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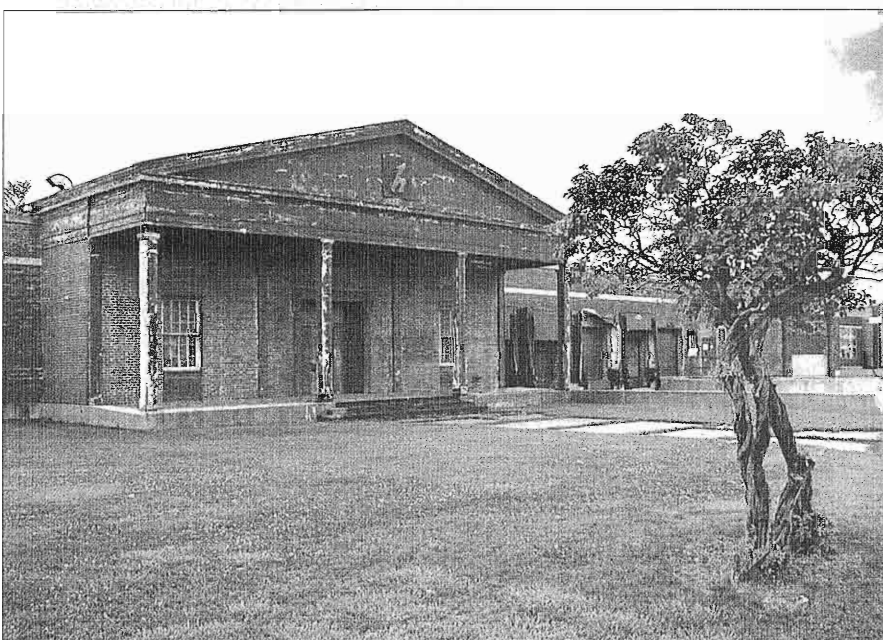
ELECTRIC RADIO

celebrating a bygone era

Number 210 November 2006



Hallicrafters' Legacy

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), David Kuraner (K2DK), Larry Will (W3LW), Gary Halverson (K6GLH), Brian Harris (WA5UEK), John Hruza (KBØOKU), Hal Guretzky (K6DPZ)

Editor's Comments

Historic FCC Rule Changes

The FCC has issued a Report and Order docket that will result in significant, long-awaited, and historic changes to the amateur radio rules. These changes will expand the phone sub-band privileges on the 75, 40, and 15-meter bands.

Once the new rules go into effect, on 75 meters, the phone band will begin at 3600 kHz for Amateur Extras, 3700 kHz for Advanced, and at 3800 kHz for Generals. For General-class license holders, this is a 50-kHz increase that is long overdue. On 40 meters, the phone segment will begin at 7125 kHz for Extra and Advanced licensees and at 7175 for the Generals. There is no change on the 20-meter band. The 15 meters changes act to move the bottom of the General Class phone band to 21275 kHz. The bottom of the phone band for Extras will remain at 21200 KHz and 21225 kHz for Advanced-class licensees.

For Novices and Technicians with CW exam credit, privileges will significantly expand for CW and data modes on the same frequencies as General and Advanced licensees currently have on 80, 40, and 15 meters: 3525 kHz to 3600 kHz; 7025 kHz to 7125 kHz; and 21025 kHz to 21200 kHz. Amateur Extra licensees have full CW privileges on all bands.

There were additional changes to the rules governing auxiliary station operations, spread spectrum transmission, retransmission of signals from the International Space Station, to the vanity call sign program, guidelines on external RF amplifiers, and clarifications to the Volunteer Examiner license testing program.

(Continued on page 34)

TABLE OF CONTENTS

Cover: If you own Hallicrafters equipment that was made after 1945, it was certainly produced at this legendary facility in Chicago. Notice how the "*h*" logo is still over the front door! Considering Hallicrafters' many contributions during WWII, this building should be on the National Register of Historic Places. Bob Harmon (W4WTO) has a photo story about the remaining Hallicrafters buildings that begins on page 2.

