFO-II dial cursor could be set at 10 Hz (for example) and tuned up and down for use as a wide-range (digital) receiver incremental tuning (RIT).

Construction Notes

I mounted both my DVFO-IIs in small Pak-Tek cabinets[3] along with either an internal 10-volt power supply or provided attachment of an external wall-wart. Selecting whatever cabinetry you desire, using the S&S-provided front-panel fabrication template, lay-out and drill the three switch and control holes and two push-button access holes. To cut out the frequency dial window, I first drill a circular hole in the middle of the window area and then use an Adel nibbling tool to cut the larger square area. The DVFO-II then mounts to the panel via the above control's mounting nuts. Note that one of the toggle switches is a currently a dummy, and is used only for securing the panel. I also included a switch and LED indicator for the internal power supply. This will prove superfluous if you use an external wall-wart. I also mounted a BNC or RCA panel-mount connector on the rear panel, along with either an appropriate wall-wart receptacle or AC line cord retainer and a mini-fuse holder. Although not really necessary, I installed a .001µF-capacitor in the RF output line for DC isolation.

For the power supply components, a Hamfest yielded a 12-VDC wall-wart and Radio Shack sold me the associated panel-mount receptacle. For the unit with the internal AC supply, I used a Radio Shack 6.3-V, 1-A filament transformer, a 1-A bridge rectifier, and a 1000-µF filter capacitor. All components were mounted on hay rakes. On the unit that employed the wall-wart, I used a 1N4007 as a steering/protection diode, a 1000-µF, 25-V electrolytic for additional filtering, and a 43-ohm, 2-w dropping resistor. Datak dry transfers were used to label the front and rear panels. I've since found some Drake look-alike knobs to replace the ones I originally installed. In the accompanying photos, both versions of the completed units are shown in one photo, while the internal wiring for the AC-powered unit is in the other.

Connection to the Drake R-4C was made via a short RG-188 coax jumper from the DVFO-II to the R-4C receiver's crystal plug-in board on the rear of the receiver. To get the coax under the shielded cover, I made a circular notch in one edge and used a very small grommet for anti-chaffing. Connect the coax braid to a nearby chassis screw using a solder lug and the DVFO-II signal out to the "hot" side of any of the crystal sockets. To determine the "hot" side of any of these sockets, ensure that the front panel crystal switch is set to "norm" and probe both pins of the crystal socket you've selected for an ohmmeter reading of about 330 ohms, to ground. The opposite side of the selected crystal socket should be an open. A pin for this socket can be made from 3/16" piece of lead clipped from a 2-watt resistor. Solder the "pin" to the coax center conductor and plug it in the "hot" crystal pin socket. Do not connect the coax via a reclaimed HC-6 crystal holder, etc., plugged directly into the crystal socket. The low side of the crystal is not at ground and will affect normal use of the receiver[4].

To initialize the DVFO-II, power up the unit and, using the S&S provided instructions, calibrate the DVFO-II and set in the required Drake offset. Then connect the coax cable jumper to the

DVFO-II. Next, turn on the receiver, set the receiver band switch and preselector to the proper range desired. Tune the preselector and ensure that the receiver is operating normally. Now, turn the receiver crystal switch to any auxiliary crystal position, thereby disabling the internal crystal(s). Turn the DVFO-II on and set the dial to the proper frequency for the band you're on (e.g. 14.000000 for the 20-meter band.). As you bring the DVFO-II to the correct frequency, you'll notice that the receiver comes back to life. You may now proceed with normal operations. I found that the buffered output of the DVFO-II is well within the required drive range of the Drake equipment, thus no padding, etc. was required.

After over a year of operating, I've detected no unwanted responses as a result of the DVFO-II and get normal reports and operation either barefoot or while using an L-4B amplifier. Note also that the added capacitance of the attached coax jumper did not cause any noticeable changes in alignment or calibration of the R-4C. My use of plastic enclosures may be subject to question. I employ good grounding and bonding techniques and don't suffer from RF floating around the shack. Others may find that a shielded enclosure may be the better choice. One additional thing I did discover was that while using the DVFO-II, and by also setting the receiver crystal switch back to the "normal" position, multiple signals could be heard. Although this might appear to provide dual receive capability, in reality there's no way to independently control both frequencies.

The only real negative I can assign to the DVFO-II is the lack of readout illumination. I tried several methods of internal and external illumination; grain-of-wheat lamps, aircraft post lamps, etc., but all proved a kluge. In the end, I mounted a small strip light above the DVFO-II, the keyer, and audio processor. Finally, I should probably mention that I have no ties with S&S Engineering whatever, short of being a satisfied customer. I met N3SAD at the Manassas, VA, Hamfest a number of years ago when I bought the first unit from her. S&S has since relocated to Arizona. As always, I'd be glad to hear from anyone needing more info or discussion.

73, Jeep - K3HVG
jeepp@adelphia.net

[1] Excluding 2.3-3.0, 5.0-6.0, 10.5-12.0 in the transmitter, only.

[2] S&S Engineering
17830 S. Sonoita Hwy
Vail, AZ 85641
N3SAD@aol.com

[3] Mouser Electronics
part no. 616-63024-510-039
800-346-6873
www.mouser.com

[4] A more involved modification requires that one selected crystal socket be rewired and isolated so that a salvaged HC-6 type crystal holder may be used and conveniently plugged into the isolated socket. You may contact the author for additional information, if desired.

ER

The KDØZS Equipment Notebook

Drake R-4 Receiver and L-4B Linear Amplifier

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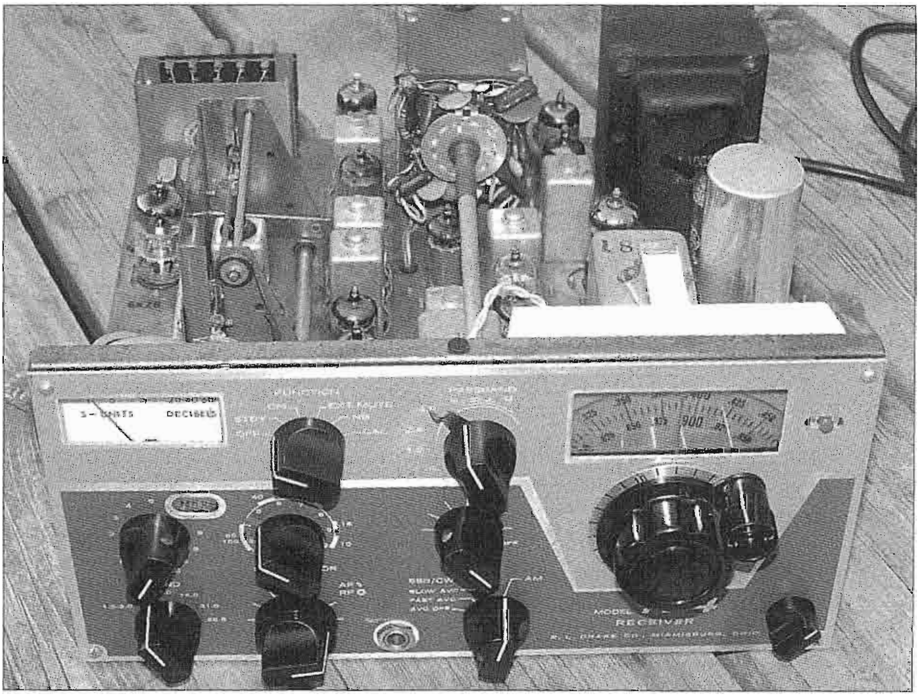
Upgrades for the Drake R-4 Receiver

On later versions of the R-4, the "B" and particularly the "C" models, improvements involve re-thinking some progressively worse design choices by Drake. Not so with the R-4, the original version. As in all Drake designs of this era, inclusive of the TR-7, they simply didn't pay any attention to the effects of power supply noise, or stability, or headroom, or thermal management. Did I leave anything out? Since the R-4 is a simpler original-concept device, improvements are also simple. True for all four models, the biggest performance improvement is the installation of an 8-pole, first-IF filter[1] (International Radio P/N 2611.1, 6-kc BW, 5645-kc CF). T5 and T6 can be modified to be filter matching transformers.

My upgrades for the R-4 are shown on the schematic of **Figure 1**.

At V1, I use a series 43-k screen resistor to linearize the amplifier. The AGC RF amplifier time constant is changed to 15 ms. (.1µF and 150-k ohms) to avoid distortion on strong signals. The screen supply for minature remote-cutoff tubes must be series only for best linearity over the control range (See RCA tube manual RC-30, p. 187). A positive screen voltage of 100 to 110 volts at full gain, rising to



The Drake R-4 receiver with the cabinet removed. The knob on the lower left is the noise blanker threshold control.

