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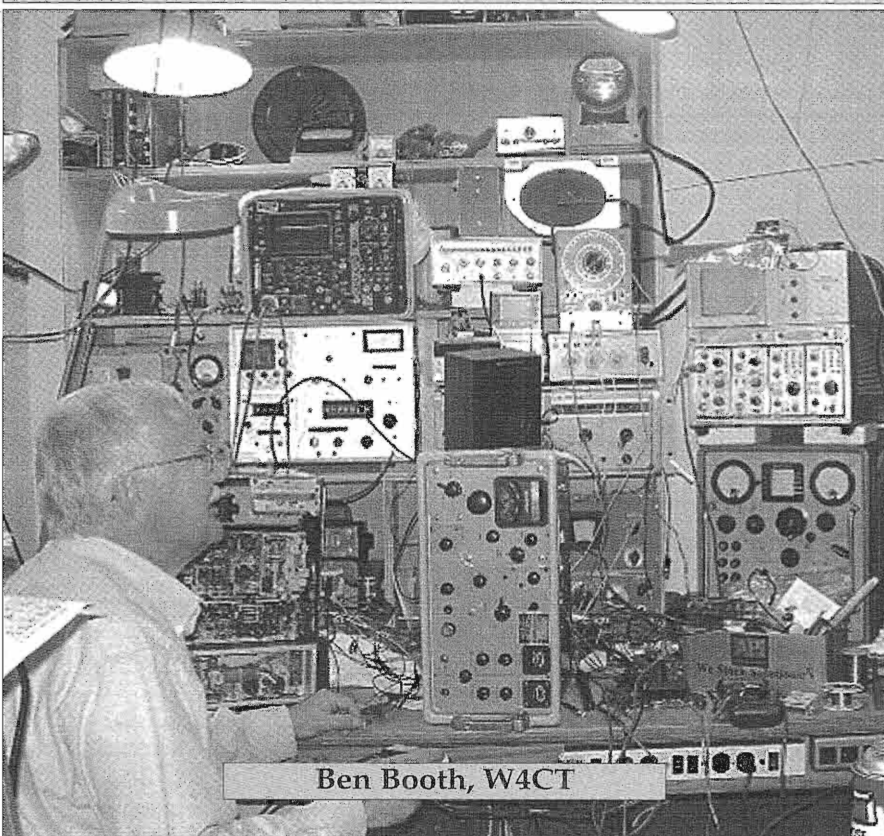
ELECTRIC RADIO

celebrating a bygone era

Number 198 November 2005



Ben Booth, W4CT

ELECTRIC RADIO

Published monthly by Symbolic Publishing Company
PO Box 242, Bailey, Colorado 80421-0242
Periodicals postage paid at Cortez, CO
Printed by Southwest Printing Inc., Cortez, CO
USPS no. 004-611
ISSN 1048-3020

Postmaster send address changes to:
Electric Radio
PO Box 242
Bailey, CO 80421-0242

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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.

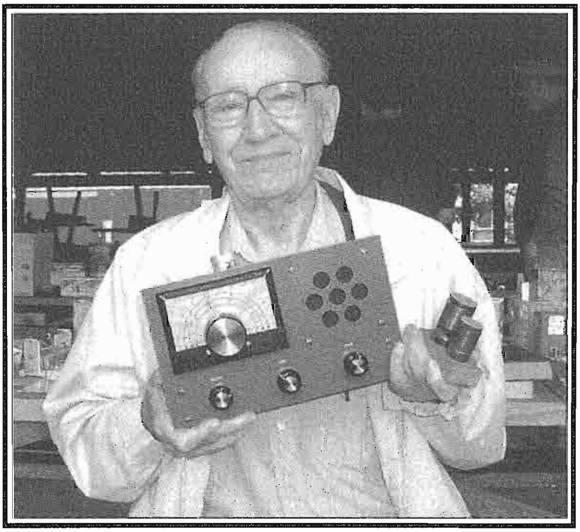
We depend on our readers to supply material for ER. Our primary interest is in articles that pertain to vintage equipment and operating with a primary emphasis on AM, but articles on CW, SSB, and shortwave listening are also needed. Photos of Hams in their radio shacks are always appreciated. We invite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

Bob Dennison, W2HBE, SK

I am sorry to report that Bob Dennison (W2HBE) has passed away after a short illness. I never met Bob in person, but I felt like I knew him well because of our many telephone conversations and letters. I didn't have an Elmer as I was getting into radio, but if I had been fortunate enough to have someone like Bob Dennison I would have been proud.



Bob Dennison, W2HBE. This photo was made during August 2004 by John Dilks (K2TQN). Bob was holding the unnamed homebrew shortwave receiver that he described in ER #167, April 2003.

I remember finding a copy of the October 1955 QST that presented his "A Deluxe Amateur-Band Receiver" homebrew superhet. It featured a Collins filter and a nice preselector, so right away I started collecting parts to build a copy of it. Over the years, Bob authored many articles in the Ham press that were an inspiration to everyone. He wrote 56 articles for Electric Radio. The first one appeared in ER #3, July 1989, and the final one was just last year in ER #183, August 2004, "The Skylark Radio Receiver."

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Cover: Ben Booth (W4CT) is working on a 1955 RCA SRA-14-A Navy shipboard receiver in his home radio shop. Ben was first licensed in 1951 as WN3SFP, and was a military radar technician from 1954 to 1955. His present call was issued in 1997.

The Meissner Signal Calibrator

By Chuck Teeters, W4MEW
110 Red Bud Lane
Martinez, GA 30907
Photography by Tony Chang, WW4TC

From 1946 until the start of the Korean conflict, times were tough at the Signal Engineering Labs at Fort Monmouth N.J. The war was over, the military was shrinking, and no money was allocated for Signal Corps developments. Many radio projects at Squire Lab were supported by surplus stuff left over from the "money flows like wine" days of WWII. The large basement, under the crypto vault, was an equipment storage area that would have put the surplus stores of radio row in New York City to shame. In addition to supporting official projects, it provided parts and equipment to many of the hundreds of Hams working at Fort Monmouth. It was convenient that the Commanding General at Monmouth was a Ham.

As a gofer for senior engineers, I was familiar with a lot of the stuff in the basement. I also had a whiz pass, which allowed me to transport government equipment on, off, and around post in my private automobile. I was therefore in demand by many of the local Hams. The suitcase 813 amplifier used by the Jersey Shore Radio Club for field days was an OSS unit that I had liberated, and half of the Hams in Monmouth County were using RG-17 coax that had ridden in the trunk of my 1947 Chevy. The rapid growth of Ham teletype in the New Jersey area was due to the great number of Model 15 machines formerly housed in the Squire basement.

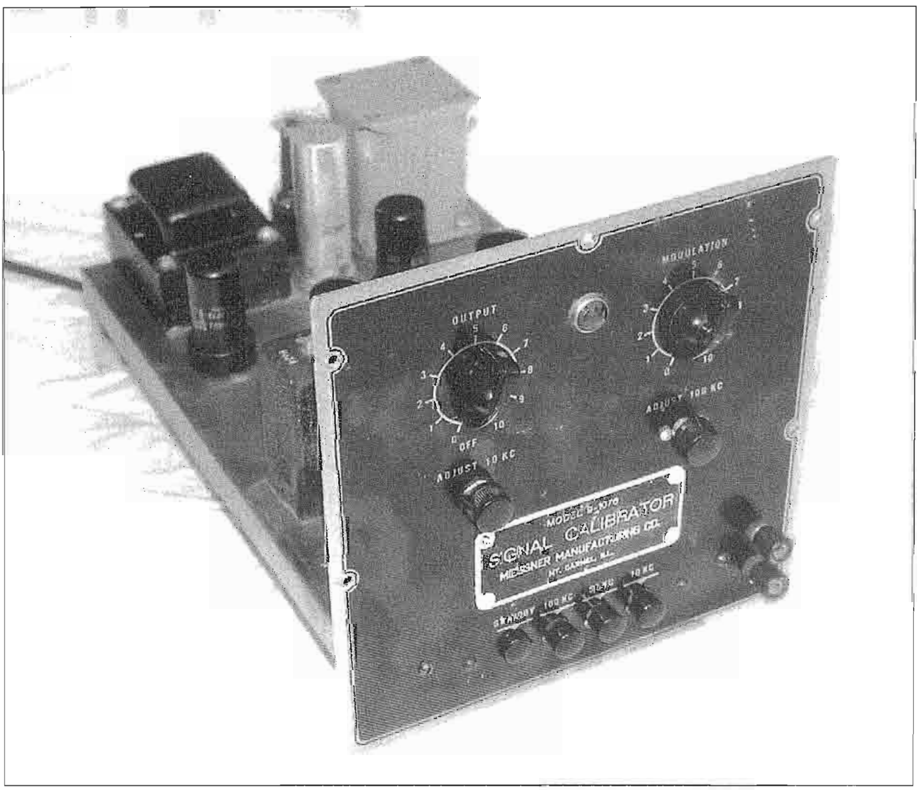
An interesting item in the basement was a Meissner 150B transmitter, a 55" wide desktop plug in coil 100-watt AM/CW transmitter. Next to the transmitter was a Meissner Signal Calibrator which looked interesting, but I already had a calibrator. Even though it was small by Meissner standards, the calibrator was twice the size of my Hallicrafters HT- 7 clone, so I passed it up. Our resident frequency control engineer (and Ham teletype guru) Marv Bernstein (W2PAT) told me the Meissner was a much better unit, so I decided to go down to the basement and get the Meissner Calibrator. However, I was too late; someone had taken the Meissner 150B and the calibrator. Every so often I wondered if I had passed up a great find, as I had never seen one since.

About five years ago I bought some old radio books. One was a 1943 Meissner "How to Build" instruction manual that included the 1941 Signal Calibrator. Four pages were devoted to the theory and use of the calibrator. It renewed my interest in what I had passed up 58 years ago, so I started to look for one. As luck would have it, I was 3000 miles from home, at the Washington State Hamfest and there was a Meissner calibrator that looked like new and had a price that said take me home, so I did via UPS.

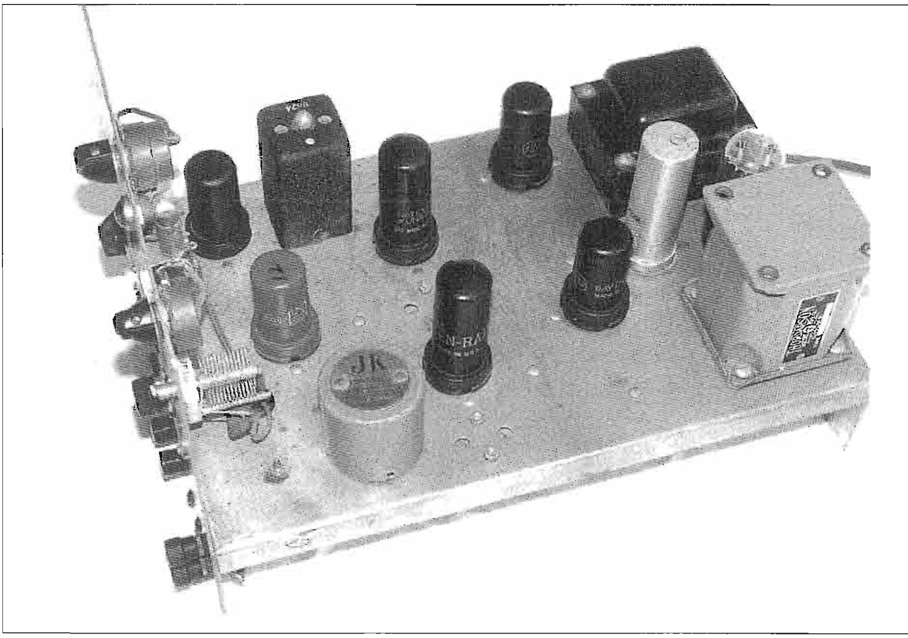
The Meissner Manufacturing Company was a Chicago, IL, radio frequency coil, wire and bakelite products manufacturer that built parts for the radio industries and wholesalers around Chicago. Their products were sold under Meissner and DeJong names. The early catalogs of Allied Radio list Meissner products such as IF transformers, RF chokes and coils, and bakelite knobs. Meissner and DeJong started the coil and capacitor company in 1924. Meissner's daughter Clara's husband, James T. Watson, took over the business in 1934 at the height of the depression. Watson moved the business 200 miles south to the small town of Mount Carmel, Illinois in 1935 to reduce costs.

In the thirties, many radio parts manufactures were turning out radio kits to help the sales of their products. Thordarson, Utah, and Stancor were selling Ham transmitter kits using their transformers. Watson saw there was no competition in the communications receiver kit business, and aimed Meissner in that direction with the "All Wave 8", "Traffic Scout" and "Traffic Master", 8, 9 and 14-tube communications receiver kits. Another hole in the kit field that Watson found was the ECO, the electron coupled oscillator, a VFO crystal substitute, employing a tetrode tube with electron coupling to the output for stability. The "Signal Shifter" kits were sold from 1939 until 1949. You can still find "Signal Shifters," however, the Meissner kit receivers have disappeared. I have been looking for a Traffic Master for years and have never found one.

The build up for WWII elevated Meissner from a small 55-employee company to a 400-man operation. They built transmitters and test equipment in addition to coils for the Army Signal Corps, and earned the Army-Navy "E" award for outstanding efforts. In 1945, at the wars end, Meissner was one of several



Front panel view of the Meissner Signal Calibrator, model number 9-1076

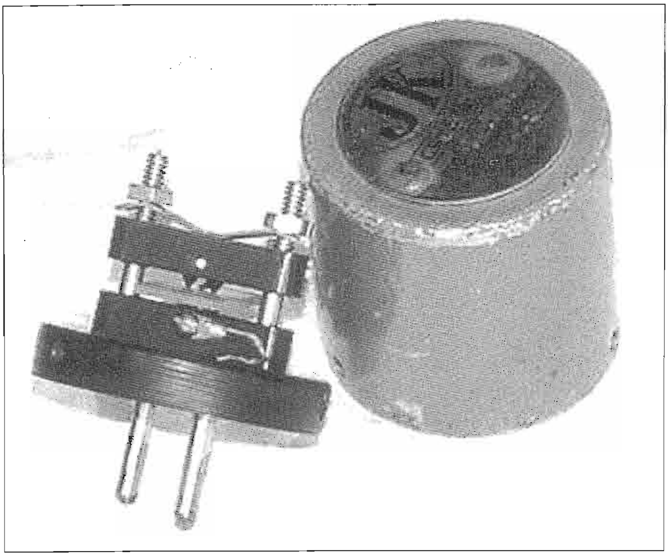


The insides of the Meissner Calibrator are seen when removed from the cabinet.

electronic manufactures bought by Components Corporation of America (CCA). The chief of the CCA was Gene Powers, with offices in New York City. Powers directed the post-war Meissner product line towards home electronics, AM/FM radios, phonographs and disk recorders. Probably their two most prolific post-war products were the 8C FM tuner and the model 11-1045 portable (at 45 lbs?) radio-phono-disk recorder. In 1950, Meissner was merged with the Thordarson transformer company, also owned by CCA. In 1958, CCA closed the plant in Mount Carmel, and the Meissner name disappeared from the radio market.

The 11-1006 Signal Calibrator is a crystal-controlled signal generator with output signals every 10 kHz from 100 kHz to 30 MHz. The frequency of the output signals is accurate to better than 10 parts per million. Push button switches allows selection of 100, 50 or 10 kHz signals and their harmonics up through 30 MHz. Two additional controls allow for modulation for signal identification, and adjustment of the output level. The Signal Calibrator is used with receivers to provide reference signals to calibrate the receiver dial, check the frequency of received signals, or check the frequency of nearby transmitters. Even with the limited frequency read out on most receivers of the thirties and forties, the calibrator allowed settings with in 1 kHz. You would find the closest 100-kHz harmonic to the desired frequency, then select a closer 50 or 10 kHz output harmonic, and interpolate to the exact frequency. If the receiver bandwidth was wide enough, a 5-kHz beat could be heard between the 10-kHz signals to help the accuracy of the setting. Most receivers of that era were more than wide enough.

The calibrator uses a 6K8 100-kHz crystal oscillator as its standard. It is followed by 6SK7 buffer amplifier, which locks in



Knife edge crystal mount with the cover removed. The tensioning screws can bee seen at the top sides, a critical adjustment.

two 6N7 multi-vibrators operating at 50 kHz and 10 kHz. Two 1852 hi-gain, broadband, cascaded amplifiers provide the output signals. The first 1852 is overdriven to generate harmonics, and the gain of both is adjustable by a front panel cathode-bias control. The second 1852 is suppressor grid modulated with a 60 Hz. signal for identification when necessary, controlled from the front panel. A push button switching assembly allows switching power and the amplifier input to the 100-kHz crystal oscillator, the 50 kHz, or the 10 kHz multivibrators, or it will turn off the B plus for stand-by. A transformer operated power supply with a 6X5 full wave rectifier provides operating voltages.

The most interesting thing in the calibrator is the 100-kHz crystal. It is a GT cut plated crystal in a knife-edge mounting. The GT crystal is rectangular with a ratio of width to length of 0.855. The GT was developed by William Mason, at Bell Telephone Labs, in the late thirties. The GT cut provided a crystal with a temperature coefficient of zero over a temperature range of 35 to 120 degrees Fahrenheit. Mason developed the crystal for Western Electric (WECo) SSB equipment. WECo 100-kHz SSB crystal lattice sideband filters had used Y-cut crystals since 1933. They would change frequency about 50 hertz per degree at 100 kHz. The GT cut eliminated drift problems with the crystals in the lattice filters. Each filter used eight crystals that had to be matched within a few hertz and the temperature induced frequency changes affected the filter characteristics.

As a side note, the WECo sideband filters were used in all WECo SSB transmitters and receivers the Army bought, starting in 1942 until the late seventies when the fixed station SSB high-frequency links were shut down. To meet the Signal Corps specs, when other companies built twin channel SSB equipment, they had to use WECo SSB filters. I always got a kick out of seeing WECo filters in Collins, TMC, Magnavox, and other military SSB exciters and receiving converters. Collins particularly went to great efforts to get a mechanical filter to meet the government specs in their OA-2180 exciter but never could. When the Army started transmitting the 16-kHz wide F9C spread spectrum crypto system over HF radio, the mechanical filter had to be taken out of the R-390A receiver due to phase shift problems. This incidentally led to one of the best cold war cover-ups the Army ever devised. To avoid drawing attention to this seemingly backwards step in receivers, an Army direction finder system took the hit as the reason for the change. Removal of the mechanical filters from the R-390A was blamed on the DF system phase shift limitations. The F9C system remained undetected well into the satellite communications era, and was used on Army Satcom links for several years.

Most amateurs are not familiar with GT crystals as they are only useable at very low frequencies. Similarly, knife-edge mounting can only be used with plated crystals at low frequencies that use longitudinal vibrations, which have a central nodal point. They are usually not seen in amateur practice. The calibrator instruction book refers to the knife edge holder as preferable to the air gap holder commonly used at low frequencies, as it eliminates mechanical vibration problems. I have used air gap holders and know that you don't shake them, or lay them on their side or back and expect them to work. They are in the same category as mercury wetted relays. To work on either, you lay on your back under an elevated chassis.

The Seattle calibrator looked like it was ready to go, but 60 years was more than some of the caps were good for. A new dual 20 mfd at 450 volt filter cap took care of the high voltage power supply. Replacing a couple of leaky .1 mfd and .01 mfd caps, and a de-oxidizing of switches and tube sockets completed the restoration. A bad 6K8 showed up when the power was applied and oscillator grid current didn't show up. A new 6K8 and everything was doing what it was supposed to do.