The Hallicrafters Legacy

By Bob Harman, W4WTO
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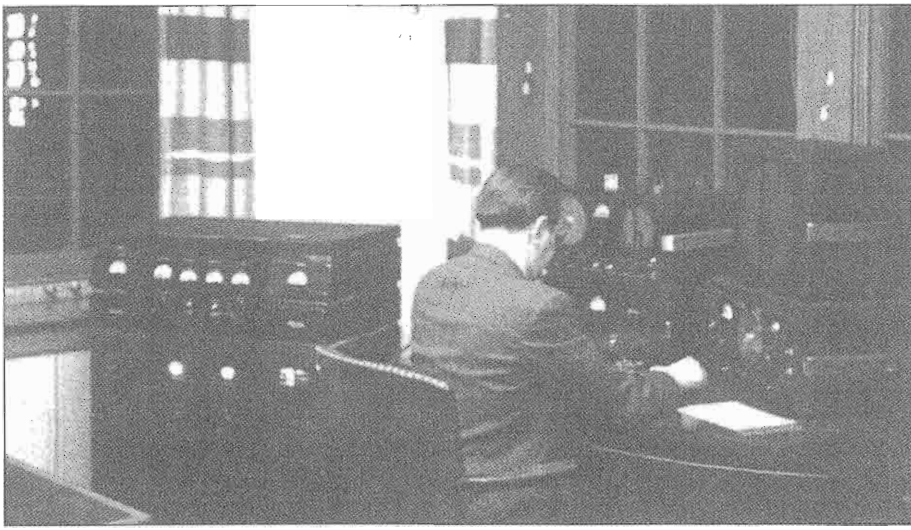
As my family and I made our way through downtown Chicago on the architectural boat tour, we were awe struck with the beauty and colossal scale of the Windy City. Not only did the magnificence of the architecture along the Chicago River impress us, the design, engineering and ingenuity of the buildings made a great impression.

Chicago is truly one of the world's great cities. The Navy Pier, Millennium Park, Lakeshore Drive, Michigan Avenue, Sears Tower, fantastic restaurants and one of my favorite hotels, the Drake, with its great view of Lake Michigan. Chicago was also home of one of the world's great consumer electronics firms, The Hallicrafters Company. Hallicrafters, as most hams know, was one of the leaders in electronics with a diverse product line including television, hi-fi, test equipment, military, consumer and amateur radio equipment. They even

Figure 1: This is the building directly across the street from the first factory at 417 North State Street in Chicago. The original building is long gone and a 1960's-era parking garage now stands on the site. The building in the photograph is typical of the 1930's architecture style and gives one an idea of what it looked like. This location was used during the early 1930s, and the early Skyrider series of radios were produced there.



Taken in the late 1930s, Bill Halligan is on the air from his ham station that was set up in the office at 417 N. State Street in Chicago. The transmitter is an HT-4, S/N 1. (Photo reproduced from Electric Radio #11, March 1990)