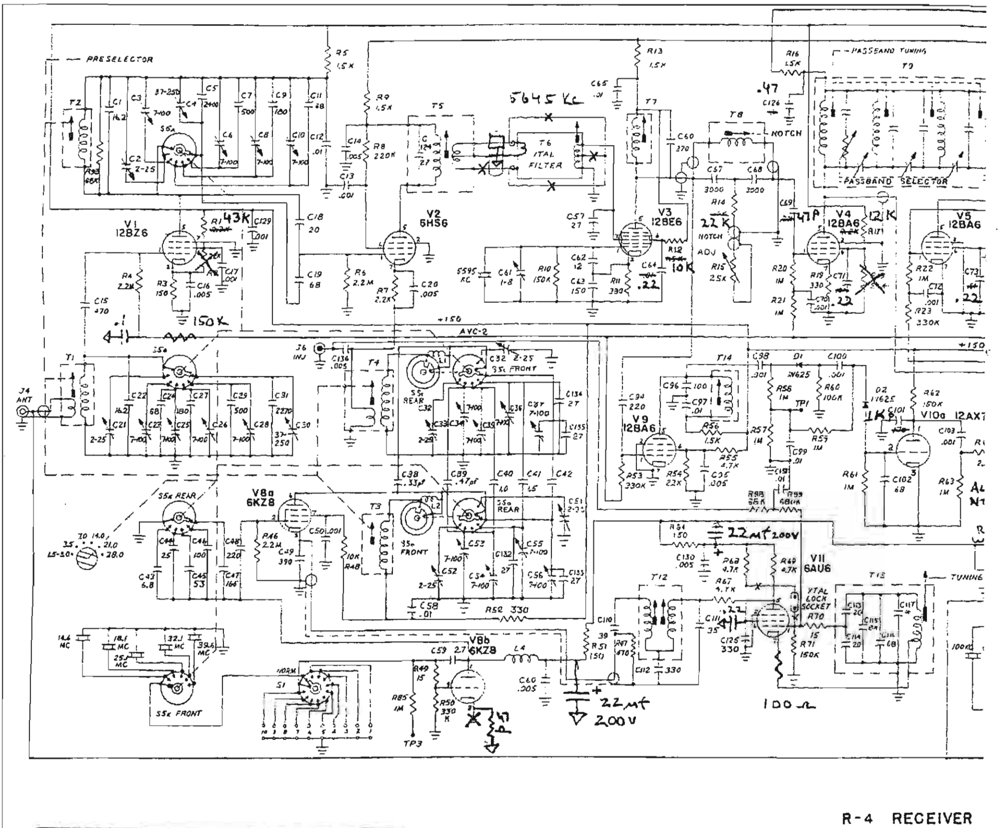


Figure 1: Drake R-4 upgrades.

plate voltage at cutoff, allows for the lowest distotion for large signals.

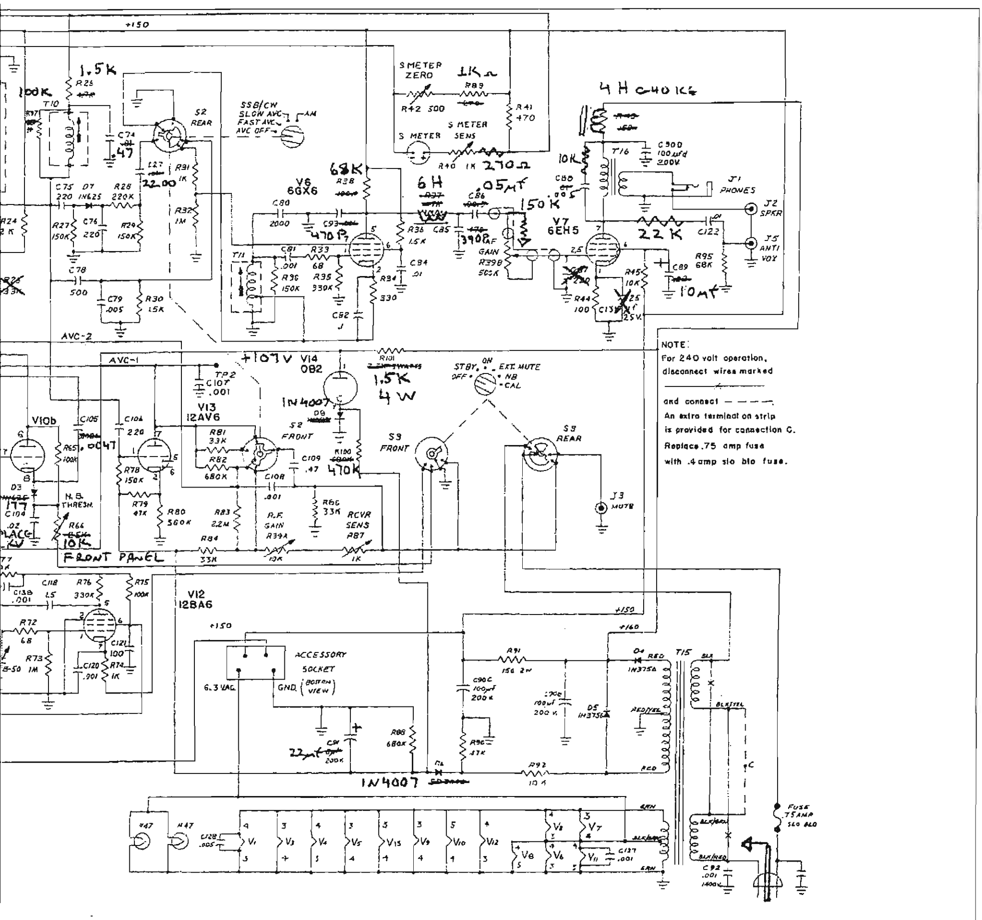
The mixer at V3 is also modified for higher dynamic range and stability by using a 10-k screen resistor and a larger bypass capacitor.

V4 and V5 have had their screen-supply resistors changed to increase large signal handling. The change allows about +100 volts at the screen, increasing with AGC action. This is good for about +10 dB better large-signal handling ability.

At the notch filter adjustment, R14 was changed to make the R15 notch adjustment centered in its range.

As in all other low-IF frequency designs, lots of shunt capacity was used in an attempt to keep IF energy out of the audio. Some times this worked, but it always generated a lot of audio phase shift at higher audio frequencies, the ones important for clarity. The audio modifications around V6 and V7 reduce rail noise (hum), open up the frequency response, allow degenerative feedback to soften clipping and reduce distortion, and add a matched pi-section audio low-pass filter that is very lossy at the intermediate frequencies.

The signal diodes listed on my R-4 schematic may have been up to the job, but I have yet to see the IN625 in any of these radios. The IN4148 or 1N34 replacements are usually found to be leaky

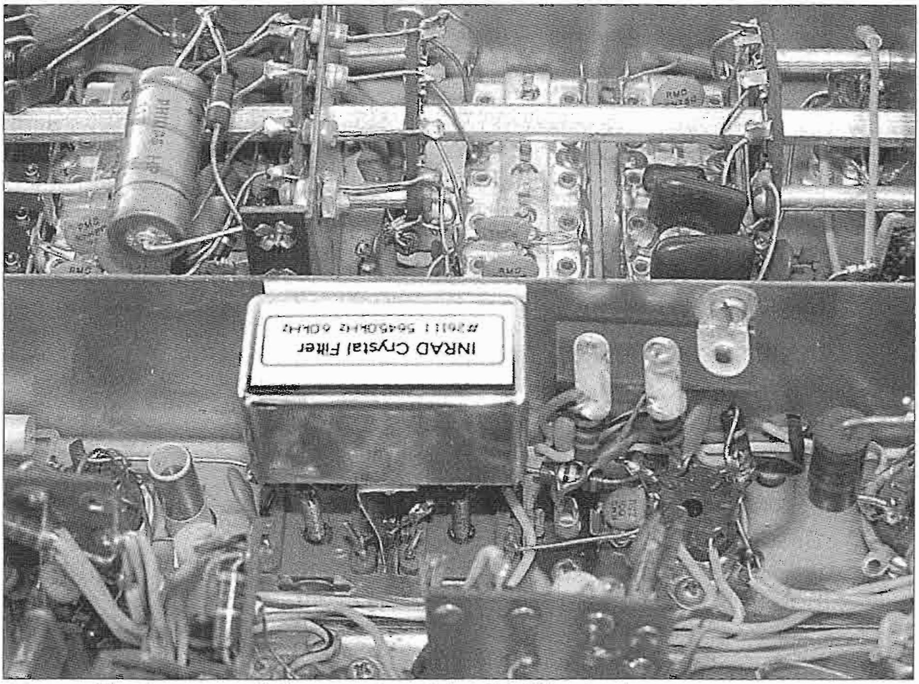


or shorted. The 1N4938 (or NTE-177) is an excellent 200-volt, low-leakage part, although they can be hard to find. They switch at 50 nanoseconds, enough to switch cleanly up to 500 kc. Replacing all the signal diodes usually gets the noise blanker going[1]. These diodes are electrically tough, but they do require a heat sink (alligator clip) when you solder them in.

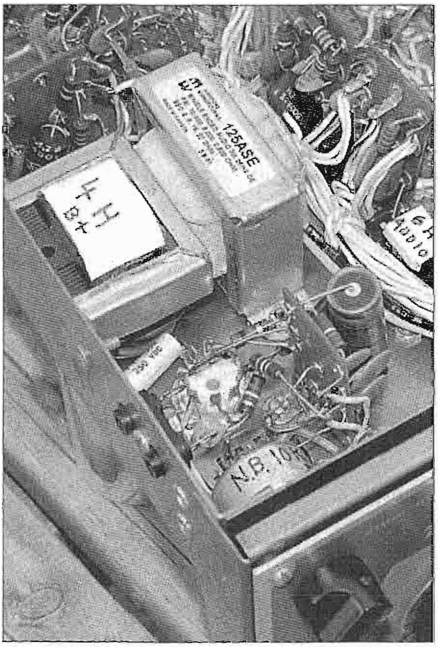
The other changes in the noise blanker circuit fine tune the blanker for slightly wider blanking pulses and minimum diode switching transients.

The first-to-second IF conversion is problematic because the frequencies are so close. Tube-type crystal oscillators tend to have pretty good phase noise performance, and since the power supplies are relatively high impedance, it's easy to filter them. There is not much modification needed here, but later solid-state versions need a lot of help. Such a close frequency conversion tends to put the mixer output on the phase noise pedestal of the conversion oscillator. This makes for objectionable noise and intermodulation products. That's one big reason why a good first-IF filter (5645 kc) is desirable here.

Actual changes are all on the schematic, except for the phone jack. See the NC-183D article in ER numbers 191 and 192 for that information. You'll notice,



<u>Above</u>: **The location of the new Inrad 1st-IF filter is shown.**
<u>Below</u>: **The lower right corner of the chassis is where the new chokes and the new control for noise blanker level have been mounted. The primary of a small filament transformer is used as the 4-henry choke.**



again, the unbypassed oscillator cathode resistors. They improve resonator "Q", and absorb harmonic and base-band energy, which reduces phase noise. The added 22-µF filter caps reduce AM noise. The C69 value reduction improved the notch filter "Q" a little, allowed faster response in overload conditions, and reduced capacitive coupling of low-frequency energy into the following amplifier. In general, capacitive-only coupling between RF stages is a bad idea. Fortunately, there is only one stage in the first version where this was done.