The first order of business was to zero the 100-kHz crystal to WWV with the front panel 25 pfd trimmer. The next test was connecting the HP frequency counter to the output and using the hair dryer on the crystal. It moved up less than 1 Hertz. I put the crystal in the freezer for 10 minutes, then back in the calibrator and used the dryer again. It moved less than 1 Hertz again. When I happened to put the dryer on the APC-25 pfd crystal trimmer it went up 3 Hertz in less than a minute. I guess you would need an oven on the trimmer, not the crystal, for extreme stability. However, the trimmer uses the front panel as a heat sink, and the hot tubes are at the rear of the chassis so apparently it was not a problem. The multi-vibrators stayed locked in with line volts changes of 105 to 130 volts. It certainly appears that the Meissner calibrator more than meets its spec of better than 10 parts per million.

Overall, the Meissner calibrator is a nice, solid, well designed and a very useable unit even though it is over 60 years old. I don't know if it is worth waiting 50 plus years for one, but in my case it proved that I did make a mistake by not moving fast enough on W2PAT's advice. A belated thanks Marv, and rest in peace.

ER

Variocoupler Era Radio

By Bob Shrader, W6BNB
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A once popular piece of radio gear but never seen any more, is my 18-inch long, 2-coil "variocoupler" shown in **Figure 1**. It dates back to the early teens. At the right-hand end is a 4.5-inch diameter, green-silk thread insulated copper-wire coil. A strip of the silk insulation has been removed along the top of this coil. The black metal slider on a runner at the top can be moved across the bared wires. The slider can move from the first turn, at the left end of the coil to any of the other 275 turns. A small "condenser" (capacitor today) was usually connected between the left-hand terminal of the coil and the slider. Such an inductor-condenser (L-C) "resonant" circuit was used to tune over the medium frequency (M-F = 300-3000 "kc" or kHz today) band. With a larger condenser it could resonate over the old maritime low frequency band (L-F = 30-300 kc). Large coils were used to increase the "Q" or quality of operation of these old L-C circuits. The higher the Q the more selective the L-C circuits were and the stronger the radio frequency (r-f) alternating currents (ac) developed in them. Today we often use low-loss powdered iron cores with only a few turns for high-Q r-f resonant circuits.

The left-hand 3.5- inch diameter, 300 turn golden silk-insulated coil can manually be pushed into or pulled out of the larger coil on the two round metal rails. The term variocoupler means it is a variable form of r-f transformer. If the smaller coil was called the "primary," the larger coil would be the "secondary," but the use of these terms might be reversed. The transfer, or coupling of r-f ac energy can be increased from almost nothing with the primary pulled out, to a maximum when it is pushed all the way inside the secondary. On the left end of the primary coil is a 12-position switch connected internally to taps every 25 turns along the coil. Not visible behind the primary are two flexible-wires. One connects to the far end of the primary and the other to the rotor of the switch, terminating at two of four binding posts on the back of the wooden coil-mount at the far end of the secondary. The switch determines how many primary turns are used.

Variable condensers were not used in early-day radios because tapped coils were less expensive and only the M-F

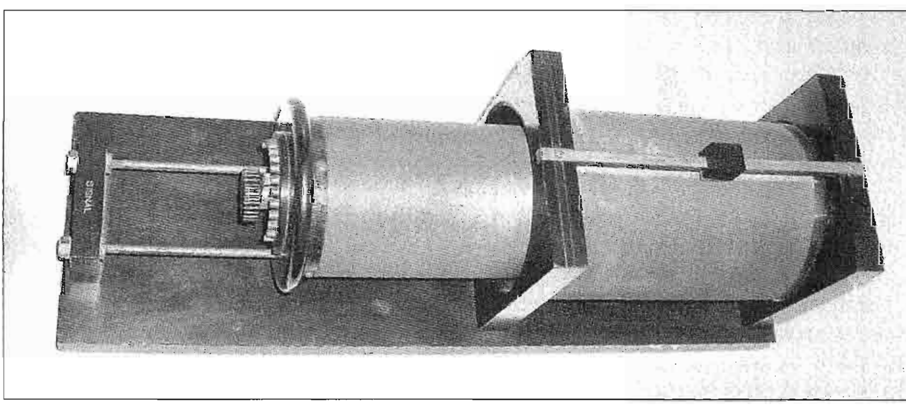

Figure 1: Dating from before 1920, this 2-coil variocoupler is 18 inches long.

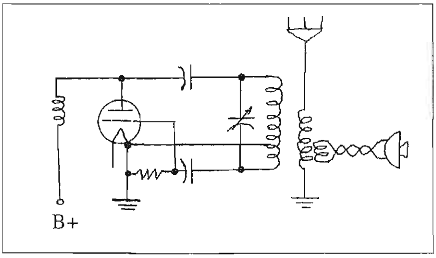

Figure 2: AM loop modulation of a Hartley oscillator transmitter.

and L-F bands were used. Tuning was by changing the number of turns of the resonant L-C circuit coils. The capacitance of some parallel resonant L-C circuits was only whatever happened to exist between the coil turns. More often a small value fixed condenser was added across the portion of the coil being used. In the early days of radio the bandwidth of spark, voice and music signals was quite broad, so a highly selective tuning circuit was not as necessary as it is today. Later, when variable condensers became available they provided a smoother frequency variation than was possible with a turn-by-turn slider, or by switching taps across coil turns. With variable condensers, fixed-turn coils could be used.

In the very early 1900s transmitted radio signals were mostly from "spark" type transmitters using American or International Morse codes. The triode vacuum tube (V-T) was invented in those first years of the century, but they were expensive and at first were hard to acquire. When V-Ts finally became available, early amplitude modulated (a-m) transmitters using them were quite simple and low powered (5-20 watts).

One of the early methods of transmitting a-m signals used only a "carbon-button" telephone microphone. It was connected to a two or three turn loop of insulated wire. The wire loop was either wound around, or pushed in between the turns at the ground end of a V-T transmitter's antenna coil or its oscillating L-C "tank" circuit coil, **Figure 2.** When spoken into, the loose carbon granules inside the microphone were pushed together and released by any audio frequency (a-f) air waves vibrating its thin metal diaphragm. This resulted in a decreasing and increasing resistance in the microphone. Changes in resistance varied the amount of r-f power the microphone absorbed from the transmitter's output. Therefore r-f radiated power from the antenna was changing in amplitude by a small amount at the a-f rate. This was known as "loop modulation."

Probably not considered then, varying the resistance across the loop also changed the frequency of any self-excited Hartley or Colpitts L-C oscillator, producing frequency modulation (f-m), pretty much unknown at that time, as well as a-m! With a slight off-frequency tuning of a receiver, detection of both types of modulation resulted, producing a reasonable amount of voice or music modulation with not too much distortion. As stations increased their r-f power output, the loop modulation microphones would heat up and tended to weld the carbon granules together. A sharp rap on the side of the microphone every so often would shake the granules loose. With higher r-f power output transmitters, touching the metal microphone could produce a nasty little r-f burn on one's finger, or worse yet, on one's lip, believe me! To keep a good distance from a stationary carbon button microphone, a cardboard megaphone might be mounted in front of it, with the small opening at the microphone. Then it was not necessary to get near to, nor shout as loud at the microphone!

When tubes became more plentiful, a-m transmitters used several of them to increase their power output. They added amplified voice or music, audio frequency AC, from microphones in series with the dc plate current of the final V-T r-f amplifier as in the **Figure 3** diagram. The result was a greatly improved a-m emission. Now no f-m was developed and the radiated r-f ac could be made to vary

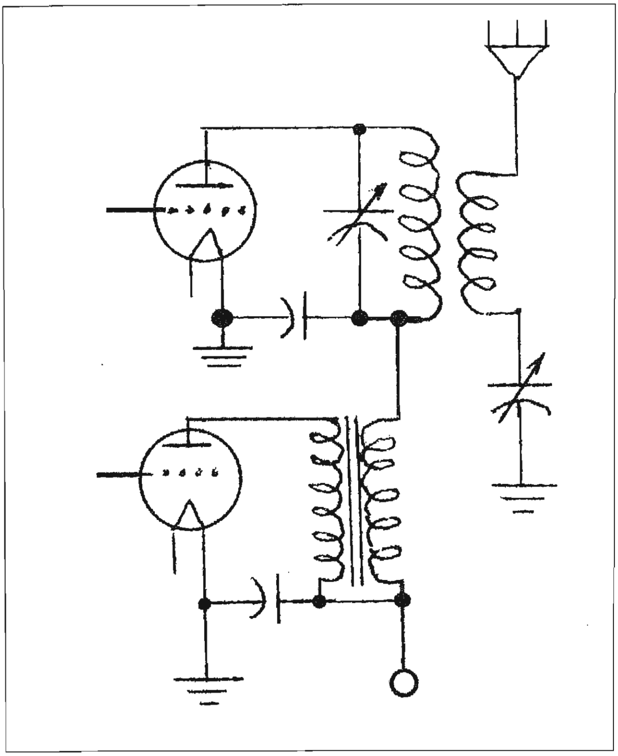

Figure 3: Plate amplitude modulation of a final RF state. Top tube is the RF amp, lower tube is an AF modulator.

from a steady no-modulation r-f ac voltage "carrier" level to twice the r-f voltage on positive voice peaks, and then down to zero r-f voltage on negative peaks. This is known as 100% amplitude modulation and is the maximum that can be produced without distortion. If the modulated signal only goes half way to both

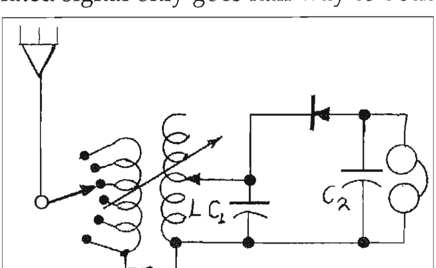

Figure 4: Diagram of a crystal coupler using a variocoupler.

maximum and to zero from the carrier level, it is called 50% modulation, is half as loud a signal voltage and is said to be "down 6 dB" (any -6 dB means half voltage) from 100% modulation. Reducing the modulation to 25% is another half voltage or -6 dB, to -12 dB, resulting in rather a weak signal.

The first really simple practical radio receiver was the "crystal detector." It required no power supply, using instead the r-f ac power in the radio signal being received to move the earphone diaphragms. The buzzing sound of the 60-500 cycles-per-second ("Hertz" or Hz today) power-line ac that developed the sparks in spark transmitters, produced a broad band of frequencies, as did speech and music. All of these could be detected and made audible by crystal sets. The first earphone was the long, heavy, telephone company "receiver" unit. Smaller and lighter earphone pairs were soon produced. One unit was used against each ear and the two were held in place with metal bands over the top of the head.

Crystal detectors depended on the rectifying effect produced by a thin, sharp wire, called a "catwhisker," touching a piece of metallic crystal at a "sensitive" or efficient rectifying spot. (These were the first "solid-state diodes!"). Rectifying the modulated r-f signal changed the received modulated r-f ac to a varying r-f "pulsating direct current" (pdc). When flowing through an earphone the varying pdc vibrated the diaphragm according to the a-f modulating ac variations. A diagram of a possible crystal detector receiver circuit using the variocoupler above is shown in **Figure. 4**. The arrow through the two adjacent coils indicates a variably-coupled transformer, not the more normal fixed-coupled type. Here, a lead-in wire, usually from a several-parallel-wires horizontal antenna, is brought down to the rotor of the switch to select how many coil turns are used in the antenna-to-ground circuit. When electromagnetic (e-m) r-f ac fields pass across an antenna wire, r-f voltages and currents are developed in the antenna-ground circuit. These currents develop expanding and contracting e-m fields around the primary antenna coil, inducing the same r-f ac into the secondary parallel L-C1 circuit. Where the slider is set determines the frequency at which the detecting circuit resonates. Any radio station transmitting on that frequency was rectified by the catwhisker-crystal junction, delivering r-f pdc through the earphones to ground. To smooth the r-f dc pulses and raise their average value somewhat, usually a fixed .001 microfarad (μfd) condenser, C2, was connected across the earphones.

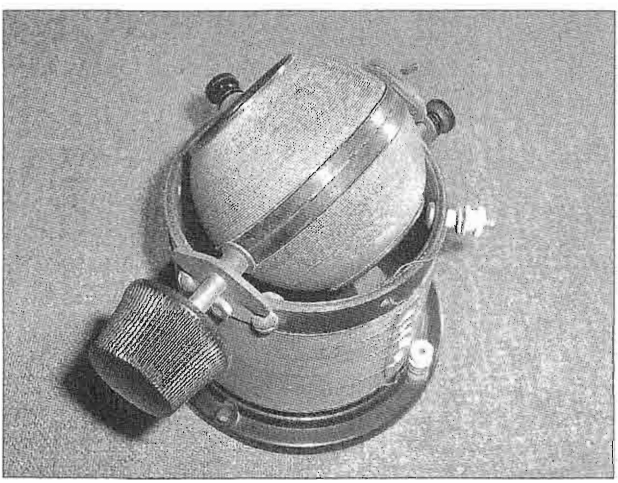

Figure 5: Small variocoupler with a tapped secondary.

As the slider was moved along the secondary coil, several different stations might be detected. If they were too weak for good "copy," the primary or antenna coil could be pushed further into the tuned secondary coil to strengthen them. If two stations were being heard at the same time, the primary coil could be pulled out to reduce the coupling and the bandwidth of the secondary L-C circuit, (increasing its "selectivity") hopefully allowing the receiver to resonate at the frequency of only one station. To improve the incoming strength of a desired station the inductance of the antenna circuit could also be varied by adjusting the taps on the switch to bring the antenna circuit closer to the series resonant frequency of the desired station.

Early receivers and transmitters were usually constructed with all of their parts screwed down onto wooden "breadboards," using no front panels or metal enclosures. Those came later.

The real early radio communications were mostly on the M-F band between ships at sea and coastal stations operating between 300 and 600 kc. Eventually, the frequency of 500 kc, which is a "wavelength" of 600 meters, became the International Calling and Distress Frequency or wavelength. (People talked more in wavelengths than frequencies in those early days.). Many maritime L-F ship stations also operated on frequencies around 100 kc (3000 m). To tune for M-F stations the secondary slider-coil might have been used alone or possibly with a small value parallel condenser from the slider to the left end of the coil. To tune to L-F band stations, a larger value condenser would have had to be switched in.

A smaller M-F type of variocoupler is shown in **Figure 5**. Note that this one has a tapped secondary. A crystal detector circuit using this variocoupler is shown in **Figure 6**. Using a ±250 μμf variable

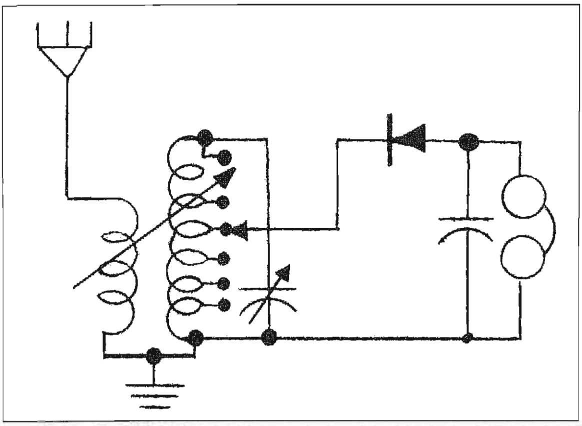

Figure 6, left: A crystal detector using a variocoupler is shown. Tapping down an LC circuit decreases its bandwidth and raises its Q.

Figure 7, below: 2 common styles of variocouplers. The secondary winding of the larger variocoupler is on the inside of the black outer shell.

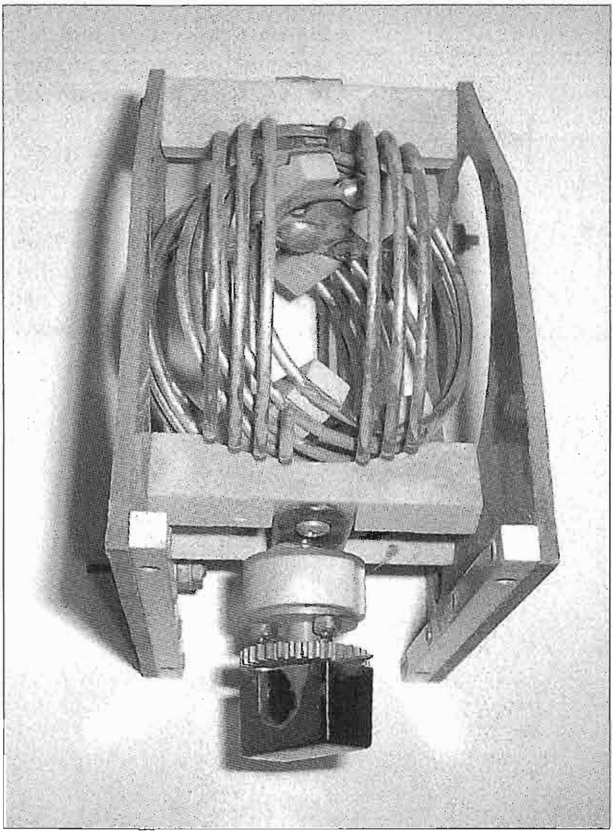

Figure 8: A large variocoupler that was used in HF transmitting equipment like the Collins ART-13.

condenser, C1, it was probably used to tune the a-m broadcast band, about 550 -1600 kc. R-f signals picked up by the antenna are fed to the rotary primary coil. By turning this coil 360 the r-f ac induced into the secondary could be reversed (from a positive to a negative). But by rotating the coil only 90 the r-f ac induced into the tuned L-C circuit can be varied from zero (coil turns vertical) to maximum (coil turns horizontal). The r-f ac in the secondary is rectified and fed to earphones as explained before. However, earphones act as a load on the tuned L-C circuit. The less load on a tuned L-C circuit the more selective it becomes. In this circuit the load on the L-C circuit is reduced by connecting the earphones to one of the taps, perhaps about half way down the coil, as shown. This greatly reduces the loading, improves the selectivity and may increase the sound level of the received signal.

Two other common versions of variocouplers are shown in **Figure 7**. The secondary winding of the larger variocoupler is on the inside of the black outer shell. Although only discussed here as being used in receivers, larger variocouplers were also used in transmitters. A high-frequency (H-F) transmitter variocoupler, or variometer, is shown in **Figure 8**.

There were other forms of variocouplers. If the two coils were connected in series it became a variable inductor and was called a "variometer." When a variometer was used as the inductor in an L-C circuit it could be rotated from a maximum value of inductance (all turns in the same direction) to almost no inductance (coil turns in opposition) by turning the rotor 360.

Over the years there were many crystal and V-T detector circuits developed. By playing around with tapped coils, degrees of coupling, and sensitive spots on crystals, and later trying different types of receiver and transmitter forms, types of modulations, plus developing many different antennas, it is no wonder that radio was so fascinating and attracted so many early experimenters and amateur radio operators.