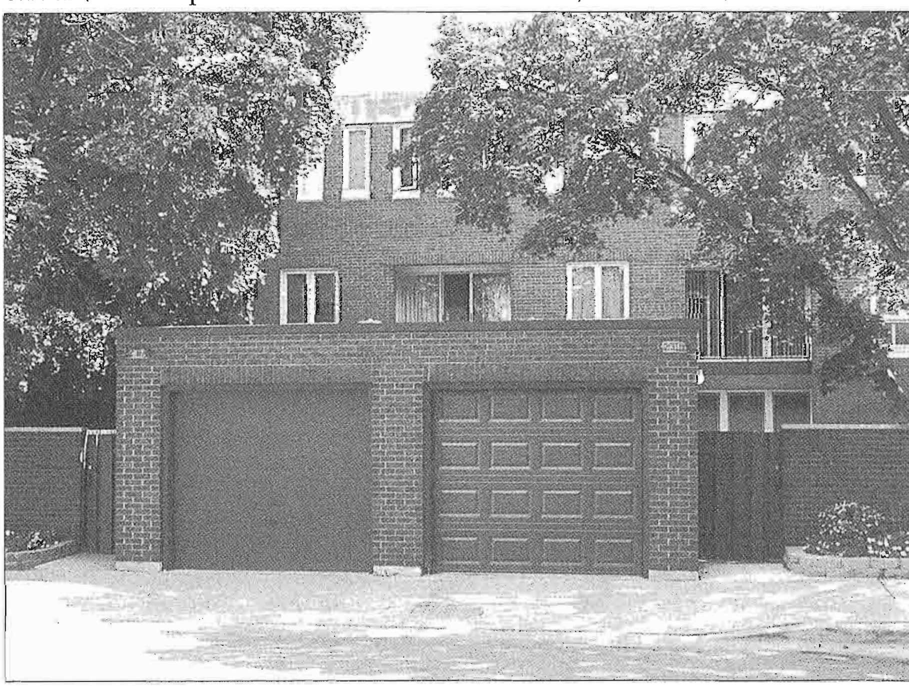


Figure 2: This is the second site on 2611 Indiana Avenue. The apartments pictured here, 2611A and 2611B, now stand where all of the production took place from the mid-1930s through the end of WWII . The Super Skyrider series would have been manufactured at this site. It is interesting to note the garages pictured here are trimmed in the same plum red color paint as the third plant at 5th and Kostner.

manufactured a line of clock radios. The list goes on and on.

My interest in Hallicrafters, which began as a teenager in the mid-1960s when I received my first real radio from my very supportive parents, a slightly used SX-101A, the "Heavyweight Champion" of the boat anchor world. Although I did not know it at the time, I had something in common with William J. Halligan, the founder of Hallicrafters. More on that later.

Meanwhile, back in Chicago, I found myself in the middle of Hallicrafters' country. What a great opportunity, from an industrial history perspective, to see what I could find still standing at the various locations spread all over the Chicago area. The challenge was there; my family was sure I had finally gone nuts, so I grabbed my map and camera and hit the street.

As mentioned before, the Hallicrafters story and their great products are well known in the amateur radio community. Not being very technically minded concerning radio theory, I will not give any technical opinions on the equipment, but will try to give a brief comment on what I found at each site I visited and the approximate time frame of each location, and even some of my personal thoughts on the old buildings and locations. There are a few good books and web sites on the products and production facilities Hallicrafters used for those readers that would like more detail on the subject. The following photographs were taken in August 2004, and March 2006, and are roughly in order of the time period they were in operation.

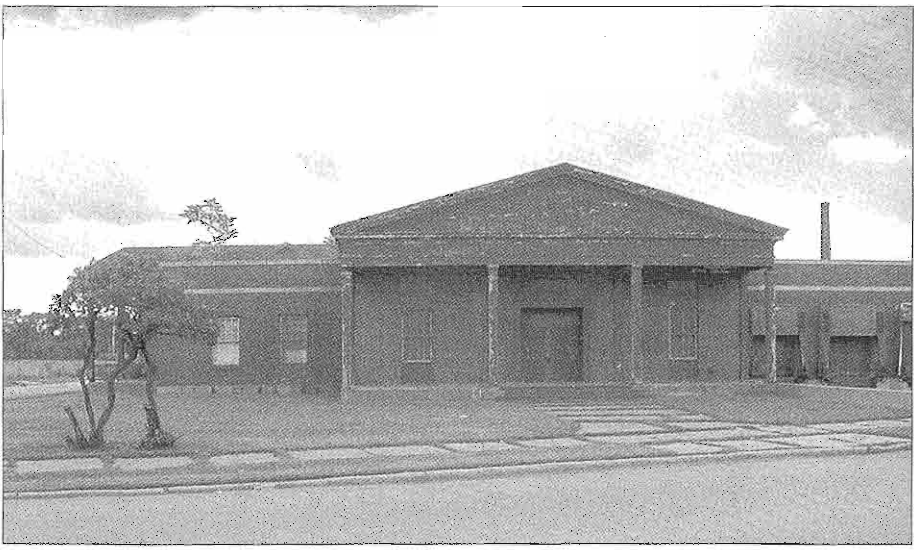


Figure 3: This is the famous 4401 West 5th Avenue factory at Kostner Street. Used from 1945 to around 1966, Hallicrafters produced their finest products here including radio, television, and other electronic equipment. Those great SX-series receivers and HT transmitters were made here. The building appears to be some sort of warehouse, still in use today. You can even see some of the original landscaping in the picture. Had I been there on a weekday, I would have gone inside for a closer look. This is a really large facility, and as I peeked in a broken window along Kostner Street, I could almost hear and smell the sounds of radios being crafted!