The resistor changes in the S-meter circuit make everything adjust smoothly in the center of the control ranges.

Changes at V14, the regulator, are to make the tube start reliably.

A photo of where I mounted the Inrad filter is shown in Figure 2. I used brass shim stock from hobby stores and doublesticky foam tape to mount the new filter. The brass is also a shield. To convert the original Drake "T-6" crystal filter into a filter-matching transformer, and use T5 for same the same purpose, follow the following directions:

1. Remove crystals + put in pile of Drake parts.

2. Disconnect end of smaller coil at pin. Remove crystal clips.

3. Unwind half the turns, strip and resolder that end to one of the now-open pins on the other side. This now becomes the low-impedance winding to match the 8-pole filter to V3, the second mixer.

4. Use one phase of T5's output winding to drive filter input.

5. After installing filter, peak T5 and T6 on the weaker of two sidebands, or at zero beat.

Adding a 3-wire power cord for safety is very important. Nothing goes out of my shop without a 3-wire cord, including AC-DC sets. This change is shown in the lower right corner of the schematic.

Drake L-4B Linear Upgrades

This amplifier is, in general, a well done, classic design linear. But, being a Drake, it has power supply problems. The full-wave, capacitor-input, voltage-doubler configuration equals large surge currents for the diodes and filter caps.

If there is a p.c. board with high-voltage diodes and equalizing resistors on it, and it hasn't yet arced, loose it and wire the circuit point to point.

The Drake schematic shows a 1.5-amp diode string and I'll bet those have all been replaced since the amplifiers were built. This unit came with 4-amp, 500-volt units. One diode, number 3 in each string, was shorted. I replaced all eight with 6-amp, 1-kV diodes rated for a 400-amp surge current and I matched them for back resistance with an HP-412A VTVM[2]. This should be reliable. The filter capacitor issue is a tough one. The equalizing resistance is 100-k ohms per cap and only 4 ma. This series-stringing configuration in a high voltage supply can only be reliable with recently manufactured capacitors from the same batch. Survival of these caps depends on two unstable parameters, equivalent series resistance (ESR) with a very high current-charge cycle, and leakage in the electrolyte, which ages at different rates. When one of the string of electrolytics starts getting hit with over voltage or reversed voltage, the end is near for the whole string. A soft start would help here.

Individual protective circuitry should extend the lives of the filter capacitors significantly. In this unit, I used new surplus computer-grade capacitors rated at 270 µF, 500 volts[3]. I paralleled them with the original 100-k ohm resistors and a 1N4007 diode for reverse protection, and then a 500-volt MOV for over-voltage protection. This protection should extend the filter's useful life well beyond the time when the aging specifications cause unprotected caps to be damaged at turn-on. I thought of splitting up the main bleeder, but that would have been a thermal can of worms, plus, a 120-volt supply is derived from the end of the existing bleeder. I think "soft start" is the key word here.

[1]Fairchild 1N4938 (aka NTE177) diodes are available from the Electric Radio store in packs of 20 for $10. Please include $1.00 for shipping charges with each order.

[2]International Radio
13620 Tyee Rd
Umpqua, OR 97486
541-459-5623
http://www.qth.com/inrad/

[2]Suitable power supply diodes can be found at Mouser Electronics, 800-346-6873, P/N 583-6A10.

[3]New power supply electrolytics are available: Mouser P/N 598-DCMC450V271

ER

Feeding Multiple Receivers the Hybrid Way

Part 2

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Core Selection

The permeability of the core selected depends on the frequency range you want to cover. My LF hybrid transformer was designed for a frequency range of 150kHz to 10MHz, and uses a Fair-Rite 43 material core to obtain the winding inductance necessary to achieve this low frequency response. In fact, the frequency response is only 1dB down at 120kHz with a Fair-Rite 2843000302 core, providing that there is a reasonably well-matched load on both ports. Other Fair-Rite cores of the same material and shape, but slightly larger size, can also be used. They go under the Fair-Rite part numbers 2843000102 and 2843000202, but these are ones I can't find in the UK, so I've never had the chance to try them. You may have better luck in the States, and the larger cores should give you lower LF cut-off frequencies for the same core material and number of turns.

The insertion loss of the hybrid transformer depends on the core material and the number of turns, and varies with frequency. My LF hybrid transformer has an insertion loss of 0.3dB at 1MHz, 0.4dB at 7MHz and 0.8dB at 14MHz with the 43 material 2843000302 core. It has 7 turns on the primary and 5 turns bifilar for the two secondary windings. The upper end of the response would normally be determined by the leakage inductance, and drop off in a similar manner to the low frequency roll-off, but in the case of many high permeability ferrite broadband transformers the response begins to tail off earlier, and more gradually, as the frequency is increased because of increasing core loss. I measure my frequency responses between the points where the low frequency and high frequency performance drops by 1dB relative to the lossless case. This makes them look as if they're much inferior to other designs, which ignore the insertion loss and specify the –3dB bandwidth with respect to the peak level in the passband. They're not inferior, of course, because we're all restricted to the same physical limita-

Part Number	Material	Permeability	Thickness	Width	Length
2861000102	61	125	0.280/0.310	0.500/0.550	0.515/0.540
2865000202	65	100	0.280/0.310	0.500/0.550	0.545/0.585
2861000202	61	125	0.280/0.310	0.500/0.550	0.545.0.585
2861000302	61	125	0.280/0.310	0.500/0.550	0.395/0.420
2865000302	65	100	0.280/0.310	0.500/0.550	0.395/0.420
2843000302	43	850	0.280/0.310	0.500/0.550	0.395/0.420

In all these Fair-Rite two-hole balun cores the holes are 0.140/0.160 inch diameter, and the centre-centre spacing is 0.215/0.235 inch.

Table 1 Dimensions of Fair-Rite two-hole balun cores suitable for hybrid transformers.

tions in the design and materials. The –3dB bandwidths of my hybrids are much greater than the bandwidths I quote, but since I only use them over the –1dB bandwidth, that's how I specify them!

Those of you who are happy to restrict your coverage to 1.6MHz, and above, should consider lower permeability cores, such as Fair-Rite 61 and 65 material, of the same size and type that I suggested above (102, 202, and 302 two-hole balun cores). These will probably have the advantage of better intermodulation performance at the same power level because of the lower flux density (B) in the core. The insertion loss over the HF range should be of the order of 0.2dB, and should be flatter than the response I got with the higher permeability core – less lossy at the HF end of the spectrum. I've listed the Fair-Rite data for some of these cores in **Table 1,** so that you can use near equivalents if you can't get the Fair-Rite cores that I've suggested.

Tailoring to Your Needs

The number of turns used for the windings should, theoretically, be in the ratio 1.4142:1 (primary to half of the secondary) for a splitter with 50 ohms in and 50 ohms out. However, this exact ratio can be hard to achieve using a small number of turns. Very often, you can get the frequency response you want with a small number of turns, but the port impedances aren't exactly 50 ohms. This doesn't matter too much as long as the output impedance is not too far off 50 ohms. In such cases, I always make sure that the antenna port is 50 ohms, and allow the output port impedances to be whatever is right to give the best isolation. After all, the receiver input impedances probably aren't exactly 50 ohms, anyway, and isolation and a good match to the antenna are more important than the exact value of the port output impedance. So, I assume that the antenna source impedance is precisely 50 ohms, and then work out the resistance that will reflect across each half of the secondary winding using the turns ratio that is nearest to the ideal that I can achieve. For example, using a Fair-Rite 2865000202 core I can get a 1.5 to 40MHz response (to the –1dB points) with a 4 turn primary and bifilar 3 turn secondary windings – 6 turns for the complete centre-tapped biphase output winding. This reflects 28 ohms across each half of the secondary winding since we're dealing with 50(NS/NP)2, where NP and NS are the number of turns on the primary and half of the secondary, respectively. This is the same value that should be used for the balance load, and is a quarter of the value reflected by the 50-ohm primary winding across the combined secondary windings. With this arrangement the output impedance is 56 ohms (twice the balance load) at each receiver port, and the isolation is very good because the balance resistor (two 56-ohm resistors in parallel) is the right value for the hybrid transformer. The difference between 50 ohms and 56 ohms is not worth worrying about in terms of the mismatch loss, even if your receiver inputs give a perfect match to 50 ohms, which they probably won't! It's worth maintaining the best possible isolation that you can achieve between output ports, and this requires the balance load to be correct for the turns ratio of the windings.

As a guide, **Table 2** gives the details of a few of the hybrid transformers that I've used in different splitters over the years. You can substitute a core made of 61 material for one made of 65 material, and improve the low end response a small amount without adversely affecting the high frequency end much. You can even get a slight improvement in the low-end response using the smaller 102 type balun core in place of the larger 202 type if you substitute 61 material for 65, because the increase in permeability more

Freq. Response	Core Number	Wdg 1	Wdg 2	Wdg 3	R_B
0.15 – 10MHz	2843000302	7turns	5turns	5turns	25 ohms
0.70 – 50MHz	2843000302	3turns	2turns	2turns	22 ohms
0.50 – 30MHz	2865000202	7turns	5turns	5turns	25 ohms
1.50 – 40MHz	2865000202	4turns	3turns	3turns	28 ohms

All frequency responses are quoted to the –1dB frequencies (including insertion loss).

Table 2 Details of hybrid transformers used in three-port splitters by the author.

than compensates for the reduction in size. I believe that larger sizes of balun core are available, but I've never found anyone in the UK who stocks them. There is a 2861006802 Fair-Rite core which is nearly twice the length of the 2865000202 that I used for the 1.5 to 40MHz splitter, and this should be fine for covering the same frequency range with marginally better intermodulation performance, if the primary has 3 turns, and the two secondary windings have 2 turns each. Stackpole also used to make two-hole balun cores, but I have never been able to buy any of these in the UK. According to the old catalogue I have, there is a Ceramag type 11 material that has a permeability of 125, and comes in 0.296, 0.500, 0.527, 0.565 and 1.0 inch long balun core shapes that are similar in cross section to the Fair-Rite ones. These are Stackpole codes 57-9109, 57-9130, 57-0922, 57-9433 and 57-0963, respectively. Ceramag type 11 material looks to be the same as Fair-Rite 61 material.