ER

The Simple 2005 Antenna Tuner

By Van Field, W2OQI
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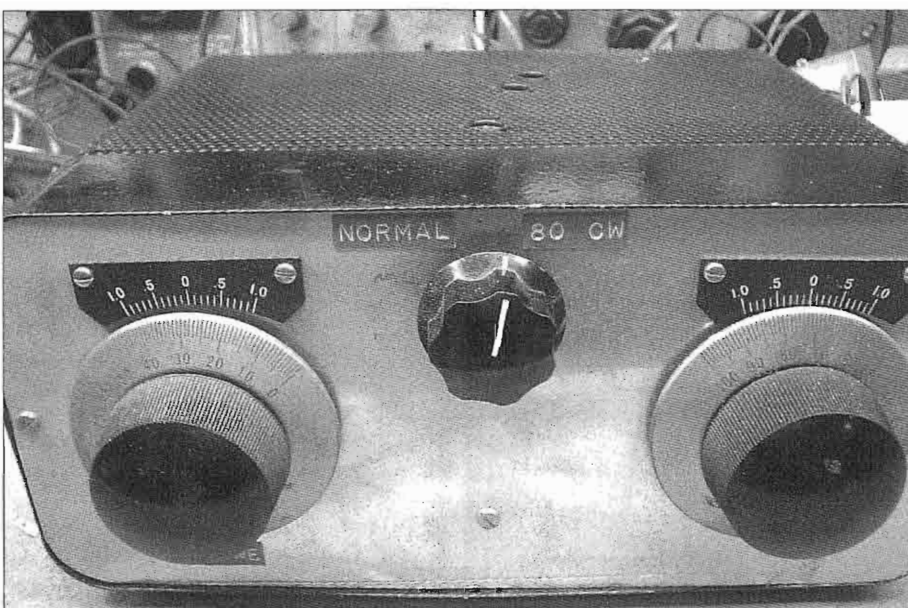
Center Moriches, NY 11934

Before WWII, National Radio Company ads carried a component that was a multiband tuning unit. With the resurgence of amateur radio after WWII, due to the many new operators trained by the armed forces, National redesigned their product and put it on the market as an MB-150, with a smaller matching model called the MB-40. During this time, most Ham transmitters were either built from scratch or were modified WWII surplus equipment. My father (W2PDU) used one in his 813 transmitter, no doubt a QST design.

Down under, the ZLs and VKs resurrected the circuit to use as an antenna tuner. Bill Orr (W6SAI) read about it and decided to try it. It's called the Z-match tuner. Its unique design allows one to go from 80 thru 10 meters with NO bandswitching, no rotating coils to crank, and no high-loss balun to contend with. The best part is it matches about any feedline, single ended or balanced.

The downside is the need for a vernier tuning dial on the two capacitor shafts. The "why" is that when covering so much bandwidth with one 180 degree swing of the dial, tuning tends to be a bit sharp.

Look at the diagram in **Figure 1** for a moment and notice that there is a two-gang tuning capacitor across the coil. The whole coil and both capacitors are tuning from 3.5 thru 8 MHz in a 180-degree swing. It crosses over at 7 MHz and the capacitors may need to be closed to tune 7.3, certainly the 5 MHz band. The rest of the bands will tune thru the



This is my packaged model of the tuner described in the text. It has an added switch to cover 3.5 MHz with 200-pF tuning capacitors.

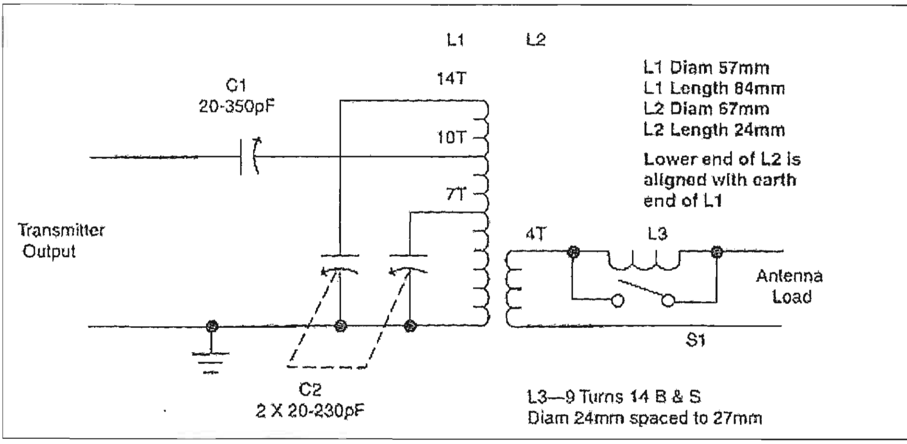


Figure 1: Complete schematic diagram of the 2005 Simple Tuner.

180-degree arc, so with the capacitors almost open you are on 10 meters.

I have used National 3:1 vernier dial assemblies, and I prefer the Jackson 6:1 unit, which needs a pointer to be made up. The second capacitor is not quite as critical, but seems to need some vernier spread.

Parts

In this day's world of prepackaged electronics, one has to look a bit to find good parts. Transmitting-capacitor spacing is in order if you intend to operate in the 100-watt range. There are only three RF parts, three 350-pf capacitors and one 14-turn tapped coil wound on a piece of 1–3/4 inch PVC tubing. These are shown in **Figure 2.** One can't get much simpler than that!

Ideally, a 2-gang, 350-pf capacitor is desired but a capacitor no larger than 200 pf seems to work OK. In a few of the tuners I've built, I have used a shaft coupler to make my two-section capacitor, see **Figure 3**.

The coil is wound with 14 turns of #12 wire, spaced 3-3/4 inches long. There are 2 in-line end holes that are drilled to clear a 6-32 screw. There is plenty of room to reach in and insert the screws. Put nuts on the outside and tighten them. A solder lug and a second nut can be added. Number 12 wire is a bit stiff, so I calculate the length I need and clamp one end in a vise. I use a short piece of PVC, and wind the wire to preform the coil. The hard part is to figure out where the tap should be and clean the wire covering off. Maybe this is a good place to use bare copper wire from Home Depot. It saves scraping the enamel from the wire. A heavy soldering iron or soldering gun is needed to get good connections to this combination. Stranded-wire pigtails can be added to the assembly and soldered. The stranded wire should be no lighter than #16. The circulating current in this tuner is high, so heavy duty wire is the name of the game. A recent article in QST called for using a large toroid, and the builder was looking to compress his unit into a small space.

The second capacitor has to be insulated from a metal chassis. I often use heavy-duty perf board as a chassis. The holes are already there and the insulation is taken care of. Just remember to use a plastic shaft extension or an insulated shaft coupling. The old insulated couplings are great because they allow for small shaft misalignment.

The 4-turn pickup link belongs on the ground end of the main coil. I used #12 Teflon-covered wire. Good insulation is important here to prevent arc thru. This coil is inter-wound with the larger coil.

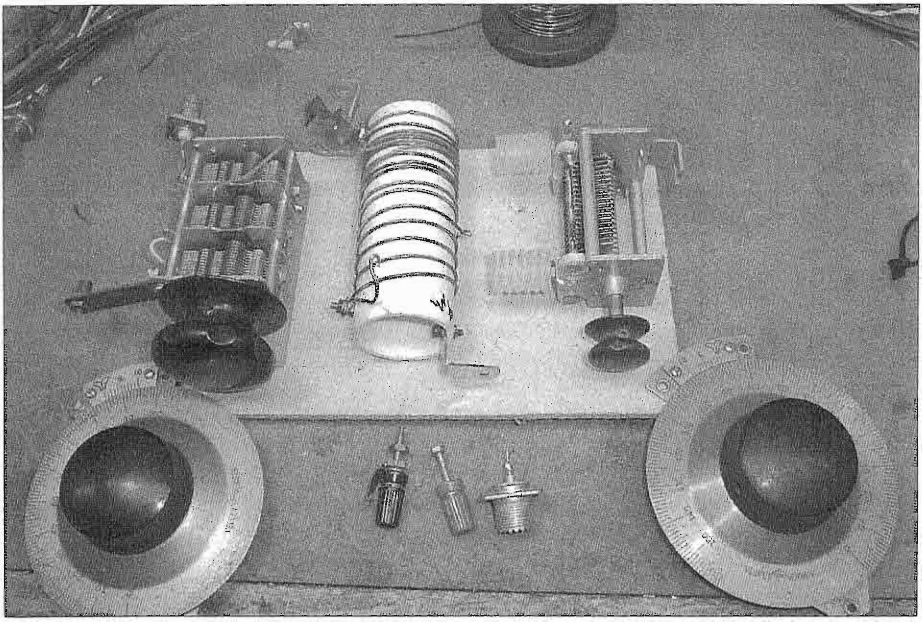


Figure 2: Here are the parts that are necessary to build a complete 80 to 10 meter tuner. No parts are special or hard to find.

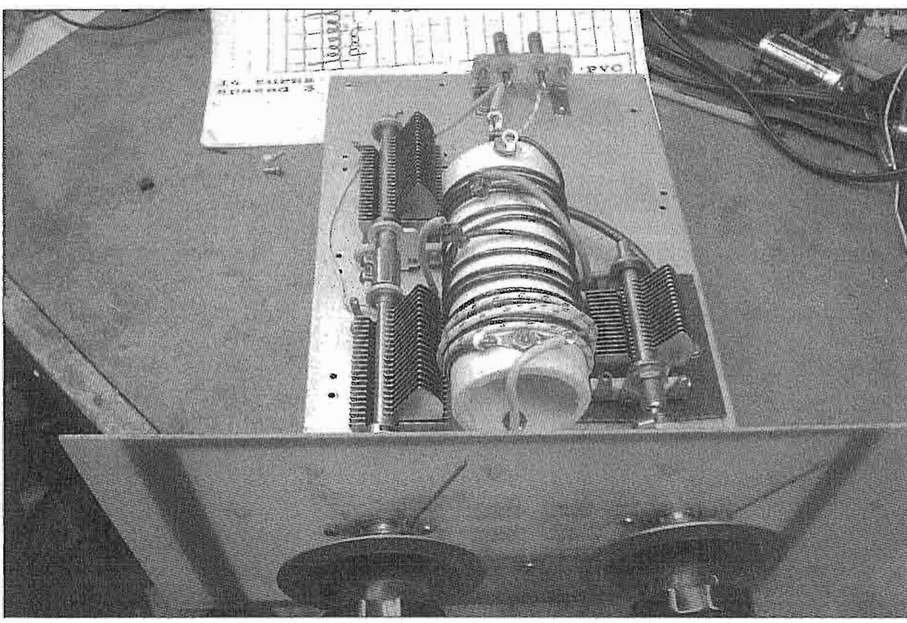


Figure 3: Here is one low-power model using Jackson vernier drives and a dual capacitor made from shaft couplings.

This coil goes to a pair of insulated binding posts, where open-wire line can be terminated. A single ground wire can be brought out at this point and used to ground one of the terminals if the unit is used to feed a single wire. Remember that a good external ground or counterpoise system is called for with single-wire feeds.

As with most tuners, beware of trying to feed an antenna system at a voltage node on the end of the transmission line. It can cause capacitor arcing. I have a modified version (no 80 meters) that I use in the car to trim out my tapped, base-loaded whip.

Tuning the Monster

Because of the sharp tuning, the unit can be tricky to initially tune. Once resonance has been accomplished, a tuning chart should be made up, as with most tuners. I find the MFJ-259 antenna impedance device perfect for the job. Resistors make dummy loads for different impedances. It really takes 2 hands to initially tune up. If you still haven't added an SWR bridge to your collection of Ham tools, consider the one Radio Shack sells for CB. It is inexpensive and it works fine.

If you seek more information, put "Z-match antenna tuner" into your search engine for a wealth of information on this circuit. Emtech[1] has a QRP kit version available. There are many versions around. I've found that W6SAI's original version works fine for me with whatever antenna I'm using.

One antenna that doesn't get much play anymore is a single half-wave wire, off-center fed. It is fed 14% of a half wave, off center, with a single piece of antenna wire. It is for one band, but it should work all bands and only needs a reasonable counterpoise system. It has the added advantage of not being very obvious to the neighbors. It was my very first antenna, before you could buy transmission lines.

160 Meters

To extend the tuning range to 160 meters, a band switch that cuts in some heavy-duty, fixed capacitors is needed. 160 is what I call a "special needs" band. The antenna needs to be special, as does the tuner.

References:

W6SAI Column , CQ Magazine, September and October 1993

W6SAI HF Antenna Handbook, pg 7-7

QST, January 2003, pg 28

QST, September 2004, pg 65, Antennas 101

Web sites: Put "Z-match Antenna Tuner" in your Internet search engine and you will read more information on this circuit than anyone could want. It has been studied to death!

[1]Emtech, 1127 Poindexter Ave W., Bremerton, WA 98312, 360-405-6805. Internet address is http://emtech.steadynet.com/

[Editor's note: Also see ER #171, August 203, The Multi-Band Tank Circuit - Another Balanced to Unbalanced Antenna Tuner by Frank Van Zant, KØOR]

ER

[Comments, from page 1]

Bob wrote his autobiography as a two-part story back in ER #s 124 and 125 in the fall of 1999, and there is little that I can add to that fine piece.

Born in Salina, Kansas, in 1921, he was introduced to radio at an early age when his Mother brought home a Philco 90. He built his first homebrew receiver before reaching the age of 10, and on it he discovered the 160-meter Ham band through the transmissions of Hoisy Hoisington (then W9NOE). Bob got his first ticket in 1936 as W9YRQ, and right away was able to get a job repairing radios part time while still in high school. During this time he built his first phone rig, a grid-modulated 2A5 that was used on 160 meters in the winter to work his friends around Salina. He also upgraded his receiver to George Grammar's 3-tube TRF design from January 1933 QST magazine. During WWII, Bob was a Navy man and became a shipboard radar officer. Using the G.I. bill, he went back to college after the war and spent the next 31 years working for RCA as a TV set design engineer.

Thanks Bob for all you gave to amateur radio over the years. We will all miss you.

The 2005 Heavy Metal Rally

As mentioned last month, the Heavy Metal Rally will be running on Friday, December 30. This year there should be no conflicts with the Christmas or New Years Holidays.

Suggested Frequencies: 1885 Kc east of Mississippi, 1900 Kc West; 3830 Kc, 3870-3890 Kc, nationwide, 7290 Kc.

As in years past, this is not a traditional Ham radio call sign echo. Although the Heavy Metal Rally was originally intended to include only big tube-type equipment, it should now be seen as a night for friendly AM QSO's and is open to anyone using restored broadcast, military, homebrew, any commercial Ham gear meeting the requirements, i.e. Johnson Invader 2000, Viking Desk KW, Globe King 500, Collins KW-1, etc. and big solid state Class-E equipment. This includes using a solid-state exciter as long as the PA is Heavy Metal, such as a 300 pound Henry 8K! I want as much participation in the rally as possible. Obviously, we would all like to work as much tube-type Heavy Metal as possible, and a point advantage is given to tube equipment.

The rules for this year's Heavy Metal Rally are the same as before: **Scoring**: You get 1 point per contact on each different band. If you work the same station on both 80 and 160 it counts for two points. You get 1 additional point per contact if you are using all tube-type heavy metal. 1 point for each different state worked. 1 point for each letter or email received from Hams or SWLs with positive comments about a station's signal or sound quality. So, if someone works 20 stations in 10 different states with a tube rig, the score is: 20 contacts + 10 states + 20 tube points = 40.

If two emails are received complaining that "KØXYZ" broke their S-meters but sounded darn good doing it, that's 32 points total.

The winner should be running a rig weighing 250 pounds ***or*** running at least 250 watts. This includes big homebrew, military, and vintage commercial Ham gear, and Class E solid state rigs as long as they meet the qualifications. For example, some vintage Navy rigs weighed in at over 300 pounds, but only produced 100 watts of carrier—that's still Heavy Metal! (The "or" statement is intended as an illustration, and should not be misread as an intent to keep someone out.)

You can't win unless you're running a Heavy Metal rig—NO exceptions!

This is Heavy Metal night! Everyone is welcome to participate with smaller rigs, but the winner needs to be using Heavy Metal.

Completed logs should be sent by email to Ray@ERmag.com or by US mail to the Electric Radio address printed inside the rear cover. Please have your point totals calculated when you send in your log, and be sure to mention the equipment used during the rally.

The winning top scorer this year will receive the Heavy Metal trophy. All participants sending in their logs will receive a nice participation certificate from Electric Radio, which will be similar to the certificate sent out in other years.

Electric Radio Photo Contest and the 2006 ER Calendar

The calendars will be ready by the time this issue is in the mail. At this time, it looks like the cost will be $11.95, postpaid.

73, Ray, NØDMS

A Seven-Foot-High Antenna with 9-dB Gain

The 40-Meter NVIS Antenna

By Jerry Barry, K5AXN
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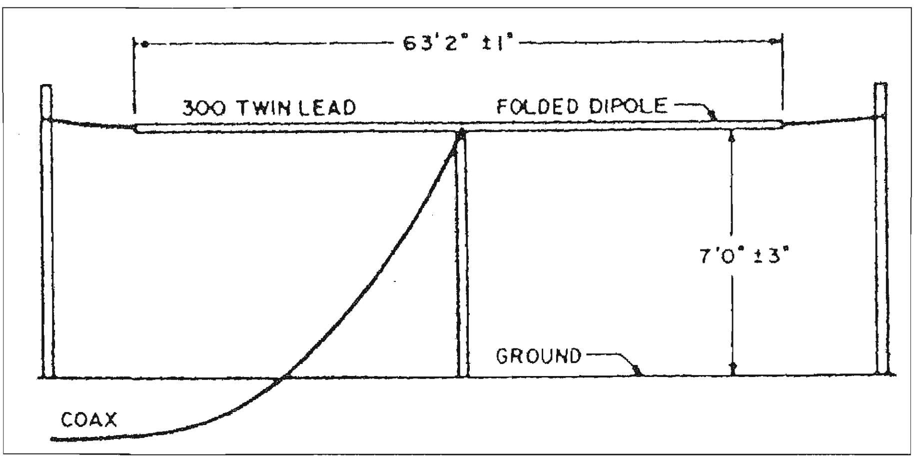
San Antonio, TX 78217

I am not an antenna expert, but I just like to mess with them. I have found an antenna that worked for me and I thought ER readers might like to try it. My friend Don Janota (K5ALX) suggested that I try a NVIS (Near Vertical Incidence Sky-wave) antenna from the October 1969 issue of 73 Magazine, pages 8 to 1, by Ed Dusina (W4NVK). Ed called it a super-gain, 40-meter antenna.

We have a group of friends that grew up in San Antonio but are now spread all over Texas, 200 to 300 miles apart (see Electric Radio #181 June 2004 P10). We have a SSB QSO on 40 meters every Sunday afternoon on 7.266 kc, from 5-6 PM Central Standard Time. This NVIS antenna makes the difference between not being able to even hear a station to being able to talk to them. W8SYD, Byron Armstrong, compared it to his 160-meter G5RV that is 50' high, and his antenna had 10-db signal gain in both Dallas and Houston, Texas. As an added bonus, this antenna has a rejection of 15db of foreign broadcast. Some days this rejection really makes a difference. If both stations used this antenna you would have a signal/noise improvement of 29db! Is this the kind of gain you get with a full size beam? The 73 Magazine article used a 300-ohm, twin-lead, folded dipole fed with 50-ohm coax, but after trying that I changed my antenna to a regular dipole fed with 50-ohm coax. I used the dipole because it was easier to adjust the length to set the SWR. W4NVK used 63'–2" for his folded dipole tuned for 7.250 kc. My dipole took 59'–2" because of a metal roof that is close and power lines on 2 sides. Start long, and fold it back until your SWR is the lowest. The MFJ SWR Analyzer is cool to do this. You install your dipole 7"–0" above the ground (This needs to be close). I used 3 pieces of 1" PVC pipe standing up to make sure that



My antenna was based on the 40-meter, super-gain NVIS antenna from page 8 of the October 1969 issue of 73 Magazine.