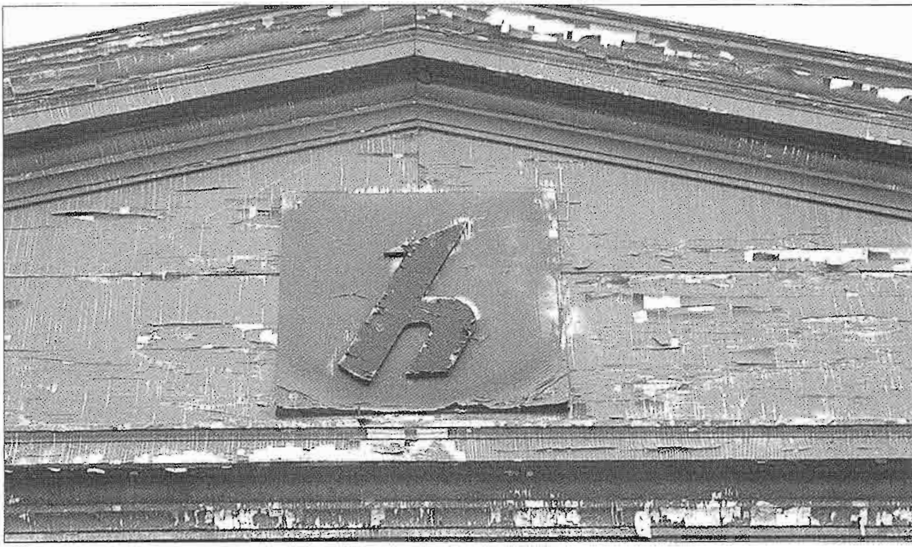


Figure 5: The tilted "*h*" was the final Hallicrafters logo. This logo appears over the main entrance at 5th and Kostner. The logo and the entire building are painted in a plum red color which is peeling off the building. The original white paint can be seen showing through.

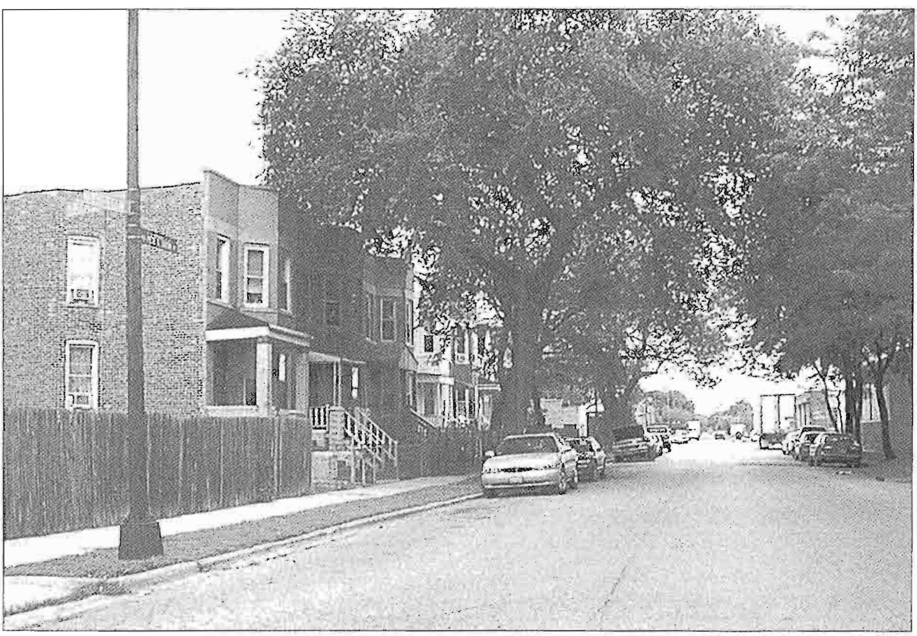


Figure 4: Looking east toward downtown Chicago gives one an idea of the size of the 5th and Kostner plant. The town homes on the left must have certainly housed those great Hallicrafters' employees. They didn't have far to walk to get to work!