Intermodulation

Don't worry about the intermodulation issue, initially. It probably won't affect you at all. Build one of the hybrid splitter designs using the 0.4 or 0.5 inch long balun core transformers listed in **Table 2**, and see how it works at your location. In the unlikely event that you do have problems, you should be able to solve them by reducing the flux density in the core of the transformer by either of two ways. The first involves reducing the number of turns used, and increasing the size of the core to maintain the same primary inductance – you don't want the frequency response to change. This gives you less than 10dB improvement in the third-order IDPs every time you double the volume of the core. The second is a more effective way. This involves using a material with a much lower permeability. If you're already using one with a permeability of 100 or 125, that usually means dropping down to powdered iron at a permeability of 10, although I believe Stackpole does a nickel-zinc mix with a permeability of 35, if you can get it. You can increase the number of turns to restore the primary inductance to its original value, and get more than 20dB improvement in the third-order IDPs using the same size core – the increased number of turns is a bit of a pain, though. However, if you restore the primary inductance by a combination of increasing the transformer core size and increasing the number of turns by a lesser amount, you can get a greater improvement in intermodulation performance without too much trouble. You could make your own jumbo two-hole balun cores out of T37-2 toroids, if you wanted, but this may prove quite an expensive way of doing it. A minimum of twelve T37-2 toroids should be used in two side-by-side stacks of six toroids to make the core. You'll probably need about 19 turns

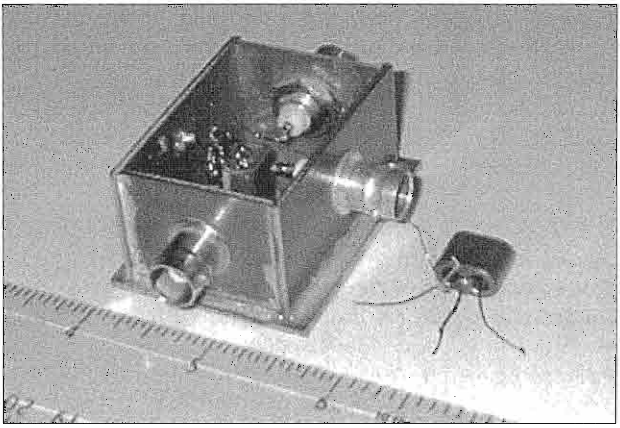

Figure 3: Photograph illustrating the construction of both the hybrid transformer and the complete three-port splitter.

on the primary and two 13-turn bifilar secondary windings to get a response down to 1.8MHz. Sixteen T37-2 toroids and fewer turns would be better for lowering both the frequency response and the intermodulation level. Alternatively, you could use two of the Micrometals powdered iron (2-mix) sleeves glued together. They come in various lengths, as shown in **Table 3**. You should aim for a primary inductive reactance of 350 to 500 ohms at the lowest frequency you want to cover, for a 50-ohm system. Remember to re-calculate the value of your balance resistor if you change the primary-secondary turns ratio. Don't be afraid to experiment if you don't get the performance that you need first time round.

Construction

I like to wind the primary close to the core, and then put the shorter bifilar secondary windings over the top of the primary. It helps identification if you have different coloured polyurethane-coated wires for the three windings. All my hybrid transformers are made with 0.22mm diameter polyurethane-coated copper wire (about the same diameter as 34AWG). The diameter of the wire is determined by what you can thread through the balun core holes to achieve the required number of turns. **Figure 3** shows a photograph of a typical hybrid transformer next to a homemade box containing a three-port splitter. The transformer core is a Fair-Rite type 2843000302, and you can see the twisted leads of the primary curling up away from the core in the picture. They are twisted together near the core at about 3 twists per inch to maintain a low characteristic impedance right to the input socket when installed in a splitter. The middle lead of the lower three leads in the picture is the secondary centre tap. This lead is formed by twisting together the start of one secondary winding with the finish of the other, and since they

Part Number	OD (in.)	ID(in.)	Length (in.)
H520-1002	0.312	0.137	1.250
H68 - 1002	0.375	0.125	0.500
H616-1002	0.375	0.125	1.000
H616-1302	0.375	0.137	1.000
H918-1002	0.570	0.245	1.125

Table 3 Micrometals powdered iron (2-mix) hollow sleeve cores.

come out of different holes in the end of the core this tends to hold the windings in place. The transformer shown in the photograph is the same as the one used in my 0.5 – 30MHz splitter, and has a 3-turn primary and 2-turn bifilar secondary (4-turn total winding). The complete, but lidless, splitter contains a 1.5 – 40MHz transformer. The balance resistor is mounted vertically alongside the transformer, with its lower lead soldered to the copper ground plane at the bottom of the box. The connection between its upper lead and the transformer secondary centre tap is that fuzzy mess projecting just above the left-hand side of the upper end of the ferrite core, level with the blob of solder on the inside wall of the box. The grounded end of the balance resistor was originally connected to this solder blob, but was later changed to the other, more convenient point. The transformer core is held in place by its leads.

My homemade box is tailored to suit the size of the connectors and components I used. How small you make the three-way splitter box is really determined by the size of the three connectors you use, but there's no real merit in making it extremely small just for the sake of it, particularly at LF and MF where reasonable lengths of lead to the sockets can be tolerated. I use BNC connectors because I find them much more convenient than the so-called UHF type (PL259/SO239), and since I was making my own enclosure, I made it to fit. You can use anything convenient that's to hand, and if it's not made of a conducting material you can always line three sides of the box internally with copper-clad board to use as a ground-plane, and connect the grounded side of the three sockets together with it. The type of plastic box that comes with an aluminium top cover can also be used. In this case, all three of the coax sockets can be mounted on the conducting top cover, and the grounded end of the balance resistor(s) soldered to an earth tag mounted on one of them.

Feeding 3 or 4 Receivers

Providing you have sufficient signal level from your antenna that you can tolerate halving the signal voltage to each receiver, you could use 3 hybrids to feed 3 or 4 receivers. One hybrid is used to split the signal to two other hybrids, and if you only want to split the signal 3 ways, rather than 4, you can terminate the unused fourth port with a small 50-ohm load to get the best overall frequency response from your splitter system. If you want to feed many more receivers than this, or can't tolerate the signal division loss, then an active distribution system with 807 tubes would be your best solution, but as Kipling said, "That's another story!"

ER

AM Calling Frequencies

160 meter band: 1885, 1945 kc. In the Midwest, listen on 1980 and 1985 kc.
80 meter band: 3870, 3880, 3885 kc. In the Midwest also try 3891.
40 meter band: 7200, 7290 kc national calling frequencies. Also 7295 in the Midwest.
20 meter band: 14.286 Mc
15 meter band: 21.400 to 21.450 Mc. Try CQ on 21.4, move up for QSO
10 meter band: 29.0 to 29.1 Mc
Try CQ on 29.0, move up for QSO
6 meter band: 50.4 Mc
2 meter band: 144.450 Mc

Vintage CW Calling Frequencies

80 meter band: 3546 kc
40 meter band: 7050 (+/- "Fists" club)
30 meter band: 10120 kc
20 meter band: 14050 kc

The SX-101A

Hallicrafters' Heavyweight Champion, Part 4

By Ray Osterwald, NØDMS
PO Box 242
Bailey, CO 80421

This is the final part of the SX-101A story, and I will first discuss some simple, easily reversible modifications that greatly enhance the receiver's basic performance. Then, I have some circuit alignment procedures that make working on any of the selectible-sideband receivers a lot easier. Finally, I'll have some performance testing results that show what the receiver is and is not capable of doing.

AGC Performance

There is no standard test to measure AGC performance that I'm aware of. I have developed my own test that I use to characterize AGC systems in HF receivers.

You can't use a normal attenuator scope probe to look at an AGC waveform because it loads the high-impedance AGC bus and will give false results. You need to use a probe with an extremely high input impedance, known as an "FET" probe. It is connected to the AGC bus at some convenient spot on the AGC-rectifier side of an AGC-decoupling resistor. The increasingly negative-going AGC voltage that is produced by an RF input signal from my generator, when it is switched from "off" to "on" at a –65 dBM (126 microvolts, or "μV") level, is used to drive the external trigger circuit in a Tektronix digital storage scope.

The ideal AGC generator in an HF receiver would have a risetime that is faster than any signal in the IF channel. Unfortunately, in real-world equipment this is not practical. To meet this requirement in a 50-kc IF channel, risetime should be less than 200 microseconds (μS), and in a 455-kc IF channel it should be less than 2 μS. The ideal fast-rising AGC would have a risetime showing no overshoot or ringing on the leading edge. The Collins 75S-3B has the best AGC system in vintage receivers I've tested to date, and I compare other receivers to it. With a –65 dBm input signal, it has a 718 μS risetime with very slight overshoot and no ringing or other instability. Other receivers have longer risetimes and more overshoot and/or ringing.

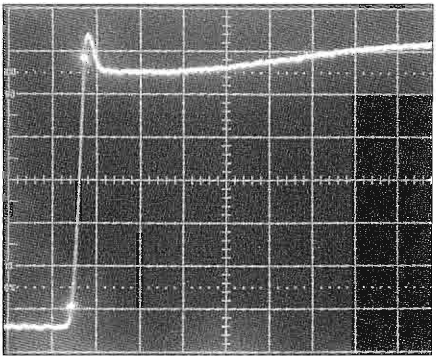

Figure 1: SX-101A AGC "Fast" rise time.