I kept the correct spacing. Directly below the antenna, lay a ground wire directly on top of the ground. I made mine 70'–0" long, but you might try the regular dipole length plus 5%. I used #14 solid copper wire (Lowe's $15.00 for 500' in black, green, or white). If you mow the grass low before you put it down you can pin it down with V-wire clips and mow over it when the grass grows back. Next, you need to go 6'–0" to one side parallel with the ground wire directly below the dipole and add another 70'–0" ground wire, and then go to the other side and add a third ground wire 6'–0" to the other side also parallel with the ground wire directly below the dipole. What you have made is like a 2-element beam pointing straight up with 3 reflectors laying on the ground.

I use mine with my Viking Valiant and imported ICOM. In both cases, I use them without an antenna tuner. This antenna would make a really nice portable antenna for doing hurricane work that you could set up in the grass at a motel or even on the side of the road. You could carry one in your RV. I used one for Vintage Field Day. You could use RG-8X coax and everything would go in the trunk of a car. I asked my friend Don about adding a director on top but he said you would defeat yourself and you would not have the 200 to 300 mile range in daytime or the 1000 mile range at night. The NVIS should work on 80 or 160 meters if you scale its dimensions like any other antenna. You will also need to change the height above ground to scale and the spacing of the reflectors to scale. NVIS antennas are used by the military, in the jungles and in the mountains. If you try one, you might like it!

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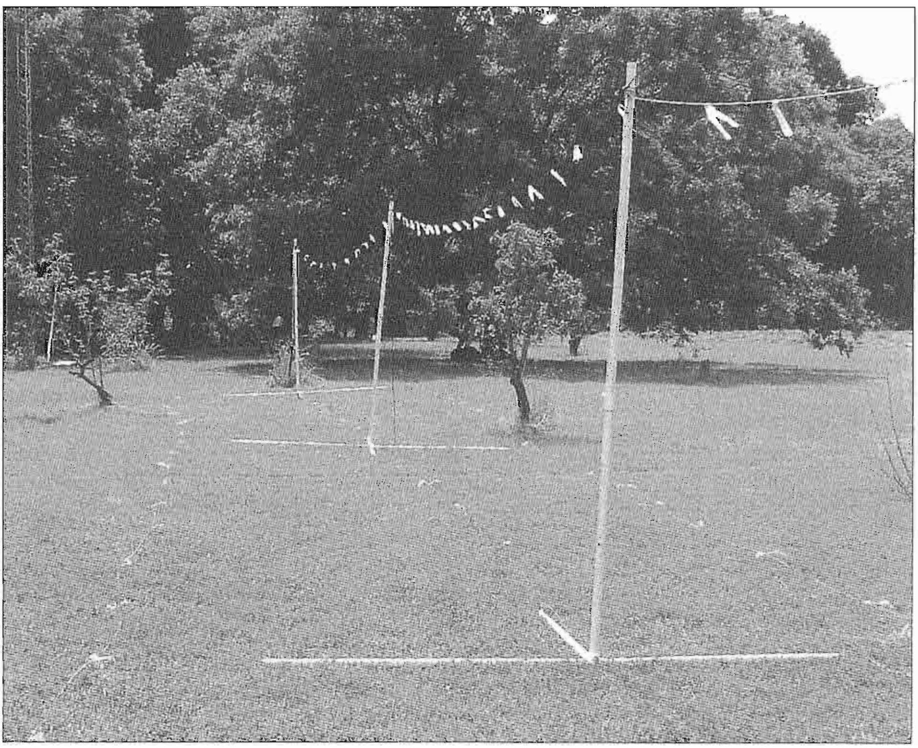

The AM Broadcast Transmitter Log

Part 5, The Gates/Harris BC-1 Series

By David Kuraner, K2DK
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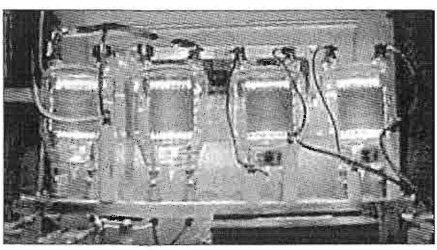
Haymarket, VA 20169
k2dk@comcast.net

The Gates line of broadcast equipment is one of the oldest and dates from the 1920s. Gates was taken over by Harris around 1960, and retained the Gates name up until about 1970. The BC-1 1-kW series is one of the most commonly available broadcast transmitters. The series started in the 1940s with the heavy and well-built BC-1E/F. It lasted into the mid 1970s with the BC-1-T/H/J/G. The suffix designation was not in alphabetical order and can lead to confusion among those not familiar with the series. The later models were much lighter as solid state technology evolved and was incorporated into the design. Some of the later models were considered by many to be cheaply made and less reliable. None should be discounted for amateur service. The two things all models have in common was the use of the 833A triode and fixed capacitors in the final tank circuit with variable inductors. Design choices in this series are much different from the transmitters previously described employing 4-400s. Although not specifically mentioned in previous articles, the manufacturers employing 4-400s also introduced solid state technology, but often changed the series' model name. As an example, the Collins 20V eventually became the 820D series with 5-500s.



Glowing 833s in the Gates BC-1H at K6RLC, owned by Dennis Jones.

The 833A was introduced in 1939. With filament caps on the bottom and grid and plate caps on the top, it is one of the most unique and endearing RF devices. It requires a one-of-a-kind socket—if you can call it a socket. At one point, both the 4-400 and 833A were readily available at Hamfests. As radio stations replaced the 1-kW tube rigs for solid state, broadcast pulls began to disappear. Fortunately, new Chinese tubes are available from vendors such as RF Parts[1]. The 4-400 tetrode is occasionally seen, but I have not observed the almost mystical 833A being offered. Again, the two items, aside from shape, differ between the triode and tetrode configurations. The triode requires neutralization and its grid drive is significantly different. In broadcast service at the 1-kW level, typical control grid current is 25 mils for the tetrode. For the 833A triode, expect about 120 mils.

The number of readers providing input for this article became overwhelming. I have chosen to include two approaches to retuning, and a composite of control system circuitry. The later shows the most desirable features with simplicity as the objective. As with previous designs presented, the delay afforded by daisy-chained relays works quite well. Also, this transmitter normally keeps the exciter stages powered constantly; again they are disabled during receive/standby. And as in previous designs, the RF dies instantly since both the HV and exciter go down simultaneously.

Exciter Tuning

On the more recent models the oscillator and buffer are on a separate, remov-

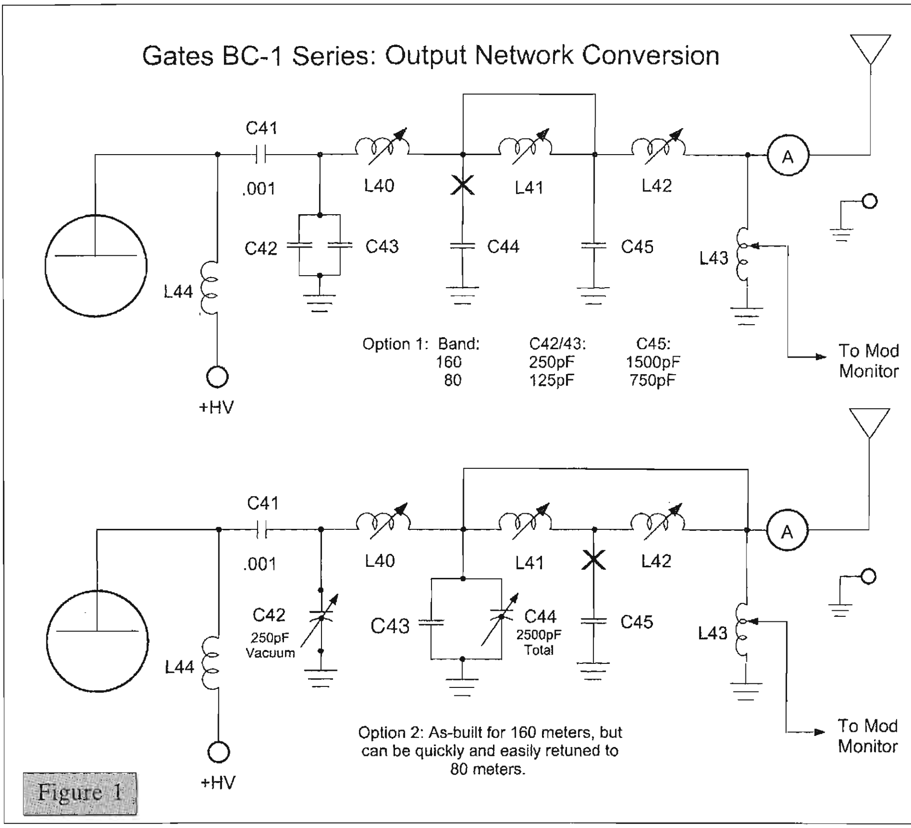


Figure 1

able chassis. Some people, when multi-banding, will use a separate plug-in oscillator chassis. The oscillator is a 12BY7 Colpitts and the same tube is used as a buffer. The crystal socket will need to be rewired for FT-243 crystals. In order to use both crystal control and VFO feed, C4 was changed from 800 pf to 220 pf and C3 was removed. These are the grid-to-cathode feedback capacitors. Others have not made this change. Units such as the Heathkit VF-1 or Johnson 122 have been used with excellent results. Tune the buffer, L3 and C11, for maximum output. For 80-meter operation, remove turns from L3. I recommend about 10-15 turns at one time from both sections. Back the slug of L3 out to the top and set C11 at mid range. When it starts to resonate, again adjust L3 and C11 for maximum output. An alternative is to replace it with some other coil. With a little experimenting, which you have to do anyway, you can achieve the same results.

To neutralize the final adjust the tap on the driver output coil coming from the grid of the final, in conjunction with the neutralizing capacitor. A quick and dirty way to do this is to tune the final through resonance (***no high voltage***) and adjust the tap and neutralizing capacitor for minimum change in grid current as the final tank goes in and out of resonance on the highest band. You may need to short out a turn or so for resonance on 160. However, people have reported that this is not necessary. For 80 meters, expect to short out at least five turns of the driver coil to achieve resonance in that stage.

The Final Tank Network

We devoted last month to an in-depth discussion of the final output network. Now we are about to see the practical implementation with two separate approaches. They are totally different from anything described thus far. The original network can be described as an L followed by a PI and another L. It could also be thought of as a double PI followed by as single L. That last coil, L-43, is for a modulation monitor tap. See **Figure 1**, page 21. In both cases, the network has been simplified.

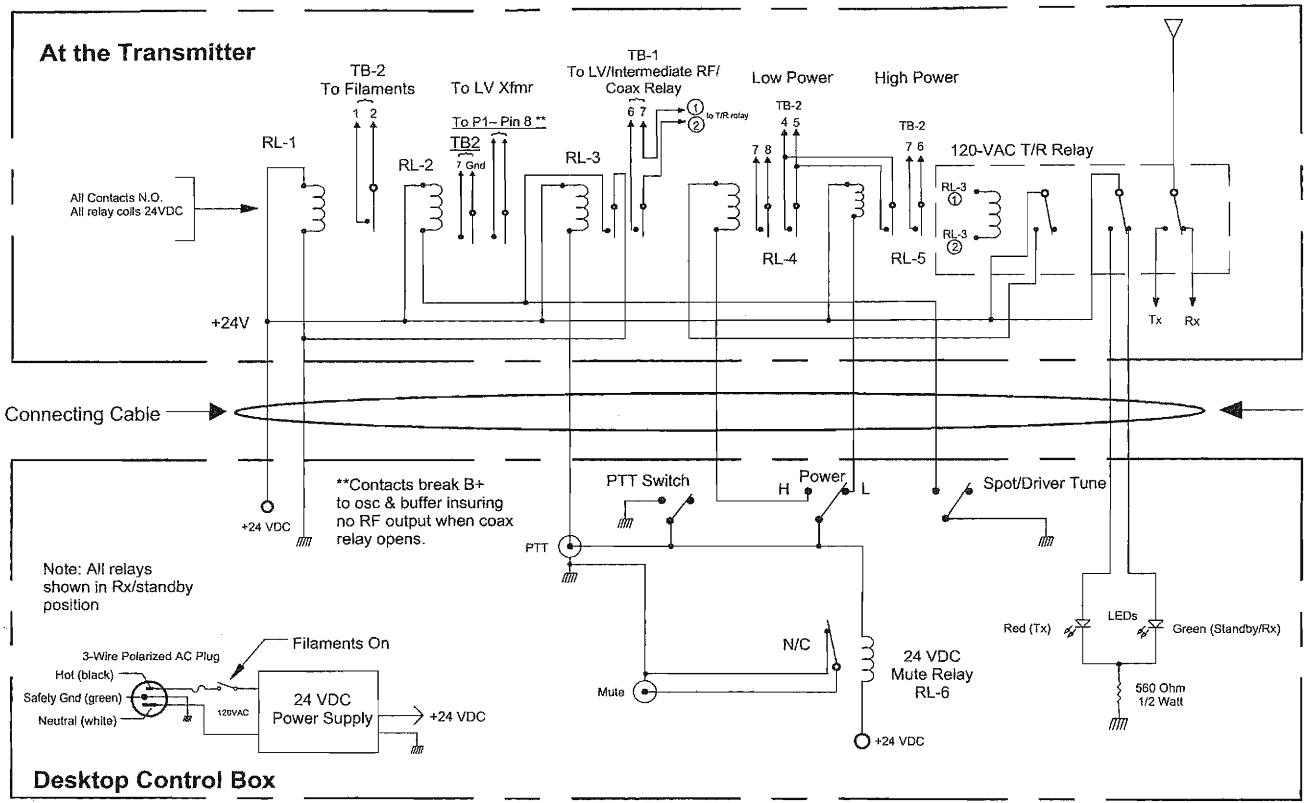
The first approach is to retain the fixed tuning and loading capacitors. It turns the network into the more common–for broadcast equipment–PI-L configuration. The tuning and loading controls remain the same as before, adjustable coils. Most of the Gates units that are tuned for the top of the broadcast band will use a pair of fixed 250-pf, G-2 mica capacitors for tuning at C42 and C43. Remove one from the circuit for 160-meter operation. For 80 meters, you can place them in series for a total of 125 pf. You are still tuning with L40. The next section consisting of C44 and L41 is removed from the network. It should be simple to disconnect the capacitor and jumper the coil.

This modified Gates BC-1H has been built into a wall, as was typical with broadcast station installations.

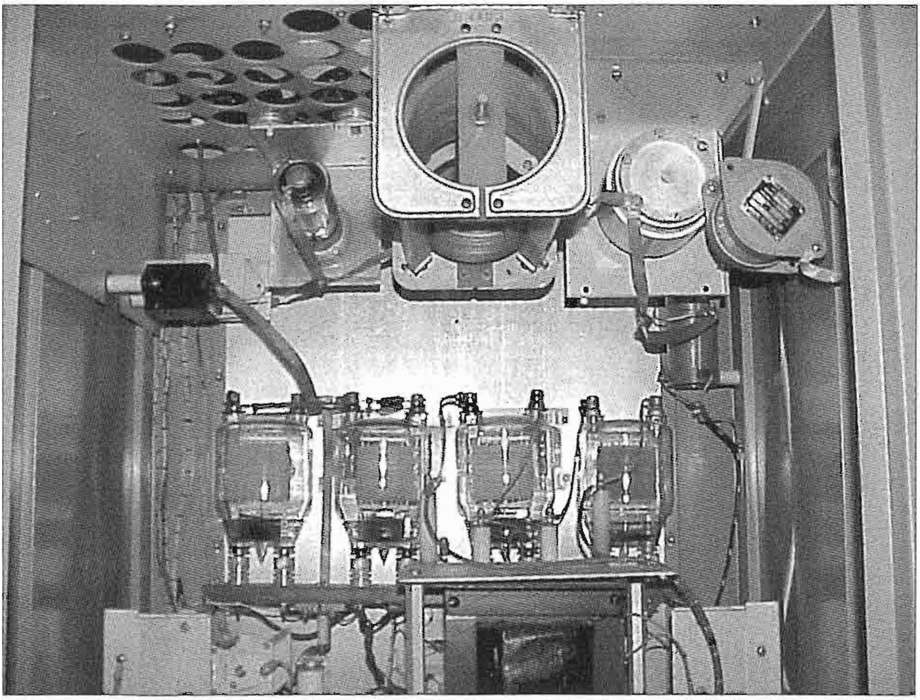
For loading, the fixed capacitor C45 is replaced with 1500 pf for 160 meters, and on 80 meters it is 750 pf. Bear in mind that, although there is less voltage here at the output end of the network, there is still a large current to be addressed. Fortunately, as the frequency increases, the current handling ability also increases. People have reported to be using smaller mica capacitors than the G-2 style with satisfactory results. This change (for 160) is estimated to result in a Q of 10 for the first section and between 2 and 3 for the second, thus bringing the overall Q to the ideal target of 12 to 13.

The second approach changes the network to a simple PI. The fixed-tuning capacitors, C42 and C43, are replaced with a vacuum variable of 250 pf or greater. The tuning coil, L40, is retained and also used to adjust tuning and to change the circuit Q. The loading capacitor, which schematically would be C44, is replaced with a combination of fixed and vacuum-variable capacitors, resulting in a maximum of about 2500 pf. This network has only been used on 160, but is easily retuned for 80. In the transmitter where this was implemented, the estimated value for the tuning capacitor is 180 pf resulting in an estimated Q of 8 for the network. While this is below the acceptable value needed for second-harmonic suppression, the transmitter is feeding an antenna tuner. The tuner provides more than adequate harmonic attenuation. Simply reducing the inductance and increasing the capacitance while maintaining resonance will increase the Q as needed. The photos show the

Figure 2



Gates BC-1 Series Control Circuitry   K2DK, November 2005



Here is a rear view of a modified Gates BC-1H. Note the vacuum variable capacitor in the upper left corner.

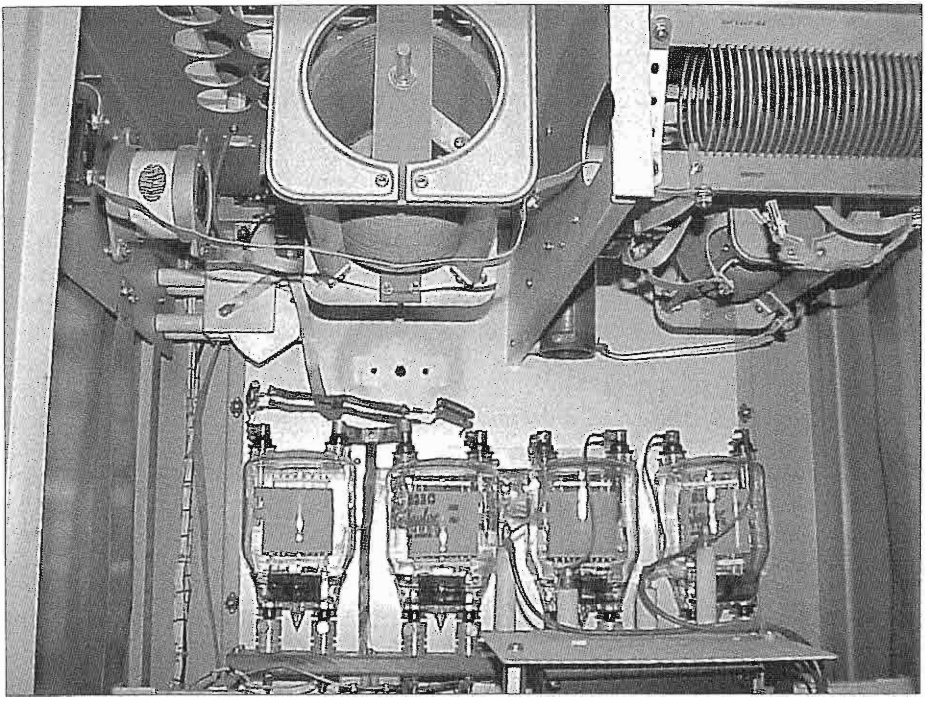
original network in a transmitter about to be modified and one functioning on 160 meters at 1885 kHz. The front view of the already-modified unit includes turn counters which are very desirable for band changing and large frequency changes, especially on 160 meters.