Figure 6: The final production facility was located at 600 Hicks Road in Rolling Meadows, Illinois, about 30 miles northwest of Chicago. In the late 1960s, when Northrop bought Hallicrafters, production was moved from 5^{th} and Kostner to this location, and continued until the early 1970s when the last of the great radios from Hallicrafters ceased production. The plant, now in expanded form, currently houses a Northrop Grumman facility.

I hope the reader has enjoyed this brief look into the past of a great American electronics firm. Personally, it was very gratifying for me to visit the locations even though only two of the buildings remain today. I *really* felt a connection to Hallicrafters after my two visits.

My personal connection to Hallicrafters you ask? It just so happens that when a young Bill Halligan went to work for the Merchant Marine after the First World War, his job was the wireless operator on

A NEW WORLD OF COMMUNICATIONS EQUIPMENT

FIFTH & KOSTNER AVENUES

CHICAGO 24, ILLINOIS

Figure 7: The "Waving Girl", Florence Martus, greets all ships entering the Port of Savannah. Bill Halligan had a picture of the seventeen foot statue (erected in 1972) of Miss Martus in his ham shack. Maybe Bill Halligan was the long lost friend of Florence Martus!

the vessels he sailed. The young Bill Halligan frequented many ports on the East Coast, one of which is my home QTH, Savannah, Georgia. Savannah has a well known folk tale about Florence Martus, the "Waving Girl". Legend has it the heart broken young lady waved at each ship entering port hoping to find her long lost lover who never returned from the sea to marry her. There is a beautiful bronze statue of her along the east end of River Street waving to the sailors as they enter the Port of Savannah. As a young sailor, Bill Halligan *must* have seen Miss Martus waving to the sailors. She made such an impression on him, he kept a photograph of the statue of Florence in his ham shack.

Standing there in Chicago, on the corner of 5^{th} and Kostner, looking at that now-classic tilted "*h*" logo over the main entrance, I realized that I too, had a connection with Mr. Halligan and his great radio company. Boy, I wish Hallicrafters were still around!

ER

The Hallicrafters SX-117 Receiver
Part 1

By Ray Osterwald, NØDMS
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Bailey, CO 80421

It seems like everything having to do with 1962 happened a long time ago. On September 30, 1962, CBS broadcast the final episodes of "Suspense" and "Yours Truly, Johnny Dollar," marking the end of the Golden Age of Radio. On October 1, 1962, James Meredith, escorted by Federal Marshals, registered at the University of Mississippi as the first UM black student. October 3, Wally Schirra's Sigma 7 Mercury space capsule was launched into orbit on top of an Atlas 113-D rocket, the mission lasting for 6 orbits. The Columbus Day storm of 1962 was the most powerful windstorm to strike the Pacific Northwest in the 20th century. Four days later, on October 13, amateurs who had been licensed since the start of radio licensing in 1912 were honored with commemorative plaques at the Hotel Statler in New York City. The very next day the Cuban missile crisis began, escalating political tensions to new highs that lasted 14 long days. Providing a much-needed break from the crisis, the Yanks beat the Giants in game 7 of the 20th world baseball championship on October 16th. On November 3, 1962, the words "personal computer" appeared in a New York Times article, reportedly for the first time.

Out in the Midwest, at 5th and Kostner Streets in Chicago, Hallicrafters' advertising and engineering teams had been hard at work throughout 1962 on a new communications receiver. It was to be released in the early fall of that year, and they hoped its combination of high performance, light weight, and reasonable cost would be attractive to amateurs.

The new receiver was designated model SX-117, and announced on the opening page of QST for October 1962. It enjoyed a 3-year production run and was featured in the 1965 Hallicrafters catalog. The last QST ad for the SX-117 was in June 1965, but some dealers continued offereing them for a few more months. The 1964 price list showed a list price of $379.95 without a speaker.

Electrically, it was a cost-reduced version of the SX-115 and was in production concurrently with it throughout 1964.