Figure 1 is a scope photo of the unmodified SX-101A AGC system in the "AGC Fast" position ("AVC" in Hallicrafters lingo). The probe was connected to the junction of R50, R51, and C73,

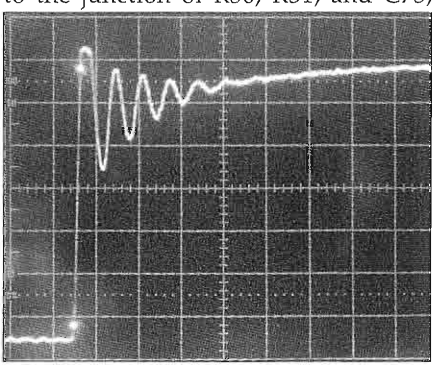

Figure 2: The SX-101A AGC system oscillates in the "AVC Slow" position.

which is a terminal at the "AVC Fast-Slow" switch. The sweep speed was set to .1-second per division, and the vertical deflection was 1 volt per division. The two bright dots on the left side are placed at the approximate 10 and 90 percent points on the rising waveform to measure the AGC rise time, which according to the Tektronix measurement system is a very acceptable 781 µS. There is considerable overshoot on the leading edge, about a volt in amplitude that lasts for 39 milliseconds (mS). After 1/4 second the AGC level becomes increasingly negative for another 1 second because the AGC loop gain is not stable.

Figure 2 shows the AGC system oscillating in the "AVC Slow" position. Again, this is the AGC attack-time waveform, but the sweep speed was increased to 5 mS per division to expand the display. This is known as "ringing," and is a textbook example of a feedback system at rest that has been disturbed by a transient event. In this case the event is fast-rising AGC voltage. The attack time is 1 mS, and there is 2.7 volts peak-to-peak of overshoot after the initial voltage rise. The oscillation has a period of 3.9 mS, and the event lasts for 16.3 mS. You can hear this distortion in a stock receiver in the "AVC Slow" position. It sounds like rapid fluttering as the AGC voltage swings through 2.7 volts and comes approximately to rest. AGC oscillation pulls the VFO off frequency because the mixer bias changes, which changes the load on the unbuffered VFO.

Fixing the SX-101A AGC

The reason for the ringing effect is because the AGC feedback system is "under damped." You could add resistance in the loop and the ringing would stop, but the risetime would lengthen and you'd hear the familiar sound in the audio, popping or snapping, typical of AGC with a long risetime. Another way to change loop response is by changing the number of controlled elements, or by changing the locations of the controlled elements in the loop. If you remove AGC from the 1st mixer and add it to the 50.75-kc IF amplifier, the AGC ringing quits, the range of AGC control increases, the VFO stability will increase, and the AGC will stabilize. This is a four-for-one mod, four problems are fixed for the work of one! Here are the steps to make the change:

- Unsolder R8, the V2 AGC decoupling resistor, from where it attaches to the AGC bus on a nearby terminal strip. Resolder R8 to the center pin of V2, if the center pin is grounded. If it isn't, solder R8 to ground at a nearby ground lug.
- Install a new threaded terminal post through one of the vent holes around the power transformer, nearby V6. Run a new wire from position 2 of the long 12-pin terminal strip, where R8 was formerly attached, and solder it to the new post.
- Disconnect R21, the AGC decoupling resistor for V6, from ground and attach it to the new terminal post. Add a .001-µF, 200-volt bypass cap to ground at this point.

Feed-Forward AGC Control

Another mod that may be worth trying is adding what is known as feed-forward AGC control to V9, the 6K6GT output tube. The 6K6GT is a semi-remote cutoff pentode amplifier that responds well to AGC. Adding a controlled stage that is outside of the normal AGC loop "flattens" the audio output levels and really makes this receiver have outstanding AGC action. You won't need to ride the audio gain control any more when this mod is done, all you have to do is set it for comfortable audio from the weakest station in a roundtable.

- Unsolder R74 from ground and run it to pin 3 of the 11-position terminal strip just above V9. This is on the AGC bus. Connect a .27µF, 630-volt Mylar cap to ground directly at the new connection. This is an audio bypass that's necessary to keep audio off the AGC bus.

The drawback to this mod is that the

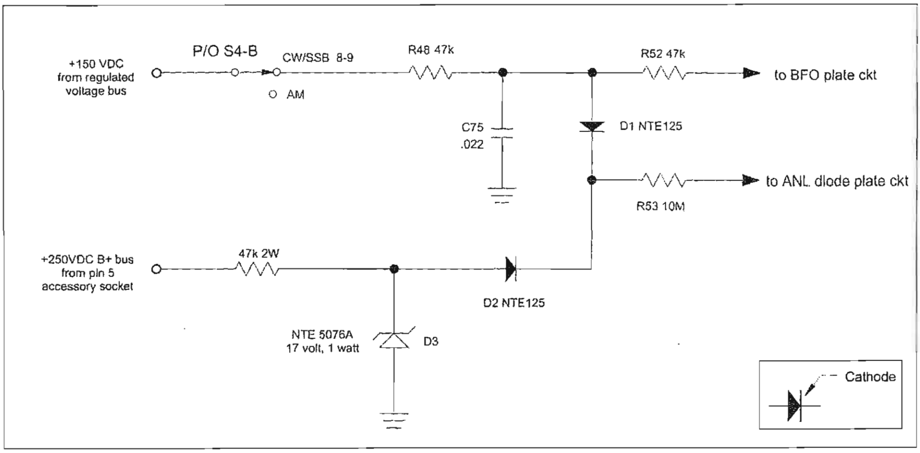

Figure 3: Schematic of the new ANL bias circuit.

.27-µF bypass cap will increase the AGC time constants. The attack and release times will lengthen somewhat.

Adding Audio Inverse Feedback

Adding some audio inverse feedback will reduce distortion and broaden the frequency response of the SX-101A's audio system. I've only added feedback around the output transformer and the 6K6GT PA tube because the 1st-audio stage, V8, has a common cathode with the BFO. I didn't want to make a drastic modification or use a different tube.

- Find the yellow wire coming from the output transformer secondary. Find the place where the yellow wire attaches to pin 12 of a long 12-position terminal strip just to the rear of the BFO pitch and response controls. At this place, attach an 1800-ohm, metal-film resistor and a .1-µF, 200-volt non-polarized Mylar capacitor, wired in series.
- The other end of the series combination goes directly to the cathode of V9, pin 8. Leave R75 alone. I made a "flying connection" with these two new parts and insulated them with heat-shrink tubing. Remove C101, the 10-µF bypass capacitor at the cathode of V9. This simple change reduces total harmonic audio distortion to less than 3%.

C82 is the original AM audio coupling capacitor in the SX-101A. If you change it to a .027-µF, 600-volt Mylar cap the AM audio passband will be wider and will sound much less harsh.

Fixing the ANL System

Part three of this article discussed problems with the ANL system that were brought about when Hallicrafters added a product detector to the SX-101, and how the diode bias was wrong in the AM position. By adding four parts and one new terminal strip I designed an automatically-switching ANL system, providing correct diode bias in the CW/SSB and AM modes.

The new parts are shown in **Figure 3**, the ANL schematic. The mod consists of D1, D2, D3, and a 47-k resistor. D1 and D2 are general purpose rectifiers with a PRV of 1 kV. D3 is a 17-volt, 1-watt zener diode.

Here is how the modification works: When the "Response" switch is in the CW/SSB position, diode D1 is forward biased, the ANL diode plate, pin 6 of V7, has a positive bias from a voltage drop across the regulated 150-volt bus, and the BFO turns on by the voltage drop across R52. When current flows in D1, D2 is reverse biased because voltage at its cathode is higher than the voltage at its anode. When S4 is in the AM position, the regulated 150 volts is cut off, D2 is forward biased, and D1 is reverse biased by the positive voltage at its cathode. 17 volts DC bias is supplied to the ANL plate across R53 from D3, the new zener diode. In my receiver, 17 volts seemed to give excellent noise clipping action with weak signals but didn't cause excessive clipping with a strong signal. You may want to try different zener voltages if the signal clipping of strong signals is too great for your way of operating. Going to a higher bias voltage will cause less clipping.

Study the schematic and the locations of all the parts you will be working with before you start. Take your time and follow the steps below to complete the modification:

• Preassemble the three diodes and the 47-k resistor on a 6-position terminal strip. Use a heat sink when you solder the diodes. On the right side of the chassis, remove one sheet metal screw at the lower center side that holds the chassis side brace. Use the now-empty hole to mount the new terminal strip with a screw, lockwasher, and nut.

• Run a new wire from pin 5 of the rear-panel accessory socket to the open end of the new 47-k resistor. Pin 5 is on the +250 volt power supply bus.

• Carefully unsolder R53 from where it attaches to pin 7 (counting left-right) of the 11-position terminal strip to the front of V9. Connect a new wire to R53, and cover R53 and the new connection with heat shrink tubing. Run this new wire to the new terminal strip at the pin where the cathodes of D1 and D2 are connected together.

• From the anode of the new D1, run a wire to pin 7 of the terminal strip where R53 was removed and solder it in place. This connects the BFO plate to the B+ source.

That's all there is to do, except for enjoying the new ANL action!

I used cotton-covered wire when I made these mods, and it is hard to tell which wires are the new ones. Be sure to document your changes and keep them with the receiver manual so that the next guy down the line knows what's been done.

Receiver Alignment

When all the defective components have been replaced, good tubes are installed, and all the mods that are to be made are finished, it's time to do the final alignment. Be sure that the sideband selection crystals, X1 and X2, are both active and are within 1% of their marked frequency or you won't have much luck doing the IF alignments. Usually a test lead wrapped a few times around V12 with its shield removed will pick up enough signal to trigger a frequency counter.

Hallicrafters' alignment instructions for the 50.75 and 1650-kc IF amplifiers are are confusing, contradictory, and difficult to follow. I have a Hallicrafters service bulletin from the 1970s that makes the 50.75-kc alignment much easier. You will need a VTVM and a frequency counter. As a bonus, this procedure is good for *any* Hallicrafters with a 50.75-kc IF, including the SX-117, SX-115, and the SX-100 Mark II.

• After at least an hour warmup, turn on the receiver calibrator and tune to one of the 100-kc markers on the 80-meter band.