Protective Bias and CW Operation

Considering the possibility that the finals may only be available as new Chinese tubes, people have come up with protection schemes in the event of lost RF drive. One is even used to operate the transmitter on CW while keying the lower-powered stages. Fixed bias is applied to the final grids across the self-biasing resistors, R15 and R16 (resistors in parallel). The bias supply of about 50 volts negative is floating, so there is no chassis ground reference.

The CW modifications are the brainchild of Don Chester, K4KYV. He increased the bias voltage to about 100-volts negative so there is no doubt about complete cutoff. The HV supply must be stabilized, as the key-up condition would see the voltage climb to above 4000 volts. Since the modulation reactor is not used during CW operation, and it is 5 times the power supply reactor, it too is now placed in the power supply filter circuit. Also, an additional 25-µf filter capacitor is placed in parallel with the original. The HV going to the center tap of the modulation transformer is disconnected.

Next, the 807 and 12BY7 buffer stages are keyed in their cathodes. Both stages need to be keyed as a backwave signal is heard when only the 807 is off. The key line is about 600 volts at 230 mils. Don used a TV sweep transistor rated at about 1500 volts at 4-6 amps in a keyer built for another project. You may be able to use something like the wet relay found in the Hallicrafters HA-1 keyer. And last, he found that an RF choke was needed in



This is an unmodified BC-1H that can be compared with the photo on page 24.

the key line to produce the correct waveform. Don was kind enough to demonstrate it on the air and it sounded great!

Controlling the BC-1

The several designs received from readers all had one thing in common. Nobody directly switched the 240-volt control ladder, a very good idea for safety. As with the other transmitter control designs presented in this series, everything brought out of the transmitter was 24-V DC lines for safety. One design used a 120-VAC coaxial relay. Since sometimes these devices are on hand or otherwise available, I included the switching arrangements for the coil's voltage. Also, 120 VAC is readily available within the transmitter on one of the terminal blocks. This design, and the terminals, are based on the G model that uses two primary taps on the HV transformer to achieve power reduction. Other models use resistors in the RF final's DC line to lower the voltage on the plates.

Again, as with the other design schemes, the filament comes on with the 24-VDC remote power supply. The relay provides a contact closure on terminals 1&2 of TB-2. The low voltage for the exciter stages is switched on with both the spot and PTT function. The low voltage is disabled by breaking the ground return of the T-42 transformer secondary center tap. In the schematic, this center tap goes through a protective overload relay, K-4, to ground. Either breaking the connection from the center tap to the pin 1 of the relay, or pin 2 of the relay to ground should work. The coil of the relay is in series with the ground return, so excessive current will pull in the overload relay, shutting everything down.

The plate-control ladder is the normal momentary switching. I expected to see at least one design where the control commands were momentary. Everyone chose not to do this. With two separate taps on the HV primary for high and low power, two 24-VDC relays are required for power-level selection. The connections are noted in **Figure 2**, the schematic on page 23, at TB-2. The proper relay is selected at the desktop control box. As always, an antenna interlock is employed so the coaxial relay must close before either the high or low power HV plate command is given.

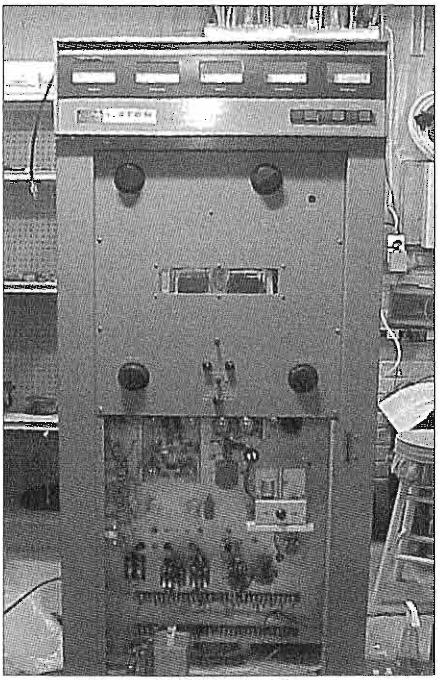
Since we are using a coaxial relay with a 120-VAC coil, an intermediary 24-VDC relay is required to avoid line voltage being brought out to the control box. This relay is activated with the low-voltage supply relay. So, the chain of events is as follows:

1) PTT command ground.

2) LV and intermediary coaxial relay closed. Coaxial relay closed.

3) HV 24-VDC relay commanded on. HV 24 VDC closed.

4) Transmitter's HV plate activator commanded on. Receiver muting starts with the PTT ground and status LEDs switch with the RF relay.



A Gates BC-1H in the shop.

A word of caution: check your documentation as the connections to the control ladder are based on the BC-1G. It would be difficult and confusing to provide this information for each model in this series.

The Maintenance Log

During BC rig conversion efforts there have been at least two reports of the final RF plate choke frying. A discussion of plate choke design to avoid unintentional resonance at the operating frequency can be found in the ARRL handbook. Unfortunately, not much design guidance is given. In one case, the incident occurred as a BC-1H was being "walked up" from 160 to 80 meters. Resonance occurred at about 2.6 MHz with rather dramatic results. The second incident, with a different manufacturer's transmitter, the individual just stated that the choke resonated at the operating frequency and rewinding another gave better results. This was also an 80-meter conversion.

The incidences appear to be quite rare since only two have been reported compared to the hundreds of conversions. Should you need to replace a barbecued plate choke, rewind it so turns are grouped with spaces in between and then another group for several iterations and even a section with a different coil diameter wouldn't hurt. Also, be sure to use a coil form that will handle that high voltage. There is no need to replace one problem with another.

My sincere thanks to the following people who contributed, directly or indirectly, to the information contained in this article: Tim Malony (W3TIM), David Aabye (W4QCU) with Steve Dewey (KJ8CQ), David Huddleston (W3NP), Phil Galasso (K2PG), Robert Login (AA8A), and Dennis Jones (K6RCL). They are all very experienced and always ready to help.

73, Dave, K2DK

[1]RF Parts Company, 1-800-737-2787

ER

Simplified T/R Relay Sequencing

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Introduction

Lacking in most amateur stations using separate transmitters and receivers is the proper sequencing of the transmit and receive functions of the transmitter, receiver, antenna changeover and auxiliary equipment. Most stations, except those requiring that the transmitter and receiver be separately switched with manual switches, simply rely on one T/R switch to accomplish the changeover function using relays. These relays all switch over instantaneously. Often this does not cause a serious problem, but it is possible to damage the transmitter, receiver and/or antenna changeover relay if these operations do not occur in the proper sequence.

When the transmitter is turned on, the antenna should already be changed over from the receiver to the transmitter, the VFO should be running, the receiver should be muted, and the antenna input to the receiver should be protected from stray RF from the transmitter. The monitor scope should already be on, so that any spikes that occur in the RF envelope as the transmitter is switched on can be observed. When the station is switched back to receive, the transmitter should immediately be deactivated before the antenna contacts drop back to receive, the receiver is unmuted (to avoid hearing the annoying thump), the VFO shuts down (to avoid a split second with full plate voltage on the amplifier stages with no RF excitation, which can cause parasitics and other damage), the receiver input protection is disengaged (to avoid the possibility of damage to the front end of the receiver from any RF spike from the transmitter), or the monitor scope is turned off (to allow observation of any lingering RF spike as the transmitter is switched back to standby).

To accomplish this, the delay must be shifted so that upon transmit the transmitter is last to come on, but upon receive, the transmitter is first to be turned off. This can be readily accomplished with solid state logic, but the following is a very simple, passive circuit that accomplishes the proper sequencing using three DC relays, one capacitor, four diodes and three resistors.

How It Works

The relay system that controls the transmit/receive function of the station operates from a power supply that delivers 24 to 32 volts DC. It turns on the low, medium and high voltage transmitter plate supplies and silences the receiver during transmit, turns off the modulation monitor scope and VFO output on receive, energizes the antenna changeover relay during transmit, and grounds the antenna input to the receiver during transmit.

All relays used in the station operate from DC, except for the main antenna changeover relay, which operates at 120-volts AC. This relay is activated by a separate SPST DC pilot relay that delivers the AC voltage to the antenna relay coil.

Originally, the T/R switch simply delivered DC from the relay power supply to all the relays in the station. Every relay was energized instantly when the T/R switch was put into the transmit position. The problem was that the transmitters tend to deliver RF for a fraction of a second after being switched to standby for reception. This is due to the time it

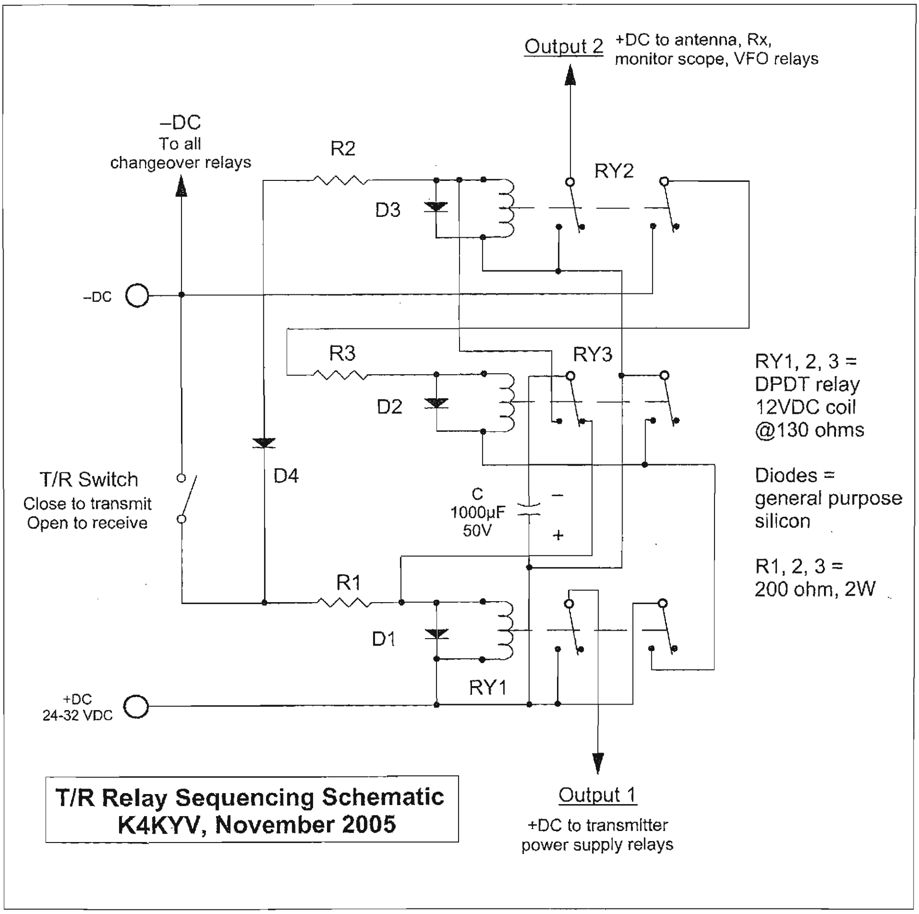

Figure 1: Complete schematic for simplified T/R relay sequencing. See the text for details of the circuit's operation.

takes for some of the power-supply filter capacitors to discharge, and the fact that some of the relays are faster acting than others. The result was that the antenna changeover relay would sometimes draw an arc across the contacts when switching from transmit to receive. With my two homebrew transmitters, this sometimes produced a visible arc at the relay with little damage, but when I put the Gates BC1-T broadcast transmitter online for 160 meters, it immediately fried, to a crisp, the standard amateur radio quality Dow-Key relay I was using.

I replaced the Dow-Key with a "new old stock" Gordon RF Relay, manufactured before WWII by Gordon Specialties Co. in Chicago. This is a large open frame DPDT relay built for the purpose of switching open-wire tuned feeders. The 3/8" diameter contacts are mounted on ceramic blocks and contact spacing is approximately 5/8". When I switched from transmit to receive using the Gates, there was a heavy "zorch" across the contacts as this relay opened. I quickly realized that even this heavy duty relay would soon self destruct, so I designed a sequencing circuit that would delay activating the transmitter until the antenna relay had definitively changed over to the transmit position, and that would delay switching the antenna relay back to receive until the transmitter was completely deactivated.

I happened to have in the junkbox a pile of identical miniature 12-VDC, DPDT relays on hand, each with a 130-ohm coil. The timing of the delay is controlled by the timing capacitor C (see **Figure 1**) and the series resistors R1, R2 and R3. The resistors were chosen to drop the 24 to 32 volts DC down to 12 volts at the relay coils. The value of C controls the duration of the delay. With the value used, 1000 mfd, the timing is approximately 250 milliseconds.

The circuit works as follows (refer to **Figure 1**):

1. T/R switched to transmit: applies negative DC to the relays through the SPST T/R switch. RY2, which controls the antenna changeover, turns on immediately via series resistor R2. The other set of contacts supplies DC voltage to latching relay RY3.

2. (a) RY1, which controls transmitter HV, turns on after a delay. The delay is produced by series resistor R1 and capacitance C across the relay coil.

(b) RY1 also activates latching relay RY3. RY3 transfers delay capacitor C to RY2.

3. T/R switched back to RX: Kills DC to RY1 and RY2. RY1 is de-energized immediately.

4. RY2 is de-energized after a delay, as C discharges. The second set of contacts on RY2 open to cut the DC to unlatch RY3, returning the system back to the original condition.

D4 prevents charged C from delaying the dropout of RY1 when the T/R switch is opened. D1, D2 and D3 suppress the inductive kick from the relay coils, protecting the relay contacts.

A prototype of the circuit was built and tested. You can hear the fraction-of-a-second delay whenever the T/R switch is switched from receive to transmit, and vice versa. This completely eliminated any sign of arcing at the antenna changeover relay contacts. Other station T/R functions such as switching the VFO output, monitor scope and receiver muting were sequenced with the antenna relay, causing the transmitter to be the last to be activated when switching to transmit, and first to be deactivated when switched back to receive.

The circuit, which uses no active devices such as transistors or tubes, was permanently constructed on a small bakelite perf board and mounted in the same module that contains the DC power supply for the relays. It has proved very reliable, operating without a single failure for over 22 months as this is being written.

73, Don Chester, K4KYV

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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

Converting an Old Oscilloscope into a Modulation Monitor

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Being one of those Hams getting re-interested in AM, I am in the process of building a linear amplifier and setting up another AM station. I will need a modulation monitor. I have been watching the auction places for a cheap, older oscilloscope. Recently, a pair of Heathkit IO-102 oscilloscopes appeared with an asking price of $9.99 for both. They both had a bright trace but no vertical deflection on one and no deflection at all on the other. One was missing a side cover, and both were missing the cover over the CRT base. I figured one would make a good modulation monitor and a friend wanted the CRT from the other for a sweep generator. I bid the asking price and got them. There were no other bids. Incidentally, the shipping was more than twice the bid price. Unfortunately, they were not well packed and suffered some shipping damage; bent corners and a cracked graticule cover.

The first thing I did was to repair the deflection problems. The one with no deflection at all had an open Q-301 voltage regulator transistor. That problem removed the +9 and –9 volts from both the horizontal and vertical deflection boards. A new Q-301 made the deflection on this oscilloscope operate correctly. The other one, with horizontal sweep but no vertical deflection had a shorted 9.1 volt Zener diode (ZD-3) on the vertical deflection board. A new ZD-3 made the deflection on this oscilloscope operate correctly. Both oscilloscopes had the vertical attenuator disconnected. I reconnected them and now both oscilloscopes operated as intended.

The Heathkit oscilloscope that I converted into an AM modulation monitor.

I decided on the following circuitry, shown in the schematic of **Figure 1**: Since the DC bias for the vertical deflection plates shares the same wires as the vertical deflection signal (actually, a piece of 300-ohm twin lead), I installed a double-pole, double-throw,

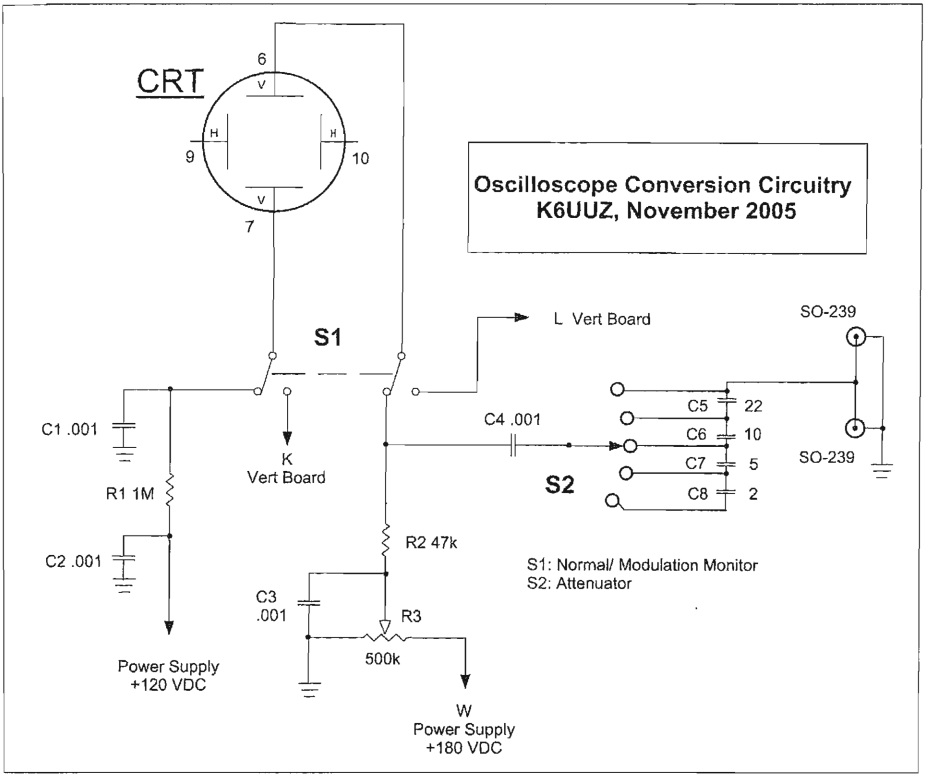


Figure 1: Oscilloscope conversion schematic diagram.

toggle switch to determine which gets to the vertical deflection plates; the original circuitry or the new modulation monitor circuitry. I called this switch the "Mode" switch. This way, the oscilloscope was still usable as it was originally designed. I also needed an "Attenuator" switch, as the amount of RF available for the vertical deflection plates varied with frequency and power output from the transmitter. A pair of SO-239s allowed the RF to be sampled as it passed through the modulation monitor. A new "Modulation Monitor Vertical Position" control was needed to bias the vertical deflection plates. This new control was mounted on the front panel and the "Attenuator" switch was mounted on the rear panel, inside a new metal box, with a shaft extension passing through the front panel. I borrowed the circuitry from the Heathkit HO-10 station monitor, with some modifications. Since I did not have the exact values for the three attenuator capacitors, I used four that I had that covered the same, or better, range. I used a five-position rotary switch instead of the four position originally used in the HO-10. Fortunately, I was able to come up with a five-position, ceramic-insulated, gold-plated rotary switch, see **Figure 2**.