In 1966, Hallicrafters was sold to the Northrop Corporation, and the era of high-performance Hallicrafters receivers ended. They continued to offer the SR-series transceivers until about 1970, and consumer-grade SWL receivers into the late 1970s.

The SX-117 was designed to meet competition from other manufacturers, and was advertised to be a "...highly stable, compact...communications receiver, loaded with exceptional features," and it boasted "a high order of electrical and mechanical stability." It could be used as a transceiver in a systems configuration when cabled to the matching HT-44 transmitter, very similar to the competition in Cedar Rapids, Iowa, the Collins S-line equipment. The HT-45 Loudenboomer amplifier matched the styling of the other two, and all three complementary-styled pieces were designed for tabletop operation.

Accessories for the SX-117 included the HA-10 low-frequency tuner, the R-47 and R-48A speakers, and a rare R-51 speaker that included a Numerichron synchronous digital clock.

Electrically, the SX-117 is a triple conversion superhet, using a crystal-controlled first-conversion oscillator, and a narrow-band tunable 1st IF that is gang-

the *new ideas*
in electronics
are born at....

hallicrafters

MODEL SX-117 RECEIVER

The SX-117 is a new triple conversion heterodyne type communication receiver with crystal controlled high frequency oscillator on all ranges.

FEATURES

- A high order of mechanical and electrical stability
- Transmitter type V.F.O.
- Constant tuning rate
- Back-lash free tuning mechanism
- Crystal controlled 1st and 3rd conversion oscillators
- Selectable side bands
- 2 crystal positions for operation between 85 KC and 14 MC
- 2 crystal positions for operation between 14 and 30 MC
- 3 extra crystal positions for full coverage of 10 meters
- Crystal position for WWV
- Selectivity variable in 3 steps from 500 to 5000 cycles
- Product detector for SSB/CW-envelope detector for AM
- I.F. type noise limiter
- V.F.O. can be used as crystal locked oscillator—Locks V.F.O. on any frequency within tuning range
- Spurious responses down 50 db
- Audio inverse feedback
- The SX-117 is shipped with crystals to cover
  3.5— 4.0 MC, 7.0— 7.5, 14.0—14.5, 21.0—21.5, 28.5—29.0

- Receiver can operate on most frequencies from 3 MC to 30 MC with use of proper crystals and with accessory unit HA-10 can be extended downward from 3 MC to 85 KC.

Hallicrafters SX-117 sales brochures such as this one were available from dealers or by mail. (Courtesy Jerry Tastad, N7JT)

tuned with the VFO. The use of a crystal-controlled first mixer and the 6-to-6.5 Mc tunable IF matches the SX-115 design.

The second IF is at 1650 kc, similar to the SX-101A, and departure from the SX-115 design begins in this stage.

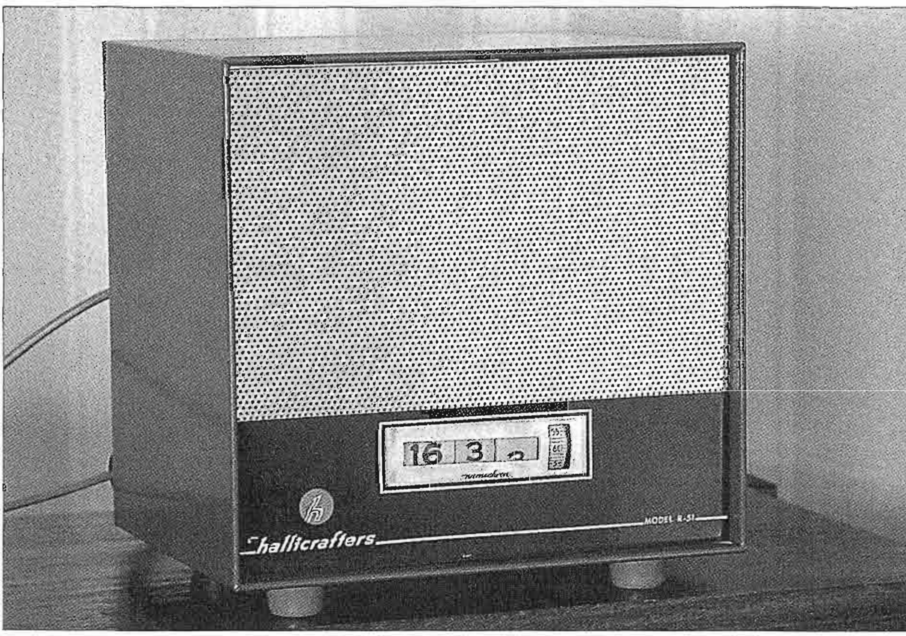
The third mixer is crystal controlled, and produces the 3rd IF of 50.75 kc. The receiver uses Hallicrafters' selectable-sideband system that was first used with the introduction of the SX-88 in 1953. Its selectivity is established with LC circuits of the same design as the SX-101, SX-115, and other receivers.