• Center the BFO frequency with the "Pitch" control per the instruction book <u>exactly</u> so that switching from upper to lower sideband causes no change in zero beat. This is the most important step in the procedure. Then set "Selectivity" to the 500-cycle position.

• Connect the frequency counter across the speaker output, set the sideband selector for lower sideband, and tune the dial slightly higher than zero beat until a note is heard. Keep moving the tuning knob higher until 750 cycles is measured. It is important to have it accurate within a few cycles. Be sure the receiver is warm enough so that the hetrodyne is stable and won't change frequency while you are aligning the IF.

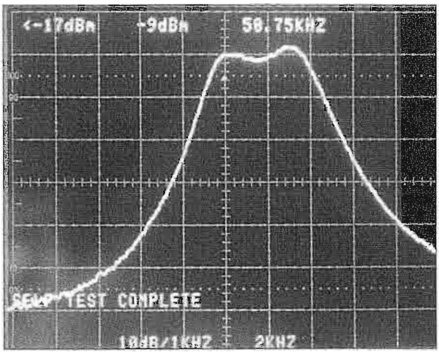

Figure 4: The 6-kc selectivity position is 4.4 kc wide at -6dB.

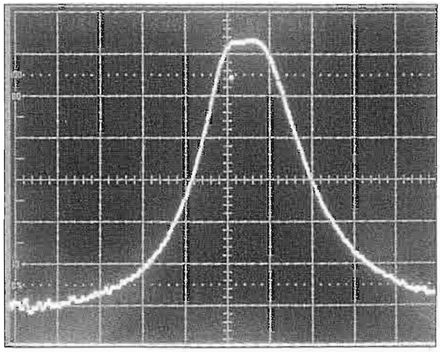

Figure 5: The 3-kc selectivity position is 2.5 kc wide at -6dB.

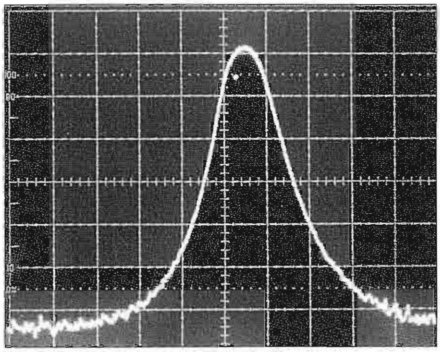

Figure 6: The 1-kc selectivity position is 1.2 kc wide at -6dB.

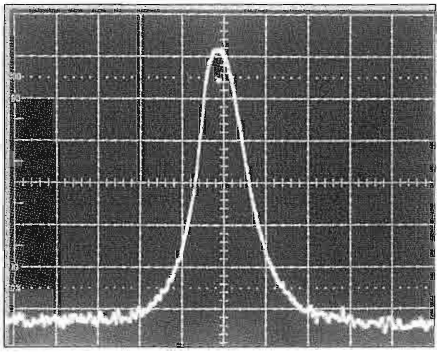

Figure 7: The 1/2-kc selectivity position is 660 cycles wide at -6dB.

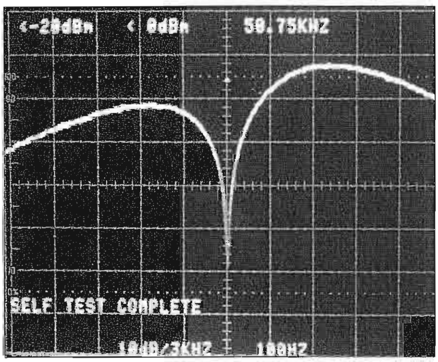

Figure 8: The notch filter has about 48 dB maximum rejection and is about 100 cycles wide at -28dB down. Horizontal scale is 100 cps per division.

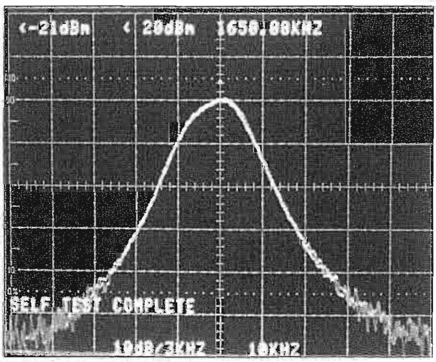

Figure 9: The 1650-kc IF amplifier is 14 kc wide at -6dB. Horizontal scale is 10 kc per division

• Connect a VTVM, probably set to its 30-volt scale, across the speaker terminals, shut off the AGC, and reduce the RF gain until the needle is about half-scale.

• In the 500-kc selectivity position,

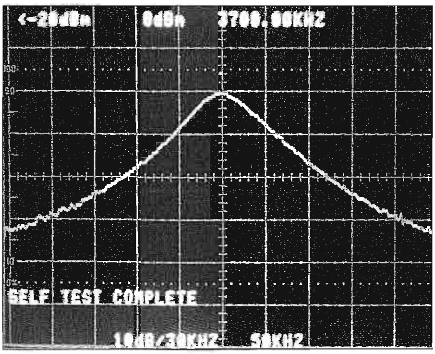

Figure 10: Showing an example of RF alignment, the RF amplifier is 6.25 kc wide at -6dB on 80 meters. Horizontal scale is 50 kc per division.

peak T3, T4, T5 and T6 for maximum 750-cycle audio voltage on the VTVM. Do this 3 or 4 times until no further improvement is possible, but be sure the beat note stays at 750 cycles.

The results of this procedure are graphed in **Figures 4 to 7**. They were made with a low-frequency tracking generator. Except as noted, the horizontal scale is 2 kc per large division, and the vertical scale is 10 dB per large division. I was using 1-kc resolution, and the sweep speed was 2 seconds per division. The bright dot that is near the center graticule line is the 50.75-kc marker. Notice how none of the selectivity positions have the same center frequency, but the lower edge of of each curve is about at the same location and that the upper edge of the passband expands as selectivity increases. This is an unavoidable result of this type of IF filtering and there is no alignment trick that will change things. These curves show the rather remarkable skirt selectivity developed in the SX-101A IF without resorting to expensive crystal or mechanical filters.

If the 50.75-kc IF alignment was carefully done, C27 is not leaky and V6 is not gassy, the notch filter will have a resonse curve similar to **Figure 8**. The notch does a good job removing single-tone hetrodynes, but is not suitable for removing wider interference, such as SSB QRM adjacent to a AM QSO.

1650-kc IF Alignment

Ignore the section of the alignment instructions that discuss the 2nd-conversion oscillator and the 1650-kc IF, they are confusing and obscure. I think they are calling for some kind of a mental sweep generator!

The first IF needs to be aligned at 1650 kc for the frequency conversions to come out right. To do that, connect a VTVM across the speaker terminals and feed a modulated 1650 kc signal into the antenna terminal. Peak T1 and T2 for maximum signal 2 or 3 times, and that's all you need to do. Figure 9 shows the swept response of the 1650-kc IF when it is simply aligned by this method. You can laboriously sweep-tune T1 and T2 for a flatter top, but doing so will result in much less gain in the IF amplifier, and AM signals will sound the same. It is 14 kc wide at -6dB when tuned for a peak, and that is fine.

RF Alignment

The SX-101A can be calibrated so that the 100-kc markers hit every mark on the dial, and the adjustments will be stable. The RF alignment instructions are accurate and easy to follow, except for the oscillator trimmer adjustments. These are high-quality, high-Q, concentric ceramic capacitors that had the adjustment soldered at the factory for best mechanical stability. It is quite likely that most SX-101 local oscillators have never been realigned because it is a rather tedious job, and may be why these receivers have a reputation for having inaccurate dials.

Examine an oscillator trimmer carefully, and find where a threaded shaft has been soldered to a metal star washer. Using rosin solder wick and a big 200-watt solder gun, remove as much of the solder as possible, until the outside of the concentric capacitor is free to turn against the fixed threaded shaft. After all the solder is removed and the caps are free to turn, be sure to let everything cool off before realignment starts, and an hour is not too long.

Set up the dial pointer adjustment per the instruction book. Place the selectivity control at 2 kc.

Following the RF alignment chart in the instruction book, when it is time to adjust the oscillator, zero beat the marker oscillator with the main tuning knob at the high end of the band you are working on. Using the pointer adjustment, zero the pointer at the high end of the dial exactly on the calibration mark without changing the tuning knob.

Crank on down to the low end and set the pointer exactly to the low-end dial calibration mark with the tuning knob, not the pointer adjustment. Now, zero beat the marker signal using the oscillator padding slug (L14, L15, L16, L18, or L17) for the band you are working on.

Go back to the high end and find where the 100-kc marker peaks up. This will probably be lower than where it should be on the dial.

Here is where my procedure is different from the book: With the tuning knob, go ahead and set the dial pointer twice as high as the error you noted. With a plastic or wooden tool, turn the trimmer (C56, C57, C58, C61, C59, or C53) CW to raise the oscillator frequency until it goes thru zero beat and is just slightly higher than the frequency on the dial pointer.

Tune the the dial back down to the low end and set it exactly on the calibration mark. Adjust for zero beat exactly by turning a padding coil slug CCW. Now, go back to the upper end and do it all over again.

Because it's probably been some 40 years since the dial was calibrated, you might need to do this 4 or 5 times for every band. You will know when you are finished. If you set the low end, go back to the high end and no new adjustment is necessary, that's it. If the main tuning capacitor hasn't been abused the calibrator will hit every 100-kc mark on the dial, with a very slight error, less than the width of the mark.

Don't resolder the trimmers because placing merely touching the soldering iron tip to the loose trimmer body will undo the alignment. Instead, gently fix the trimmer in place with a very small dab of conductive epoxy on the end of a toothpick. All it needs is a tiny dab, just enough to hold the trimmer in place. If someone 40 years from now wants to touch up your work, the small spot of epoxy should snap off with diagonal cutters.