For biasing the vertical deflection plates, you need two voltages from about 100-volts DC to 500-volts DC. One should be higher than the other. If two are not available you can use one voltage and a voltage divider to cut it in half for the lower voltage. The lower voltage goes to one vertical deflection plate through a one-Megohm resistor, bypassed at both ends. The higher voltage will go to the high side of a 500-k potentiometer with the low side grounded. The wiper of the potentiometer goes through a 47-k resistor to the other vertical deflection plate. Bypass the wiper to ground. Somewhere along the potentiometer the voltage at the wiper will be the same as the lower voltage on the other vertical deflection plate and the trace will be centered vertically. The transmitter RF comes in on one SO-239 and out on the other. While passing through the box it is sampled and fed to the vertical attenuator, where a suitable vertical size is selected. It is then coupled to the unbypassed vertical deflection plate through a .001-µF capacitor. This presents a modulation envelope on the CRT screen.

I decided to use a metal box over the CRT end and use it to house the modulation monitor components. Even though it was a little large, I used a Radio Shack enclosure I had on hand. It was a Radio Shack Catalog number 270-274B. I cut a hole in it approximately 3-1/2 inches square to go over the CRT and laid out all the screw holes going through it. I had to remove two screws that fastened the vertical center partition to the vertical end piece of the oscilloscope. I also laid out holes to mount two SO-239s and a toggle switch on the bottom of the box. Next, I laid out holes in the front panel and a matching hole in the rear panel of the oscilloscope and the box for mounting a rotary switch. On the front panel, I laid out a 3/8 inch hole between the "Intensity" and "Vertical Position" controls for a new "Modulation Monitor Vertical Position" control, then a 1/4-inch hole between the "Focus" and "Horizontal Position" control for the "Attenuator" switch shaft extension to come through, then a matching 3/8-inch hole in the rear panel to mount the "Attenuator" switch.

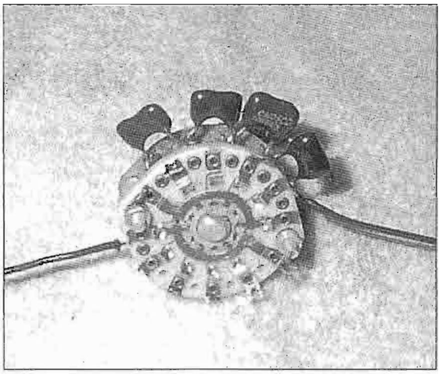


Figure 2: The new attenuator switch.

I installed the "Modulation Monitor Vertical Position" potentiometer to the front panel. I was fortunate to have a 500-k potentiometer with the correct shaft length and with a half-round shaft that the oscilloscope knobs would fit. Removing the knobs, mounting nuts and washers from the "Intensity" and "Fo-

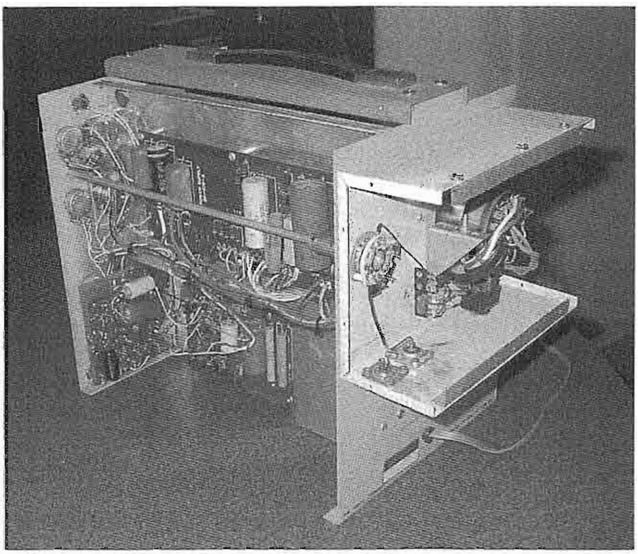


Figure 3, right: A metal box was mounted on the ten-dollar oscilloscope . It now holds the new parts that make the modulation monitor work.

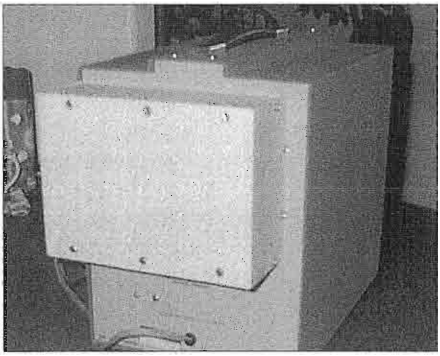
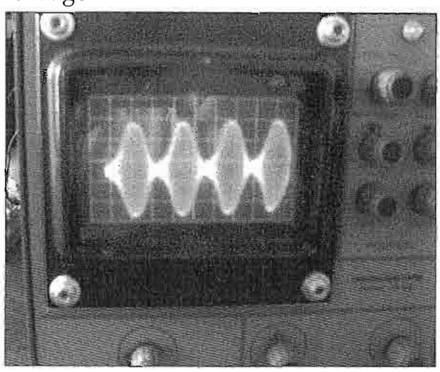


Figure 4: The completed box makes an neat assembly that is resistant to RF leakage.

cus" controls and letting them hang down inside the oscilloscope facilitated the mounting and wiring of the "Modulation Monitor Vertical Position" control. After wiring, the "Intensity" and "Focus" controls were reinstalled. The wires were run along the existing harness to the power supply and CRT socket areas where they were terminated at the proper locations. Plastic tie-wraps were installed along the length of the harness. The "Attenuator" switch (see **Figure 2**) was installed in the 3/8-inch hole in the back panel and a 1/4- inch shaft extension and 1/4-inch coupling were installed. I allowed 5/8 inch of the shaft to protrude from the front panel, and I cut it down to a half-shaft configuration. I then installed a couple of knobs from the other oscilloscope. The two SO-239s were installed with a heavy wire between the center pins. The input to the "Attenuator" switch was soldered to this wire. A double-pole, double-throw toggle switch was installed in the remaining bottom hole to be the "Mode" switch, and the rotor terminals wired to the CRT vertical deflection plates. The wires coming from the vertical deflection board were wired to the terminals on one end of the switch. This will be the "Normal" position for the "Mode" switch. A terminal strip was installed under a convenient screw to mount the capacitors and resistors. A one-Megohm resistor was installed from one of the unused switch terminals to the terminal strip where a .001-µF capacitor was installed to ground and the wire from the low voltage was connected. Another .001-µF capacitor was installed from the switch terminal to ground. A 47-k resistor was installed from the remaining unused switch terminal to the terminal strip where it was bypassed to ground by another .001-µF capacitor. The wire from the rotor of the "Modulation Monitor Vertical Position" potentiometer was connected to this terminal also. A .001-µF capacitor was installed from this switch terminal to the terminal strip where the wire from the output of the attenuator joined it. The wire from the low side of the "Modulation Monitor Vertical Position" potentiometer was grounded at this terminal strip to prevent ground loops. This completed the wiring.

The instrument was reassembled and the added-on box was modified. The box had no overlapping lip on the long sides, so a piece of lightweight angle was added top and bottom to accept screws from both pieces of the box. Additional screws were added to the ends of the box against the back of the oscilloscope. These additional screws not only improve the rigidity of the box but also reduced the RF leakage.



Sine wave modulation of an old solid-state transmitter that was running 25 watts of carrier, or 100 watts PEP. The attenuator was on position 3. ER

Feeding Multiple Receivers the Hybrid Way

Part 1

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Introduction

There are often times when you want to compare the AM performance of two or more receivers using the same signal, or monitor several bands simultaneously using a single multiband antenna and multiple receivers. In order to do this, you need some way of sharing the signal power from the antenna without undue extra loss, or interaction between the different receivers. There are several ways in which the signal from a single antenna can be split to feed multiple receivers. The crudest way is merely to connect all the receiver inputs in parallel. This can cause severe interaction between receivers, load the antenna badly, and share the remaining poor signal unequally between sets. At the next level of sophistication, a simple network of resistors can be used provide a better impedance match to the antenna and the sets, but this introduces additional loss and still doesn't solve the problem of unequal sharing of signal power caused by the input impedance of the receivers being different. If two receivers have a nominal input impedance of 50 ohms, they can be combined using three 16.67-ohm resistors in a star-network, as shown in **Figure 1**. The ideal value for these three resistors is not very convenient, but the variation in the nominal 50-ohm input impedance of receivers makes using the exact values somewhat pointless, and the standard preferred value of 18 ohms can be used with little degradation in performance. Three 15-ohm resistors would do equally well.

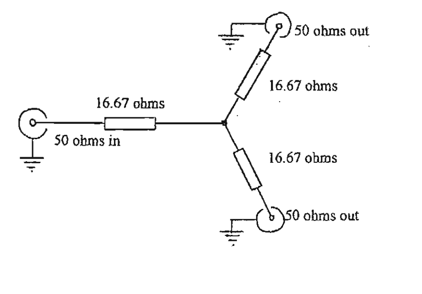

Figure 1 – Star-network resistive splitter

The use of a resistive splitter results in a signal loss of 3dB in addition to the 3dB drop in signal level caused by the sharing of power between two receivers. Also, inequalities in the receiver input impedances can affect the power sharing, and the 6dB attenuation between ports in the resistive splitter may not be enough to prevent interaction between the front-end tuning of the two receivers. To illustrate the problem of power sharing, say that your two receivers have actual input impedances of 25 and 100 ohms. Using a resistive splitter, the antenna would still see a reasonable match to 50 ohms (1.06:1), but the receivers would have input signals that were 3dB different in power level. The receiver with an input impedance of 25 ohms would see a signal that is 5.4dB down in power on the antenna output, and the other one would receive a signal 8.4dB down. The receiver with the 100-ohm input impedance would have a signal voltage at its input that is 1.4 times higher than the receiver with the low input impedance because of the 4:1 impedance ratio. Normally, if the two receivers were individually connected to the same 50-ohm antenna they would receive the same signal power because they both present a 2:1 mismatch, and the 100-ohm input impedance receiver would see an input voltage that is twice as high as that for the 25-ohm receiver.

The difference in input impedances between receivers is usually due to the turns ratio used in the RF coils, and the turns ratio of the receiver with the higher input impedance should be a factor of two less than that of the low input impedance receiver, unless the coils are inferior or the design is poor. The signal voltage at the grids of the RF tubes in both receivers would be the same if the voltage presented to the 100-ohm input impedance were twice that of the 25-ohm one, assuming that the designs are otherwise equal, and the receivers would give comparable signal-to-noise performance. The resistive splitter doesn't provide equal power to each receiver if the input impedances are different. Obviously, this difference will not be a serious problem to some people, and they would be quite happy with their resistive splitters as long as the interaction between the receivers did not cause serious front-end detuning. However, the relative performance of the two receivers using the resistive splitter would not be representative of how they would perform if they were individually connected to the same antenna, and the receiver with the 100-ohm input impedance will seem to be less sensitive than it really is. To my mind, if you're going to all the trouble of drilling a box and mounting three coax sockets on it, which is the bulk of the constructional work for a splitter, you might as well go a little bit further and get the very best performance you possibly can; especially if it's not much extra effort! The improvement in performance is certainly worth it.

The best passive way of splitting signals is with the three-port hybrid. These little circuits offer good isolation, typically 30dB, between the two output ports used by the receivers, and the signals are split reasonably equally despite variations in the receiver input impedances. The isolation between the output ports reduces the likelihood of receiver interaction. The loss of signal in this circuit is not much more than the 3dB you'd expect from sharing the power between two receivers. The only additional component required for a hybrid splitter is a ferrite-cored transformer. Some readers may worry about the intermodulation distortion products (IDPs) caused by using ferrites, but the level of these products can be rendered so low by careful choice of the size and material of the core that they are not a problem, unless you are unlucky enough to live very close to a multitude of high-power transmitting stations. Even then, the IDPs that cause you most trouble are likely to be produced in the transmitter output stages rather the hybrid transformer ferrite core. I have two medium wave broadcast transmitters within two or three miles, and they do cause me some trouble on 160 and 80m, even without the hybrid splitter in use. However, I can't tell the difference between the IDPs I get with the hybrid in circuit and the ones I get without it! The residual IDPs I have appear to be due to interaction in the transmitter output circuits, or the 'rusty bolt' effect around the transmitting site and in the main power distribution cables, because a lot of the IDPs seem to be there at the same level relative to the wanted signals even if I attenuate the signals to my receivers quite heavily, and the products peak in signal strength near the power cables. So I think they are being produced on, or near, the power cables, and being conducted down them to my property and coupled into my antenna. In order to reduce the likelihood of the ferrite core generating noticeable IDPs, I use a core that is large enough to be used in a linear amplifier at a level of a watt, or two. This means that the primary inductance can be achieved with a convenient number of turns – fewer than would be required on a smaller core - to keep the magnitude of the magnetic field, and hence the flux density, low, even at the level of pickup you might get from local high-power BC transmitters.

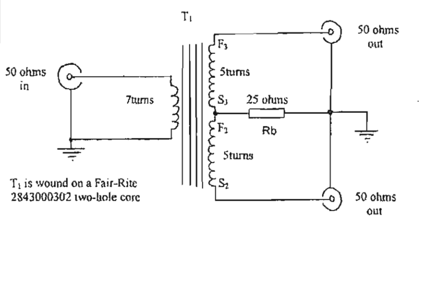

Figure 2 – Hybrid three-port splitter for 0.15 – 10MHz

The Hybrid Circuit

The three-port hybrid is an extremely simple circuit with only one transformer and one resistor. However, you might want to use several resistors in parallel to get the right value of resistance as this affects the isolation between the two output ports. The circuit of the three-port hybrid is shown in **Figure 2**. I use three 75-ohm resistors in parallel to get the 25-ohm value of the balance load, Rb, for my LF hybrid, and two 56-ohm resistors in parallel for Rb in my HF version. The secret of this little device is in the winding configuration. There are, effectively, three windings, as the two halves of the secondary are wound in a bifilar fashion with two separate pieces of wire. S_2 and S_3 refer to the start of winding 2 and winding 3, respectively. Likewise, F_2 and F_3 are the finish of winding 2 and winding 3. You can think of the two secondary windings as you would the centre-tapped secondary winding of a mains transformer, because the windings are connected to give a biphase output relative to the centre tap.

The 50-ohm input winding reflects 100 ohms across the entire secondary, which drives the two output loads differentially with respect to the centre tap. If the loads are equal, the 25-ohm balance resistor takes no signal power. When one output port is not terminated with a load equal to the other, a small part of the power is shared with the 25-ohm balance load. However, even with one port open-circuit, the other port still receives its half of the input power, provided it's input impedance is reasonably close to the output impedance of the port – 50 ohms in this case. Most of the power that would have gone into the load on the port that is now unterminated goes into the balance load, and some is reflected at the input. Really, you can't tell the difference in signal level between no load and the optimum load on the other port. It's that well isolated! Variations in receiver input impedance cause an additional loss according to the VSWR they present to the hybrid, but this is no greater than the mismatch loss the same receiver would see if it was the only receiver connected to the 50-ohm antenna, anyway. Whether the receiver is connected to the antenna direct, or through the hybrid, an input impedance of 100 ohms or 25 ohms would incur an extra 0.51dB mismatch loss in a 50-ohm system. So, the hybrid has little additional loss compared with a single receiver connected to the same antenna, other than the natural 3dB power sharing drop you'd expect from power splitting without amplification, and a small insertion loss due to the core material, which is typically 0.2 to 0.4dB in the frequency range for which the hybrid is designed. For comparison with the resistive splitter, it's worth pointing out that the hybrid would provide equal signals to two receivers with input impedances of 25 and 100 ohms. This is one of several advantages of the hybrid circuit over the resistive splitter - the others being higher isolation between receiver inputs and lower insertion loss.

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, pro-

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.

viding 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 limitations 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.

[Editor's note: Part II of this article next month will cover tailoring the design to your own needs, and suggestions for constructing and housing these simple passive signal splitters.] **ER**

The SX-101A

Hallicrafters' Heavyweight Champion, Part 3

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By 1959, the SX-101 had been in production for three years and was selling well, but it was due for a substantial upgrade. Hallicrafters decided to reintroduce it as the SX-101A. The most notable change was the loss of the 160-meter band, probably because of wide interference from Loran navigation beacons, and the addition of a "converter" band. The converter band was a good idea because at the time of the SX-101A's introduction, VHF propagation was very reliable and famous Solar Cycle 19 was in full swing. The 6 and 2-meter bands were very popular. The upper band tuned from 30.5 to 34.5 Mc and the dial had dual calibrations for 6 and 2 meters. The receiver would accept an input from any of the popular crystal-controlled converters and essentially became a sensitive tuneable IF.

The increasing appearance of SSB and high-power linear amplifiers made an increase in large signal handling ability almost a requirement in good HF receiver design. To accomodate this, the semi-remote cutoff 6DC6 amplifier tube was introduced at the RF amplifier V1, and at V6, the 50.75-kc IF amplifier. They did a very curious thing when this change was made. AGC was applied to the first mixer, V2, but not to the IF amplifier. I would like to know what the purpose of this mistake was because it didn't make any sense. Strong signals pulled the VFO off frequency because the mixer bias changed, and the lack of AGC on V6 gave a limited range of automatic control that increased distortion. This cancelled all the performance gains the 6DC6 added! Both problems were worse when a lot of strong signals were on the bands.

Another major change was the addition of V13, a 6BY6 product detector, to assist with low-distortion CW/SSB reception. This circuit had good performance, but another design oversight messed up the ANL. The SX-101s and the '101A all used a series-diode noise limiter, which did a good job if properly biased. When they added the product detector, the ANL diode was biased for good noise limiting in the CW/SSB mode and AM was ignored. In AM, the bias was wrong and made the ANL a useless distortion-producing attenuator.

I have designed some simple modifications to get around these problems that I will discuss next month in the last part of this article.

Because the product detector had a lot of conversion gain and the AM detector was lossy, the audio presented to the 6K6 output tube in CW/SSB was much louder than in AM. So, through some wiring changes in the AM position of the "Response" switch, audio was rerouted from the diode detector output to the input grid of the product detector, which then became the first audio amplifier. This additional amplifier was used only with the two AM response positions.