It uses an IF-type noise limiter, separate AM and CW/SSB detectors, and an effective amplified AGC system. AGC time constants are fixed by the selected receiving mode.

The output has two audio stages, and uses negative feedback around them.

No voltage regulation of any sort is

The HA-10 low and medium frequency tuner was an accessory that extended the SX-117's tuning range from 85 kc to 3 Mc. Basically, it was a box with a variable capacitor and four switchable slug-tuned coils.



A very rare accessory item for the SX-117 is the R-51 speaker. It included an efficient speaker and a Numerichron digital clock that was synchronized to the AC line frequency. (Photos on this page courtesy of Gary Halverson, K6GLH.)

used; no gas regulator tube or zener diodes are present in the receiver. Yet, the receiver will stay zero-beat with WWV as long as I care to have it on. When the line voltages changes by 15 volts, 110 to 125 volts, a beat note only changes by a few cycles.

In Part 2 (January 2007), I will be discussing the receiver in detail, and I'll have some restoration and electrical alignment information that should help to change the misconception that the SX-117 is not a very good receiver.

ER

A Vacuum Tube Curve Tracer from a Converted TV-7 Tube Tester and a Transistor Curve Tracer

By Paul A. Bernhardt, KF4FOR
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Introduction

The vacuum tube curve tracer provides detailed information of the characteristics of tubes used in commercial and military communications radios. Unfortunately, only one vacuum tube curve tracer was manufactured commercially. This was the Tektronix Model 570 that currently sells for more than $2000. The Tektronix Model 575 Transistor Curve Tracer may be found for between $35 and $300 but it does not have the facility to provide filament and screen-grid voltages or have sockets needed for vacuum tubes. The Military TV-7 type tube tester has all the required voltages and sockets but does not have a curve tracer display. TV-7s can be purchased for between $75 and $300. The rest of the components needed to make the TV-7 work with a curve tracer can be found in the typical junk box or can be purchased for about $30. This paper describes a simple modification of the TV-7 to allow vacuum tube plate characteristics on a transistor curve tracer. Further information on adapting transistor curve tracers to use with vacuum tubes is found in the book Tube Testers and Classic Electronic Test Gear by Alan Douglas (available from the ER Bookstore).

Hooking the Vacuum Tube to Transistor Curve Tracers

All transistor curve tracers have three terminals labeled C (collector), B (base) and Emitter (E) for connection to bipolar transistors. When field effect transistors (FETs) are tested, these same terminals are relabeled D (drain), G (gate) and S (source), respectively. A vacuum tube can be tested with the transistor curve tracer in FET mode where D is connected to the plate, G is connected to the control grid, and S is connected to the tube cathode. The transistor curve tracer steps the grid voltage and plots out the plate current versus plate voltage at each level of grid voltage.

The TV-7 tube tester is used to make the vacuum tube look like a FET to the transistor curve tracer. The vacuum tube heater is powered by the filament supply in the TV-7. A filtered supply provides 150 VDC to the vacuum tube screen grid if this is required. The plate and grid voltages referenced to the cathode are all supplied by the transistor curve tracer though three leads from the C, B, and E jacks on the curve tracer to three tip jacks labeled "P" (plate), "G" (grid), and "K" (cathode) that have been added to the TV-7. In addition, a four-pole, double-throw switch is added to the TV-7 to place it in either TT (tube tester) or CT (curve tracer) mode. The connections between the modified TV-7 and a transistor curve tracer are illustrated in **Figure 1**.