Final Performance

Noise Figure: 7 dB
Minimum Discernable Signal (MDS):
80 Meters: -135 dBm (.03 μV)
40 Meters: -135 dBm
20 Meters: -139 dBm (.02 μV)
15 Meters: -114 dBm (.45 μV)
10 Meters: -114 dBm
2-Tone Blocking Dynamic Range:
5-kc signal spacing: 51 dB
20-kc signal spacing: 73 dB
3rd-order Dynamic Range:
5-kc signal spacing: 66 dB
20-kc signal spacing: 85 dB
Image Rejection: 71 dB
IF Rejection: 82 dB
Audio: 2.4% THD at 2.5 watts output power. 3.5 watts maximum audio output at 8 ohms.

Lack of page space prevents a detailed discussion of the results. Sensitivity on 10 and 15 meters could be improved. The data indicates the high sensitivity of the SX-101A will not be useable under some conditions because of dynamic range limitations. For example, subtracting the 20-meter MDS number from the 5-kc blocking dynamic range number shows that it might have problems with average signal levels on the bands. It isn't a contest receiver, but as we all know it is an excellent choice for a great-looking, everyday receiver that will now perform better than ever.

ER

VINTAGE NETS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Advertising Information

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

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Deadline for the January 2006 issue: Wednesday, Dec. 29

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

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

FOR SALE: Large number of Balloon type tubes all checked and boxed. LSAE for list. John Snow, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: S-Line, 516F2, KWM2, Henry 2KD2, 75A4, 75A2A, 310B, HT32B, 664 Mics, n6fx@aol.com or 909-593-1861

FOR SALE: 75S-3B WE $500. G133 VLF rcvr $125. **WANT** R389, R391. Ward Rehkopf, 16173 Indian Valley St., Schoolcraft, MI 49087 269-679-3435. radiohound2@yahoo.com

FOR SALE OR TRADE: Prefer trade for gear in Wanted Ad, but will consider cash offers. Adams Morgan Paragon RA-10 Tuner/DA-2 Amplifier, super condition, works fine; Westinghouse RA/DA Pair, as good as you'll find; Browning Drake Kit, high class job, vernier knobs, exc. components; Sony FX 170 Cassette, new in box, $35. Military RM29A Remote for BC 654, exc.; Westinghouse Type U Graphic Volt Meter; Webcor Wire and early reel-to-reel, call or write, I've got several, will make such a deal! See Want Ad this issue. See our website: http://www.radioattic.com/kremer, Ward Kremer, 1179 Petunia Rd., Newport, TN 37821, Ph/Fax: 423/625-1994, E-mail: witzend99@bellsouth.net Happy Holidays!

FOR SALE: Viking Invader 2000 $1200. Heathkit SB300/SB400 twins $450. You ship. Ken Sands, K8TFD, 734-453-7658, ken.sands@juno.com

FOR SALE: Hallicrafters Skyfone Model CA-4; needs restoration; $40 plus shipping. Please contact: Mike Grimes, K5MLG; 5306 Creekside Ct.; Plano, Texas, 75094, (972) 384-1133. Email: grimesm@flash.net

FOR SALE: Central Electronics 100V transmitter in good condition $850. Bob, W1RMB, 508-222-5553, Thanks.

FOR SALE: Ranger II - $200. Drake 2NT $130. Both + shipping. Edward Sauer, KC9SP, 787 N. Peterman Rd., Greenwood, IN 46142, 317-881-1483.

FOR SALE: Heath DX-60 $60. VF1 VFO $50. Cheyenne MT1 $40. RME VHF 152A $60. Hallicrafters S40B $50. S77A $50. SX-101 $175. Shure 450 microphone $60 new. Richard Cohen, 813-962-2460

FOR SALE: Galaxy 5. DX60, VFO. BC465A. BC625A. RT19 ARC4. **WANTED:** Hammarlund Super Pro dust cover for receiver and power supply. Bill Coolahan, 1450 Miami Drive NE, Cedar Rapids, IA 52402. 1-319-393-8075

FOR SALE: Meissner Signal Calibrator, Model 9-1076. See article pages 2-6 Electric Radio #198. $45 plus shipping. Alan Lurie, W9KCB, 605 E. Armstrong Ave., Peoria, IL 61603. 309-682-1674

FOR SALE: Simpson model 479 TV-FM signal generator. Lafayette model HA-500 AM-standby SSB-CW. $50 each. Call 806-778-3933

FOR SALE: Alpha 78, one owner, excellent condition, low hrs and original manual. $1700. Dan Killian, W4BN, 239-498-9021 W4IUV@aol.com

FOR SALE or TRADE: Collins 32S-3 CCA Exc (winged) $600 shipped or trade toward Collins 51S-1F (rack mount preferred). Rare National HRO-7T mint condx, black crackle finish w/matching spkr (HRO-5 style w/audio xfmr inside) A, B, C, D coils, $400 shipped. Parts Only:

Collins 51J, 75A, 32V, Heath DX-100, Apache. Johnson Viking I, II, Valiant. Gonset GSB 100. Mint 51J-4 light gray panel, $100 shipped. Panel meter and PTO rebuild, repair, or exchange. 73, "Abe," W3DA, DE, 302-349-5389 Before 10 PM EST Please.

FOR SALE: BEEG TOOBS! We recently acquired several WW II thru 50's era new/old stock transmitting and rectifier tubes. All are American made. Most are new in the box. There are small quantities of all, but the 845. Here goes: 828, 872, 815, 813, 812, 811, 845, 866A, 810, 833A, 803, 8008. I would preferably trade for wants, see other ads, but will also consider cash offers. Happy New Year! Ward Kremer, 1179 Petunia Rd., Newport, TN 37821. Ph/fax: 423-625-1994. Email: witzend99@bellsouth.net. Website: http://www.radioattic.com/kremer

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FOR SALE: Original Viking VFO manual $25. Copy Viking Ranger II manual $20. Heath SB-614 Station Monitor with manual $150. Prices shipped. W8VBQ, John, 513-575-5561, Najomccollum@aol.com

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

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FOR SALE: Johnson Thunderbolt. Recent rework, clean, $600 w/ two spare 4-400A PA tubes. Guaranteed, local pickup preferred. Don, K5AAD, 713-942-9747

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

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

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

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

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

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

FOR SALE: BC-610I, Apache. Mohawk, Warrior, Marauder, Thunderbolt, Valiant, AR-88D, Globe King 500C, Globe Champion 300, and lots more. N9ZSV, 479-675-4376 n9zsv@cei.net

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FOR SALE: Head Sets telephonics (nothing else) gray oval ear piece w/mic built in.head band good. pops clear. $15. Military, ANB-1A CQF (NAF 48490-1) tan oval, ear piece. no pop. $5. Hallicrafters Mod. S38 Grey.(1st) a/o plays @9 $60. Bernie Samek 113 Old Palmer Rd. Brimfield, MA 01010 bernies@samnet.net 413-245-7174 fax 0441

FOR SALE: New Dow-Key 1.5-30 Mc, DKC-RFB tube preamp. Best offer. Gary, KØCX, kzerocx@rapidcity.net 605-343-6739 evenings

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FOR SALE: Lafayette HA-460 6M AM transceiver, 20W, 117V/12VDC. VG Condx. $65 plus ship. Dave Parker, wb9whg@jvlnet.com 608-234-1738.

FOR SALE: Svetlana 811A ceramic base (Russia) Never used, brand new in box. $55 Shipped. Bob, KD9GI; KD9GI@MSN.COM. 815-332-9520

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
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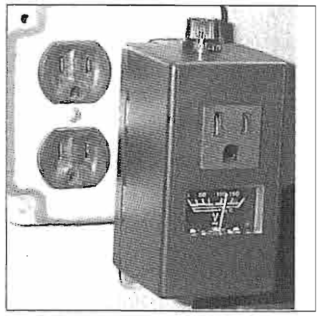
(4 or more limiters are shipped free for US orders. Overseas customers please ask for shipping quotes.)

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. All models come with a full money-back guarantee.



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Electric Radio Store
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DRAKE COLLECTION FOR SALE: R4-B, T4X-B, MS-4/AC-4. TR-4, RV-4/AC-4. SW4-A, MS-4. All manuals, cables and spare tubes, $1100, prefer meet or pick up. Steve Davis, KD2NX, 71 Oak Street, Keansburg, NJ 07734, (732) 495-8275, kd2nx_66@yahoo.com

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

FOR SALE: Prop pitch motor $100. Solid-state 4 channel mixer VU sloping panel broadcast quality $100. Rudy, W2ZIA, 3411 Home Rd., Alden NY, 14004 716-937-9279.

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: Ten Tec Model KR-50 electronic keyer, no manual, excellent, $50. Len Gardner, 458 Two Mile Creek Rd., Tonawanda, NY 14150 radiolen@att.net

FOR SALE/TRADE: Manuals and Sams Photofacts: Hallicrafters, National, Hammarlund, Collins, RME, Gonset, Heathkit, EICO, Harvey Wells. NI4Q, POB 690098, Orlando FL 32869, 407-351-5536, ni4q@juno.com

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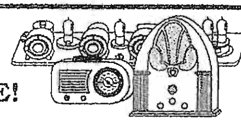

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FOR SALE/TRADE: Transmitting/ Receiving tubes, new and used. LSASE or email for list. **WANTED:** Taylor 204A, 211, TR40M and Eimac 500T. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS. 66213. PH: 913-782-6455, Email: jwalker83@kc.rr.com

CRYSTALS FOR SALE: AM and CW FT243 CRYSTALS - NEW LIST: 1885, 1900, 1930, 1945, 1970, 1985, 3721, 3837, 3855, 3870, 3875, 3880, 3885, 3890, 7018, 7050, 7123, 7143, 7250, 7255, 7260, 7280, 7285, 7290, 7293, 7295, 8400, 10106, 14286 kc. Many others available - See list at http://www.af4k.com/crystals.htm or call Brian, AF4K on 407-323-4178 af4k@hotmail@com

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

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

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

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

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

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

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

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

FOR SALE: Send for Free list TT for obsolete Triplett transformers, chokes and manual copies. USA only. 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

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.