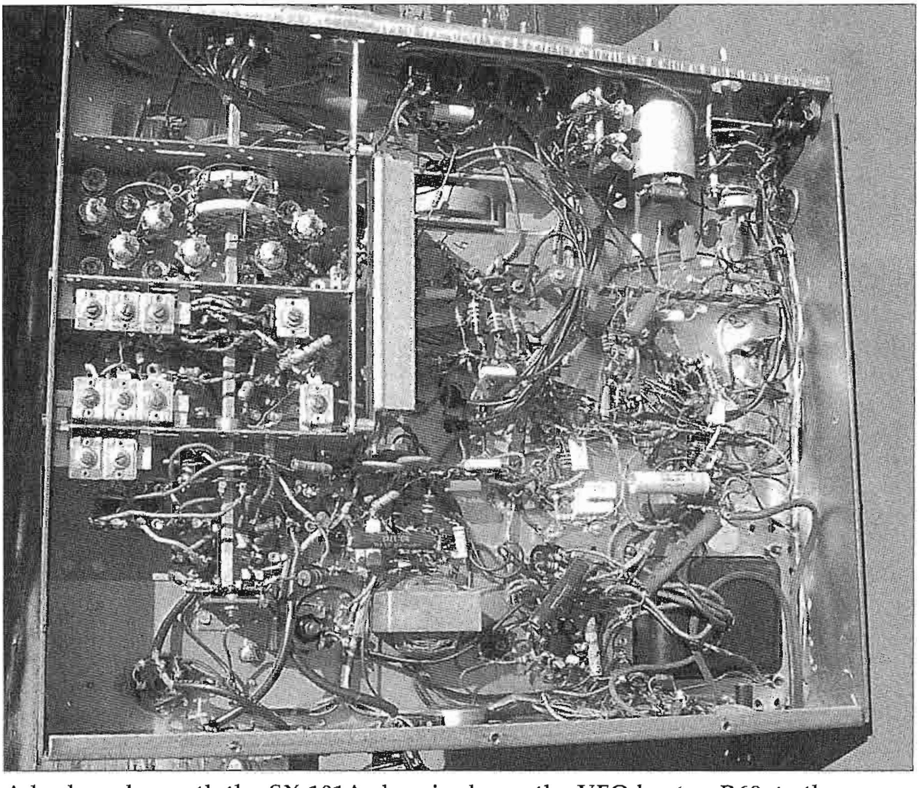
The SX-101A Electrical Restoration

After I had the SX-101A tuning system cleaned up and working smoothly, the time had arrived to tackle the electronics. As mentioned in Part 2 of this article, there were many problems noted with this receiver's performance.

The first task was tube testing, so each one of the little beauties went through my trusty military-Hickock TV-7D/U tester. This receiver still had 6 of the original tubes installed, labeled "Hallicrafters" by their maker, and they were all still good. The 6K6GT audio output tube was weak and gassy, and was replaced. The 0A2 regulator was extremely erratic and was replaced with a selected tube in a process I will describe later. V5, the 6BA6 2nd mixer, had a date code from the mid-1970s and was the newest tube in the receiver, so my suspicions about a problem in one of the IF stages were peaked when I found that it had been replaced.

Satisfied that the tubes were in good order, I made voltage measurements with each stage's tube mounted on a tube socket extender, and the results were entered on a chart. I found out that the electrode voltages had errors between 20 and 80 percent in every stage. Component testing was the next obvious step in this project.

It is easy to check resistors in-circuit with a digital volt-ohmmeter (DVM) if there is no other resistance shunting them, as is nearly always the case. I found that a total of 22% of the carbon-composition resistors had changed value. As usual, they were all high. Most of the resistance change was around 20%, but three had drifted up over 30% in value. There were three resistors that had burned up due to paper capacitor failures, and had no value. In the 2nd mixer,



A look underneath the SX-101A chassis shows the VFO heater, R69, to the upper left center inside the rectangular metal cover, mounted to the oscillator shield parts. The RF amplifier stage is to the lower left, and the VFO filament transformer is just to the right of the RF stage. The separate fuse for the filament heater is in the tubing mounted at an angle over the power transformer in the lower right. At the upper left, the BFO tuning unit is inside the round cylinder.

R208 was burned up due to a probable internal short in the tube that was the previous occupant of V5.

Most restorers use a capacitor checker to look for problems with condensers, a quick and accurate method. I started out using a milliammeter and a power supply years ago, so I have stuck with it. In this SX-101A, there were a few original disk ceramic capacitors, plus several others that had been installed during previous repairs. Not counting small value tuning and temperature compensating capacitors, there were only 5 disk ceramic bypass capacitors in the factory parts list. The balance of the capacitors in this receiver were either Black Beauty or Tiny Chief molded-paper types. 50% of each style either had direct shorts or leakage in the 10s of milliamps range. I had originally wanted to keep as much of the receiver original as possible, thinking that if I replaced a lot of parts I wouldn't have the same venerable receiver. Finding all these defective capacitors forced me to rethink that idea, and I decided to get rid of them all by replacing them with modern 630-volt Mylar caps. The power supply electrolytic, however, was fine. It had the original part number and a 1961 date code and had less than 30 microamps leakage in each section. I suppose it hadn't been made on Monday morning or Friday afternoon!

Component Replacement

There are a wide variety of parts available for use when restoring equipment. Mylar, polystyrene, or metalized capacitors are all readily available from the catalogs. When choosing resistors, there are carbon composition, carbon film, metal film and metal oxide types to choose from. How are you supposed to know what know what is best to use in a given application? I'm going to digress awhile from the restoration discussion to provide some component information that hopefully will make the selection process easier.

Are Paper Capacitors Unreliable?

Every engineer wanted his design to be reliable, but equipment manufacturers purchased components at prices dictated mainly by the accounting department's cost budget. Paper capacitors had the lowest cost-per-unit of capacitance obtainable. Except during the early-WWII period, military equipment generally used high-quality paper capacitors purchased to exacting specifications, while consumer-grade broadcast sets generally used the least expensive types to be found. Our Ham gear was somewhere in between. Generally, the higher the initial cost, the better the component was.

Most quality paper capacitors had a tubular, extended foil, impregnated in a hermetically sealed metal case, such as the excellent Sprague Vitamin-Q® or Hi-Rel® series. Cheaper paper caps were mounted in a cardboard tube and dipped in wax, shellac, or plastic.

Except for the electrolytics, in no other type of capacitor manufacture were high standards more essential than in making reliable paper capacitors. To get a good one, it was necessary to use paper and impregnants of the highest chemical purity, to reduce the amount of water in the dielectric to the absolute minimum by careful drying, and to provide a positive end seal on the finished part to prevent the entry of moisture.

Very small amounts of contaminants greatly reduced the working life of a paper capacitor. The paper pulp contained unavoidable residues of salts, acids, and alkaline substances which were difficult to remove even after the most careful washing in pure distilled water. Tiny, nearly undetectable spots of impurities which, under conditions of low temperatures and voltages would not cause problems, became highly active at high voltages and temperatures due to electrolytic action. Such chemical activity was accelerated in the presence of water. So, the paper had to be nearly perfect; free of holes, insect parts, conducting particles, dirt, water, or any impurity likely to cause chemical action after the part was placed in service.

If the impregnant contained chemically active impurities they could, under the combined influence of heat and high voltage, cause rapidly increasing dielectric loss and DC leakage current, eventually possibly causing runaway self destruction of the capacitor and other components in the same circuit.

In general, you got what you paid for, but with so many variables it is easy to see why some paper capacitors—even from the same production lot—have lasted over half a century and others have turned out to have high failure rates such as what we see today with the infamous Black Beauty caps, which in my SX-101A were acting like little "shorting sticks" rather than capacitors!

Construction

The paper capacitor was produced on automatic machinery that wound two thin metal foils, separated by sheets of paper, into a compact roll that became a capacitor after the leads were attached. They were wound in a wide range of sizes and paper thickness and were frequently combined in series, parallel, or series-parallel configurations within the container to provide many capacitances and working voltages. Higher-quality caps used two sheets of paper. When two sheets were used, the chances of two defects appearing at the same place in the dielectric became small, increasing reliability and production costs. After the unit was wound, it was vacuum dried and impregnated with wax, oil, or some other synthetic compound. Mechanical flexibility and ease of impregnation gave paper an advantage over other dielectrics. Paper could be readily impregnated with resins, oils, waxes or other special materials.

Paper capacitors were susceptible to capacitance drift, aggravated at high temperatures. They were not used in tuned circuits or in timing circuits requiring high stability.

Film-Type Capacitors

In a film capacitor, the dielectric material is some kind of plastic film, used alone or laminated with paper. The film has high mechanical strength, long-term resistance to heat, and is chemically inert if properly sealed. Materials commonly used are polystyrene, polyethylene and Mylar. Examples are the Sprague Orange Drop® and similar types. Although they might not look like it, they are constructed in a roll, the same as with paper capacitors. They are frequently dipped in quick-setting colored epoxy. In general, low-voltage units are used without impregnation or a liquid fill. Most film caps have higher dielectric strengths, lower power factors, and higher insulation resistance than paper. Mylar capacitors are rated for operation over the range of -65 to +130° C, which makes them ideal for replacements in tube-type equipment. Polystyrene capacitors which have a maximum operating temperature of +85° C and have extremely low dielectric absorption, with temperature coefficients of capacitance as low as 100 parts per million per degree, over the range of -30 to +60 C for standard-production units. They are frequently used in tuned circuit applications.

Metalized Capacitors

The construction of metalized capacitors is similar to other foil capacitors except that the metal conductors are deposited directly on the dielectric in extremely thin film sections, typically between 25 and 100 milli-microns. This thin film provides a self-healing property. When an arc-over occurs between the capacitor electrodes (the paper or film in the roll), the deposited film burns away and opens the circuit, saving the capacitor and other associated circuits! In transistorized stuff, the arc may not generate enough heat to provide this self-healing feature. At voltages less than about 200 DC, one sheet of paper or film is used. It provides a larger capacitance for a given volume than the conventional foil-type unit. In high-reliability circuits where an occasional arc-over might cause noise, use a voltage rating of twice the peak value expected in your equipment to guard against this noisy possibility. Examples of this style of capacitor are metalized paper, metalized polyester, or metalized polypropylene and they come in many trade names.

The Essential Resistor

All variable and fixed resistors can be grouped into three basic kinds: carbon-composition, high-stability film, and the wire-wound types. As the name indicates, the composition resistor is made of a mixture of a resistive material–usually carbon– and a binder that is molded into the proper shape and resistance value.

The film type is composed of a thin resistive film deposited on, or inside of, an insulating cylinder or filament.

The wire wound type is made up of resistance wire, wound on an insulated form and normally are only used in a power supply circuits because of their inductance.

Some resistors are better than others for particular purposes; no one type has all the best characteristics. The choice among them depends on the requirements, both initial and long-term; the environment in which they must exist; and many other factors.

Resistor Stability

Time, moisture, mechanical factors, as well how they are used, will all affect the actual value of a resistor. Carbon-composition resistors are the least stable type, while deposited-carbon resistors are quite stable, and wire wound and metal film types are highly stable.

Resistor Noise

Resistor noise is a very important thing to consider in the design and repair of sensitive radio receivers. Noise in good-quality fixed resistors is a small voltage developed across the resistance element itself. It is of two kinds; one type, thermal agitation or "Johnson" noise, is independent of the material of which the resistor is made and is dependent only on the resistance and temperature of the resistive element. It originates from the motion of the molecules making up the resistance element. The high levels of "Johnson" noise at resistances over 1 Meg make the use of carbon-comp resistors in circuits of high sensitivity a poor choice.

The second type of noise is characteristic particularly of carbon-composition resistors, and makes them doubly noisy. This noise appears only when current flows through the resistor, and has been termed "resistance fluctuation" noise. Because the actual resistance of a composition resistor is composed, in effect, of many series-parallel pressure connections between discrete particles, this resistance is subject to random changes because the contact resistances between the particles is always changing. For this reason, the fluctuation noise is dependent on physical properties other than temperature and resistance. It varies according to material and construction, and even from sample to sample of the same type of resistor.

Any mechanical damage to a resistor will cause a tremendous increase in resistor noise.

Noise levels are lower in physically larger resistors than in small ones. In any one size, noise increases with increasing resistance and with increasing load current; in limited ranges of current it is approximately proportional to the current flowing. Noise decreases with increasing frequency. The major portion of the noise energy seems to be in audio frequencies.

Carbon Composition Resistors

Carbon-composition resistors were once common parts. There were small, inexpensive, and were reasonably reliable when properly used. They had poor stability, poor noise characteristics, appreciable voltage and temperature coefficients, but had relatively good high-frequency characteristics because of little series inductance. There were two basic forms of the common carbon-composition resistor, the "pellet type" and the "filament type." The pellet type consisted of a mixture of resistance material and binder, formed into a resistor element with tinned leads stuck into it and with a phenolic case molded around it in one operation. The resulting resistor was a solid part that couldn't be pulled apart without breaking it. The filament type had a resistance element consisting of a small glass tube. The ends of the tube had specially formed leads inserted. The actual resistance material was a carbon-composition film deposited in a thin layer on the outer surface of the tube, and extending out over enlargements in the leads that came up against the glass tube. The resistance element was assembled separately and a plastic insulating tube was molded around it. Carbon-comp resistors will seldom open up unless they have been badly overloaded.

Carbon-Comp Disadvantages

In addition to noise, RF currents in the resistor will produce end-to-end shunted capacity effects. Because of short resistor bodies and small internal distances between the ends of the leads, small capacitors result. This can cause random, unexpected changes in tuned circuit and tube characteristics.

The actual value of a carbon-comp resisor at any particular time depends on its body temperature, the voltage across it, the moisture it retains in its body, and its previous history.

Do not use them for voltage dividers where accuracy and stability is desired. Do not use them in any circuit in which a long-term permanent resistance change of 10 percent or more can't be tolerated. Do not use them in low-level circuits where the noise inherent in this kind of resistor may be bothersome. Unused carbon-comp resistors will vary slightly in resistance from week to week, depending on the humidity of the surrounding air. Ambient temperature will also affect the values. High temperatures maintained for long periods have a seriously deteriorating effect. They absorb moisture during storage. This is probably due to decomposition of the binder used to hold the carbon granules together, and causes the values to change. The phenolic case into which they are molded is not a good moisture barrier. When they sit on the shelf or in equipment not being used they will slowly absorb moisture and their resistance will change. The least change in carbon-composition resistor characteristics is seen in equipment that has seen continuous service.

Film Resistors

Film resistors are widely used today. They have high stability, low voltage and temperature coefficients, and good high-frequency characteristics, and are useful where accurate wire wound types can't be used. Because of their high stability compared to carbon-comp resistors, they can replace them in most applications. Carbon-film, metal-film and metal-oxide film resistors are all similar in appearance and can be directly substituted for one another. They consist of continuous films of resistive material of controlled thickness deposited on a base material on a glass or ceramic core. The films are bonded to the cores at red heat, and expansion coefficients of the materials are matched. The resistor is terminated with a band of conducting material at each end, to which pigtails are attached. The whole assembly is dipped in varnish to provide a moisture barrier. For highly stable units, the completed resistor is sometimes sealed into a glass or ceramic tube, or molded in an insulating compound.

They are rugged, and are less subject to mechanical damage than are carbon-comp resistors. The core, because of its low expansion, is quite resistant to high temperatures and thermal shock. They have good high-frequency characteristics. The noise voltage developed by film-type resistors is lower than in composition-carbon resistors. The mechanism for the production of noise in film resistors is probably the same as in composition resistors, but the conducting paths are shorter, so less noise is actually developed.

SX-101A Electrical Restoration Details

The bandswitch and the other rotary switches were extremely dirty underneath the oil bath coating someone had given the receiver. Some solvents will attack phenolic, so I had to be careful cleaning the switches. I gradually softened and swabbed the goo off with denatured alcohol and very many Q Tips®. When it was all gone, I used ammonia to clean the tarnish off of the plated switch contacts, gave them a final flushing with denatured alcohol, and then lubed the moving parts with a minute dab of conductive grease. Now, there is no noise in the switches, and every position makes positive contact.

The pots responded well to normal cleaning. I did use a contact enhancer (Caig Preserve-It®) on the Volume and Notch Depth controls to get rid of residual noise.

C8 and C21 are the screen bypass capacitors for the RF amplifier and the 1st-mixer stages. Their value from the factory was .005 µF. Unless the Hallicrafters engineers were assuming that these parts should be series-resonant filters at 1650 kc with about 1.8 µH in their long lead lengths, their value as a bypass capacitor is too low. Both were replaced with .1-µF Mylar caps and very short leads. Much wiring associated with V1 and V2 was shortened, directly routed, and I went to a single-point ground in both stages to avoid any possible source of RF feedback from multiple ground paths.

While I was busy replacing capacitors and resistors, I noticed a lot of sloppy factory assembly practice. The assembly line technicians used too much solder and not enough heat on some solder joints. Many wiring tie points had big blobs of solder, so much that they were nearly touching adjacent tie points. A lot of these large solder balls, while looking OK on the outside, were crystallized on the inside, forming a noise source because of high contact resistance and diode action in the so-called solder joint. I found a few wires that were not wrapped around a tie point at all, but were stuck cold into a solder blob. It is possible that these were leftovers from previous hasty repair jobs. I went over every solder joint in the receiver, removing excess material with solder wick and resoldering everything with Multicore® SN-62. I feel that this was time well spent.

The reason the 1-kc bandwidth position was wider than the 2-kc position was because a previous technician misread the value of C51, originally .022 µF, during a repair. It had been replaced with a .2-µF cap. The original paper cap had probably failed, but enough time had passed since the old repair occured that the paper replacement was bad!

It can be difficult to check and replace components underneath the 2nd-mixer subchassis because of close clearances and insufficient slack in the wiring. If you remove the bandwidth switch from the chassis and push it back into the chassis area, and unsolder one red B+ wire where it attaches to L11 at a tie point, and then unsolder two pieces of RG-174 mini coax that terminate on the long tie strip just above the chassis hole where the wires go into the subchassis, just enough clearance is available to tilt it to one side. Components under the subchassis are then a little more accessable. I found the dropping resistor (R208) for V5 and V12 had burned up, probably due to an internal short in the tube that originally was in the V5 location. That was my conclusion because none of the bypass capacitors were bad. C204 was leaky due to silver migration. I replaced C204, C205, C33 and C34 with checked 500-volt silver micas, and I matched their value within 5% with the capacitance meter that's built into my DVM. (Actually, all the resistors and capacitors associated with bandwidth were matched as closely as possible. This matching is necessary to preserve the shape factor in the 50.75-kc LC filtering. 1-watt, metal-film resistors were used as replacements at R31 and R34 to R39.) I replaced all of the resistors under the IF subschassis with new 1-watt metal film types because I didn't want to have a carbon resistor fail later on after everything was buttoned up. There were no original paper caps under there, and this is one area where Hallicrafters used disk ceramic caps. R208, C204, and C33 were causing a lot of the problems I noted earlier with image response and low IF rejection.

I have to caution readers about R69, the "Dampp Chaser" power resistor that preheats the VFO. If you work on R69, be sure wear a dust mask because it is inside of an asbestos liner. I have no idea what kind of asbestos they used, but it is best to not disturb it. It won't hurt anyone if the particles don't become airborne. In my receiver, R69 is 8.2 ohms, 10 watts. All the schematics show it having 3.3-k resistance. The 8.2-ohm heater resistor uses about 5 watts, and produces a 30-degree rise in temperature over ambient in use, which is just about right.

Mechanically, there were several tie points with corroded, rusty steel rivets holding aluminum ground lugs. Not only were they ugly looking and poor DC grounds, but they were probably a noise source. The rivets were drilled out and replaced with stainless screws and hardware, the chassis was cleaned up, and new grounds lugs provided.