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

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

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

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

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

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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

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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

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

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

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

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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

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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

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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

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

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

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

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, 1545 S CR 1150 W, Parker City, IN 47368

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

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

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WANTED: TCS cable mounting connector to mate with the TCS-12 transmitter. James Owens, NWØO, 1363 Tipperary St., Boulder, CO 80303, 303-673-9019.

WANTED: Modulator 50-100W range with 3k output. WA9SUE, Cliff, 608-625-4527

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

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

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WANTED: Heathkit AT-1 in good condition. Phil, w1gee@yahoo.com, 207-862-5953

WANTED: Hammarlund HX50A Tube SSB Transmitter or other early tube SSB transmitter gear; Power supply unit COA 20165, antenna 66066, mic 51037 for my COA 43027 Navy type MS Transceiver; aka, Abbott TR4! Flexible coupling cable for MN-20/MN-52 loop set-up; Connectors for DZ-2 Set. Always looking for: WW I era battleship sets: IP 500; 501; Marconi 106; National 239/112; early 20's supers; Navy 10; Leutz, etc..; WW I, WW II Radio Compass Gear and sets. See For Sale Ad this issue for possible trade or cash deal. Always buying vintage mics; flags; stands; tube compressors; mixers; pre-amps. See our website: http://www.radioattic.com/kremer, Ward Kremer, 1179 Petunia Rd., Newport, TN 37821, Ph/Fax: 423/625-1994, E-mail: witzend99@bellsouth.net. Happy Holidays!

WANTED: 70H1 PTO, R390 IF deck, R389 parts, G922 tubes. Ward Rehkopf, 16173 Indian Valley St., Schoolcraft, MI 49087 269-679-3435. radiohound2@yahoo.com

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

WANTED: EF Johnson Signal Sentry Dead or Alive. Merry Christmas OMs! Jeff, KEØMT, 720-855-7347 ke0mt@aol.com

WANTED: HP606B, HP8708, HP411, HP455, Silver PA 210. Dean Soderling, 6725 Portland Ave S., Richfield, MN 55423 612-869-9264

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: Mint operational T-368 exciter. W4RML, Cliff Christlieb, 1928 Sycamore, Tavares, FL 32778 352-253-0112

WANTED: Navy WW2 shipboard receivers and transmitters. Need equipment, manuals and general operating information. Receivers of the type RAK, RAL, RBA, RBB, RBC, RLS etc, Transmitters of the type TBA, TBK & TBM (with modulators), TDE TBS etc. Equipment is for the restoration of Radio facilities aboard the **USS Alabama (BB-60)**, now part of the Battleship Memorial Park, Mobile, Alabama. I was a Radio Technician aboard the Alabama in WW2 and would like to hear from other WW2 RTs and Radio Operators concerning radio operating and maintenance procedures aboard other Navy WW2 ships. Please call Stan Bryn, AC5TW, at 1-800-984-9814 week days between 0800-1100 MST. Or email intor@zianet.com.

WANTED: The W3EWL "Cheap and Easy SSB" homebrew SSB transmitter in any condition. It is a BC-458 ARC-5 converted to a phasing type SSB 75 or 20 Mc transmitter. (Anthony Vitale QST March 1956) Ted Bracco, WØNZW. braccot@hotmail.com 217-857-6404 Ext 306

WANTED: Info on VLF loop coupler CU-352/BRR for SRR-11 RAK RBA VLF rcvr. Weber, 4845 W. 107th St., Oak Lawn, IL 60453

WANTED: Ribbons for older teletype machines. Bob, KL7HDY, 907-346-1044. 9501 Brien St, Anchorage AK 99503

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

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

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

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

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

WANTED: INTECH COM 6000 Service Manuals: COM3648, COM1000, COM1005 HF SSB Marine radio. Wes, K5APL, 870-773-7424 k5apl@cableone.net

WANTED: Meter movement for a Knight KG-600B tube tester or the complete tester for parts. Johnny Umphress, 1415 Moore Terrace, Arlington TX 76010, 817-915-4706

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

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

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

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

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

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

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

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WANTED: WW II German, Japanese, Italian, French equipment, tubes, manuals and parts. Bob Graham, 2105 NW 3Oth, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

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

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

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

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

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

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

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

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

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

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

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

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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

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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

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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: 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

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WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI 16 Carly Drive Highland NY 12528. 895-691-6247 WANTED: Circuit for the "Mitey-Mite" transmitter-receiver. Harold Schaffner, W2GMX, 519 Perine St., Elmira, NY 14904.

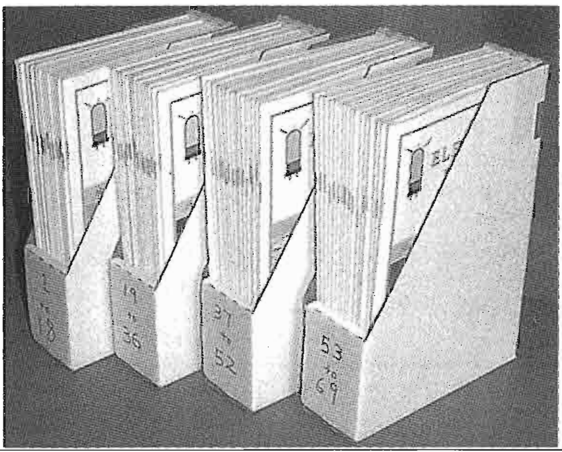
WANTED: Scott Special Communications rcvr. EA4JL, please call Kurt Keller, CT, 203-431-9740, **WANTED:** QSL card from W9QLY, Frank (Mac) Maruna, from 1956 or before. WILL PAY TOP DOLLAR. Don Barsema, KC8WBM, 1458 Byron SE, Grand Rapids, MI 49506, 616-451-9874

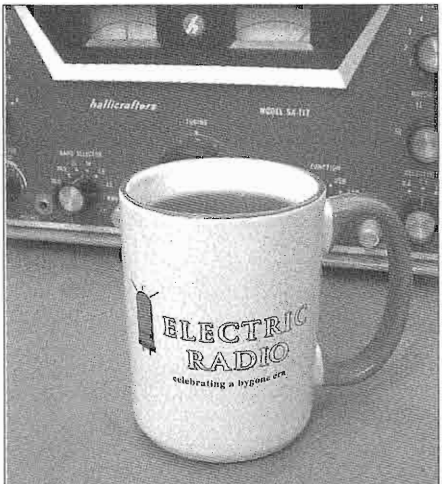
WANTED: PYE, Fairchild, Syncron, Langevin. Richard P. Robinson, PO Box 291666, LA CA 90029 323-839-7293 richmix@erols.com

WANTED 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





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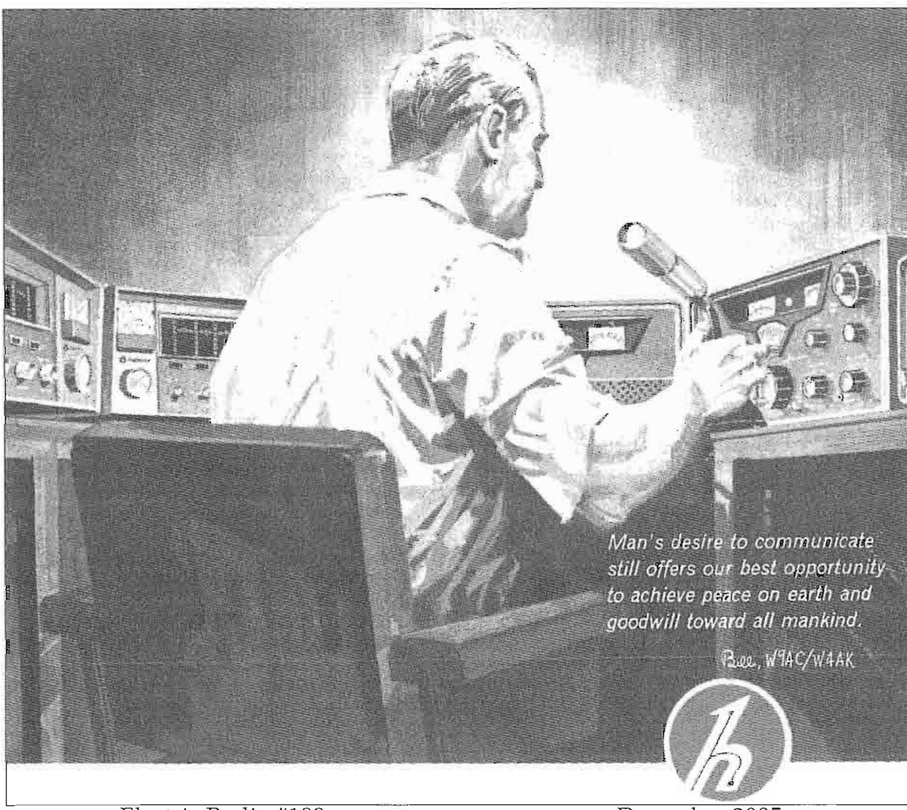

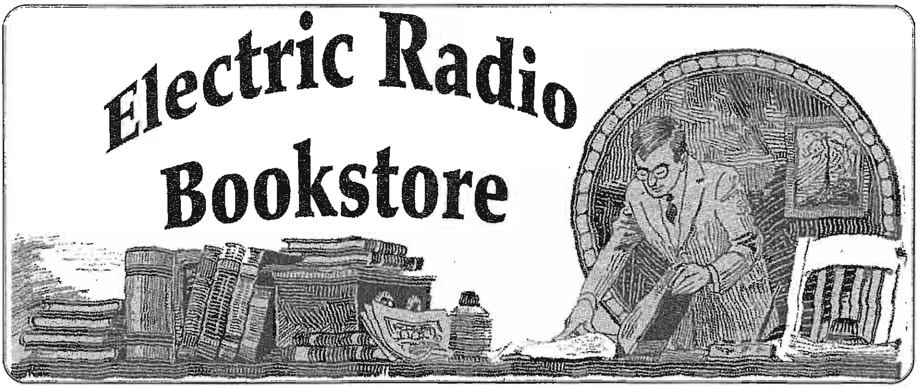

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