Voltage Regulation

V10, the 0A2 150-volt regulator, has a design-maximum rating of 30 mA. In the SX-101A there is 29.5 mA of load current on the regulated 150-volt bus if all the capacitors are in good shape. New 0A2 gas regulators haven't been made in quite a number of years now, and with a design that runs against the design maximum, any impurities in the inert gas or subsequent outgassing from internal electrodes in the tube will cause the tube to drop out of regulation. I found that it was necessary to "audition" five new 0A2s until I found one that would regulate in this circuit. The receiver was tuned to the evening W1AW code practice session, and one by one they were tried out until a good one was found.

My receiver still had some residual short-term instability. This typically is caused by line voltage spikes in a tube's filament, and affects some receivers more than others. I tried new 12BY7A VFO tubes, and on the third try I got one that was improved. Still, there was some remaining instability. It was causing random 200-cycle shifts in a CW note. Leaving the receiver plugged in as designed helped a lot, but it still was unstable at times.

I tried an old trick to get the filament transformer to regulate by causing the core to saturate. Two 1-µF, 630-volt nonpolarized Mylar capacitors in parallel were placed between the filament fuse (F2) and the filament transformer primary winding. At the secondary winding, two 10-ohm, 2-watt carbon-film resistors in parallel were added to bring the filament voltage back down to 6.3 volts. This worked great, and produced .18% regulation for 10 volts of line voltage change. All of the short-term instability vanished. The filament transformer core temperature increased only 3–1/2 degrees F. The main drawback was loud hum coming from the transformer core laminations that I found objectionable, and the modification was removed. In the shack, I have a 600-watt TripLite® line conditioner, model LS-600B, that regulates and removes line transients. I'm not sure it's still made, but any similar AC power conditioning device will do the same job.

To be continued next month. **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

Hallicrafters Collectors Association Net: *Sun.*, 14.293 Mc, 1:15 PM EST/EDT. *Sat.*, 7280 kc, 1:00 PM EST/EDT. *Wed.*, 14.315 Mc, 6-8:00PM EST/EDT. QSX op W8DBF.

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

FOR SALE: Collins 75S-1, CW filter, Waters rejection, VGC $450. Hallicrafters SX-122, working, $200. S-40B $50. Heath AT-1 $150. VF-1 $35. Murch UT2000A $100. Swan 500C, 500, 1 PS, 1 VOX, $400 total. NIB HyGain 153BA $150. Gonset G50 nice, $100. Freight paid CONUS. Guaranteed. Don, K5AAD, 1-713-942-9747

FOR SALE OR TRADE: Cleanest RAL-7 you'll ever see, w/orig. cables & power supply, all working fine; RCA AR 8506 Liberty Ship Receiver, super clean, doubt this one was ever on a boat! Will trade above for items listed in wanted or consider cash offers. Knight Kit SWR Meter, very nice, $15. Bell & Howell Filmsound, 16 mm., runs smooth. Two Webcor Wire Recorders; Waterfall, early model 7 w/ Magic Eye, and 181, enough to make one Magic Eye model 7 nice, $65/pair. **TRADE FOR/WANT TO BUY:** WW II DZ-2 Radio, whole or parts chassis; DU-1, DU-2 loop amps; other WW II nav gear; WW I era hi-end sets and detectors, IP 500, 501, CN-112/239, RCA 106, Norden-Hauck Navy 10; Golden Leutz; other supers; RAK-7; SSB gear to add to my Viking II and BC 375 transmitters. We're always buying vintage broadcast mics; tube pre's; mixers; compressors by Altec, RCA, Sony, WE. Check out our new website at: http://www.radioattic.com/kremer. Ward Kremer, 1179 Petunia Rd., Newport, TN 37821, Ph/Fax: 423-625-1994, E-mail: witzend99@bellsouth.net.

FOR SALE: 1 tube kit radio built on cigar box with plug in coils. Kit, 6 meter transceiver, neat. 1940 Motorola car radio 501. Bill Coolahan, 1450 Miami Drive NE, Cedar Rapids, IA 52402. 1-319-393-8075

FOR SALE: Two ART-13s, untouched. Two BC-522 transceivers. One Rotex silver recovery system. Best offer. Pick up on ART13. 1-570-654-2347

FOR SALE: Heathkit SB-102 with power the supply/speaker combo and digital readout. Case is mint, no dings, no missing paint, no scratches. Has all the tubes and components but doesn't transmit. Had it packed up in a closet for 15 years. It does receive. $400 + shipping. Also have other Heath equipment to sell, please call in evenings for details. Travis McKee, W5JIF, 985-872-5979 evenings or Travismary@yahoo.com

FOR SALE: Simpson Instruments 373 DC milliammeter. 370 AC ammeter. 374 DC microammeter. 378 AC milliammeter. $25 each plus shipping. Manual copy included. Ross Wollrab, 229 N. Oakcrest Avenue, Decatur, IL 62522 217-428-7385. REWollrab@aol.com

FOR SALE: Lafayette tube tester TE-50, circa '62, like new w/book and carrying case $19 + shpg. Henry Mohr, W3NCX, 1005 W. Wyoming St, Allentown, PA 18103

FOR SALE: Millen Variarm E.C.O. model 90700. Very nice condition. 40/ 80 mtr. bands. $150. Don, W7KCK, 503 289 2326, email dgkck@qwest.net Portland Oregon

FOR SALE: RARE WWII 47 Mc German field radio, corrosion on inside, 24 lbs, 15.2 x 10 x 8. Only receive section 10 original tubes remains, 281-996-5835, TomN5ACA@juno.com $400 or put on ebay as "Axis Field Radio" 30 days after ad.

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

FOR SALE: Drake MS-4 speaker $35. Globe V-10 VFO $50. Hallicrafters PM-23 speaker $50. All items are in good condition. Bob, W1RMB. 508-222-5553

FOR SALE: Complete QST 1915 to now, $7000, shipping negotiable. K8CCV, 330-427-2303

FOR SALE: 2 ea. Machlett Labs Inc 2L39A tubes NIB. 5 ea. Mallory Type 25k, 25w, 750 ohm pots. 1 ea. GAP/R model K2W. 2 ea 12AX7A Westinghouse. Gordon Shimmel, Box 101, Hannawa Falls, NY 13647 315-265-4638

FOR SALE: Cushcraft R7 w/manual, pickup. John, NE6G, 7495 Gunter Rd., Pensacola, FL 32526, 850-944-6564

FOR SALE: New Old Stock Tubes: 6-50L6GT. 1-6AF6. 1-6Y6GT. 2-12SN7GT. 1-6C5. 3-6SL7GT. 1-6X5GT. 2-6SF5. 2-6SJ7. 3-6SQ7. 3-6J5. 1-6V6Y. 1-6SA7. 1-6T4. 3-6V6GTA. 1-6V6GT. 1-12SK7GT. 3-6BQ5. 3-6L6GC. 1-6080. 1-6146A. 1-5691. 5-5763. 7-6C4. 3-6AR5. 3-12AY7. 4-12AT7. 6-12AU7. 9-6X4. 4-7199. 10-6BF6. 5-50C5. 8-12AU6. 5-6AV6. 5-6AU6. **Used Tubes:** 2-7868. 3-83. 2-CX301. 1-CX300. 1-UX245. 1-5931. 5-5V4GB. 4-5R4GYA. 2-6L6GC. 1-6L6GB. 2-6CA7. 2-6146. 6-6AS7G. 1-6AS7GA. 2-7868. Made in USA, make offer. All plus shipping. Jesus Moreno, 634 15th St., Douglas, AZ 85607. 520-364-3127

FOR SALE: Lafayette HA-90 VFO, 80-10m, self-powered, w/manual, $95. Early Yaesu speaker, $45. Richard Prester, 131 Ridge Road, West Milford, NJ 07480. 973-728-2454. rprester@warwick.net

FOR SALE: 1950s vintage Gates model MO-3777B four channel remote mixer. Gary, KØCX, kzerocx@rapidcity.net 605-343-6739 evenings

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: Hayden Electricity One-Seven series, complete, good condx. $16 postpaid. **WANTED**: Clean, working BC-344. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

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

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

FOR SALE: Globe Champion, VG, $365. Hammarlund HQ-140X w/speaker, manual, clean, one owner, works, $200. Palomar Skipper 300 linear $120. Ron, MI, 517-374-1107

FOR SALE: Knight P-2 swr/power meter & antenna block $15. CB, Pacer by, Metrotek w/mic $30. RCA, tape (training keyer) w/key & instructions $25. Silvertone Sig. Booster (for TV) M-6745 $5.Radio ham made inverter.110VAC to 9VDC neat $5. Sig. Corps Output meter M-650-SC (1-56-J) 1943 $15. Bernie Samek, 113 Old Palmer RD. Brimfield, MA. 01010 413-245-7174, bernies@samnet.net

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

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

ZIM ELECTRONICS INRUSH CURRENT LIMITERS

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

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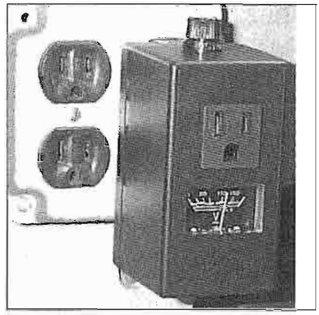
(4 or more limiters are shipped free for US orders. Overseas customers please ask for shipping quotes.)

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



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FOR SALE: Approx. 200' 7/8 Prodelin coax w/connectors $250. Kato-Lite 500W 110V 60 cy 1800 RPM generator perfect for field day $25. S-S 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: Galena crystal radios and/or parts. Also Radio tubes. L. Gardner, 458 Two Mile Creek Rd., Tonawanda, NY 14150 radiolen@att.net

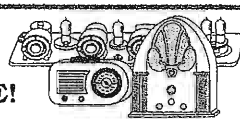
FOR SALE: Cathedral and tombstone type $35 each. Minerva Morale radio $50. Military whip antennas. Bruce Beckeney, 5472 Timberway Dr., Presque Isle, MI 49777 989-595-6483

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

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

FOR SALE/TRADE: Transmitting/Receiving tubes, new and used. LSASE or email for list. **WANTED**: Taylor 204A,

FREE SAMPLE!



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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

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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: R-390A's, R1051's, Harris RF-550's, URM-25D signal generators, military 28VDC gas generators, AS-2851 antenna kits. Call, Lots more stuff! S. Daniels, 636-343-5263

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

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

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

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

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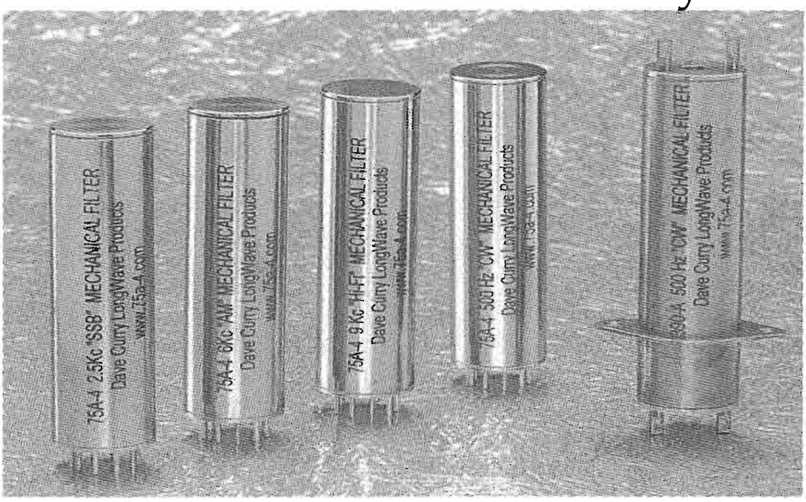
SERVICE FOR SALE: Authorized repairs and sales of all types of amateur radio, communications, and test equipment. Please call Land Air Communications, 718-847-3090, visit our web site: www.landaircom.com. We have over 3,000 items in inventory and carry all types of communications parts.

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

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

The Collins Filter Family



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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

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

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

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

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

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

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

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

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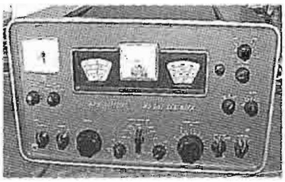

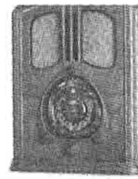

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WANTED: Plug in coils for Globe King. 160 thru 20 meters. Need final and driver coils. Bob Henriksen, KFØAM, 605-923-5309 evenings. kf0am@arrl.net

WANTED: S meter for Knight R-100A receiver. Karl Daxland, KA1RM, ka1rm@aol.com or 508-636-3281

WANTED: Eico 720 Modulator or equivalent. Bob K9LCR, 847-587-7982, ac4tibet@mc.net

WANTED: RCA CR88, CR88A, SC88 receivers. Collins TDO manual. Shane Ward, 6 Pond St. 2nd floor Amesbury, MA 01913 n1dmxradio@aol.com 978-609-1072

WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI, 16 Carly Drive Highland NY 12528 845-691-6247 w2ami@arrl.net

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

WANTED: Dow-Key DK-60/Aux contacts. Heathkit HW-30 2M AM. T.K. Stanley, KA1T, 2625 Brownsville-Heartland Rd., West Windsor, VT 05089

WANTED: Manual for Sprague TEL-OHMIKE Model TO-5 Capacitor Analyzer.

Gale Roberts WB9RWW, 920-696-3491, wb9rww@wmconnect.com

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: 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: National SW-3 Universal. Octal tube type, doghouse, coils if possible. George Rancourt, K1ANX, k1anx@charter.net, 82 White Loaf Rd, Southampton, MA 01073-9550

WANTED: Schematic and data on E.M. Sargent "10-20 Booster." 1930's nonregenerative preamp. R. Kuchera, K1TG, 270 Tawny Thrush Rd., Naugatuck, CT 06770, rwkuchera@snet.net

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

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

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

WANTED: 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

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(1) Publication name: Electric Radio (2) Publication No.: 1048-3020. (3) Filing date: October 1, 2005 (4) Issue frequency: Monthly (5) No. of issues published annually: 34800 (6) Annual subscription price: $32 (7) Complete mailing address of known office of publication: PO Box 242 Bailey CO 80421 (8) Complete address of headquarters or general business office of publisher: Same as 7 (9) Full names and complete addresses of publisher, editor and managing editor: Symbolic Publishing Company, LLC PO Box 242 Bailey CO 80421 Ray Osterwald PO Box 242 Bailey CO 80421 (10) Symbolic Publishing Company, LLC PO Box 242 Bailey CO 80421 (11) Known bondholders: none (12) not apply (13) Publication name: Electric Radio (14) Issue date for circulation data below: November 2005. Statement Ownership will print in November 2005 issue of this magazine

(15) Extent and nature of publication	Avg No. copies each issue	Actual no. of copies during preceding 12 Mo.
(a)Total no. copies (net press run)	2880	2900
(b) Paid and/or requested circulation	2600	2605
1) Sales through dealers and carriers, street vendors and counter sales (not mailed)	73	73
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WANTED: Collins 310B-3, basket case OK, 70E-8A PTO per 1948. Chicago CMS-2, pair of Taylor T-21. Jerry, W8GED, CO, 303-979-2323.

WANTED: Working original panel meter for Viking Adventurer. Ron Schwab, 3582 Bell Road, Auburn, CA 95603 k6tty@foothill.net

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: Meter escutcheon (3 by 5 1/2") for Hallicrafters SX-146 or HT-46. Andy, K8LE, Ohio, 614-864-2922 aelliott7@sbcglobal.net

WANTED: Manual schematics etc. Submarine VLF loop antenna tuner Borg Warner CU-352A/BRR. Weber, 4845 W. 107th St., Oak Lawn, IL 60453

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

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

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

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

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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 30th, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

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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

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

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

WANTED: Hallicrafters HT-33 parts unit. John, W8JKS, 740-998-4518

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

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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

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

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

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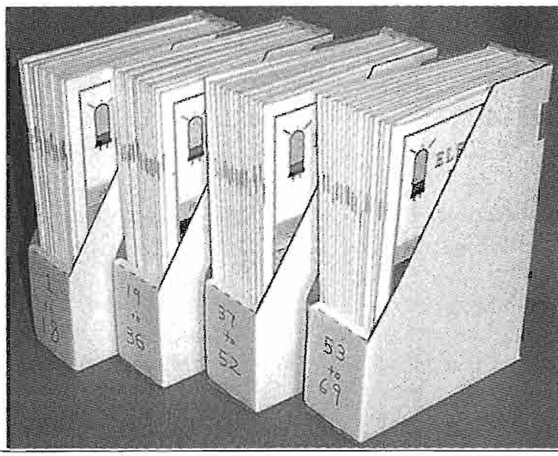

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WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI 16 Carly Drive Highland NY 12528. 895-691-6247 WANTED: Circuit for the "Mitey-Mite" transmitter-receiver. Harold Schaffner, W2GMX, 519 Perine St., Elmira, NY 14904.

WANTED: Hallicrafters SX-23 receiver in any condition. Frank, WA6RBQ, 541-479-7935 or wa6rbq@aol.com

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

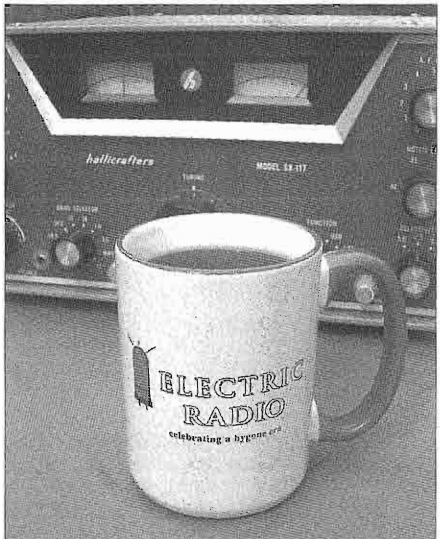
WANTED: PYE, Fairchild, Syncron, Langevin. Richard P. Robinson, PO Box 291666, LA CA 90029 323-839-7293 richmix@erols.com

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

WANTED: Meter for Johnson Viking Ranger. Damaged case OK but need usable meter movement. Arne, KØAS 16 Peck St Deadwood SD 57732 k0as@rushmore.com 605-722-2195



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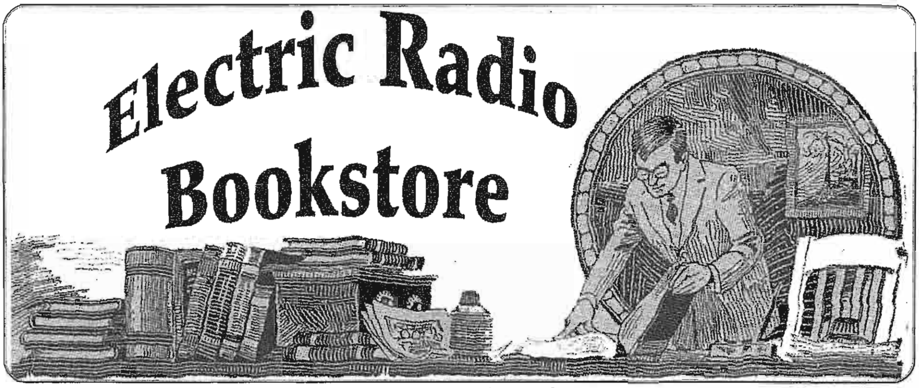

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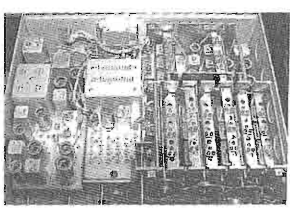

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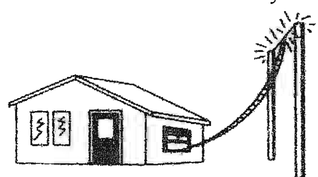

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