The first step for the TV-7 modification is to gather the electrical components.

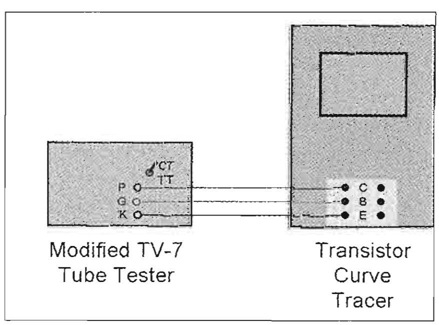

Figure 1. Three-wire connections between the TV-7 tube tester and a typical transistor curve tracer.

Table I. Components for Modification of the TV-7 Tube Tester			
Part	Description	Quantity	Suggested Source
SW-1	4PDT Switch	1	Marlin Jones
C1	560 µF, 200 VDC Electrolytic Capacitor	1	Mouser
R1	2.7 kW 10 W Resistor	1	Mouser
Jacks	Tip Jack (Red, Jack, Black)	3	Mouser

Table I: Modification components list for the TV-7

The list of parts is given in **Table I** with suggested suppliers. The four-pole toggle switch isolates the four elements of the tube (cathode, control grid, screen grid, plate) from the unused power supplies inside the TV-7. The power resistor limits the screen grid current to 60 mA when the plate voltage supplied by the transistor tester is low. The electrolytic capacitor filters the 120-Hz ripple applied to the screen grid. The three tip jacks provide external connect points to the transistor curve tracer. The only other item needed for the modification is 20 to 22-gauge hookup wire.

The next step is to drill 4 holes in the TV-7 to accommodate the three tip jacks and the 4PDT switch. These holes are placed to the left of the "shorts" indicator lamp at the locations shown in **Figures 2 and 3**. Their precise locations were chosen to eliminate any interference with the components already in the TV-7. To make the holes, remove the 12 screws that hold the TV-7 electronics inside the case and lift off the case with the TV-7 face down on a table. A 1/16-inch drill was used a pilot holes for the tip jacks and 4PDT

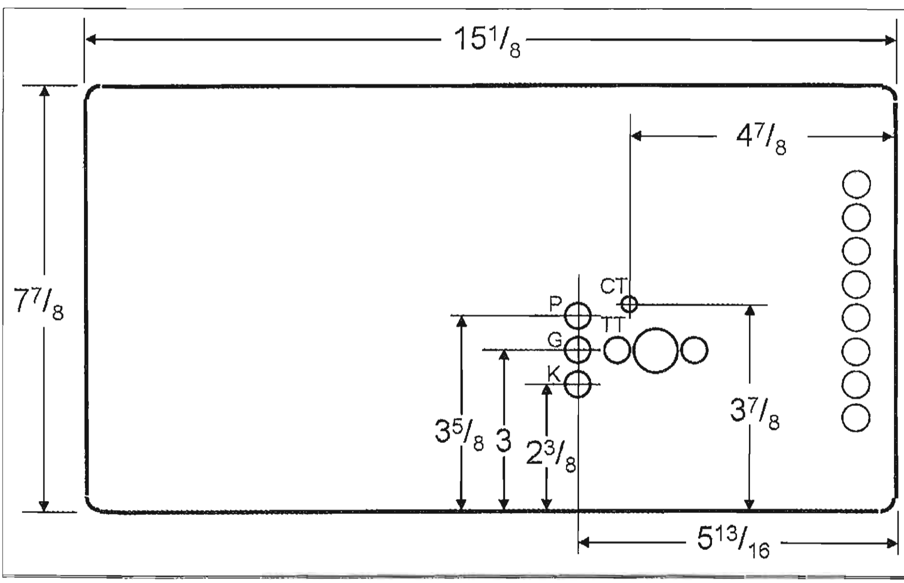

Figure 2. Locations of the four holes in the face of the TV-7 panel. The diameters of the holes should be chosen to match the three tip jacks (P, G, and K) and the 4PDT switch (CT-TT) in Figure 4b. The locations of the shorts lamp and the push buttons are shown for reference.

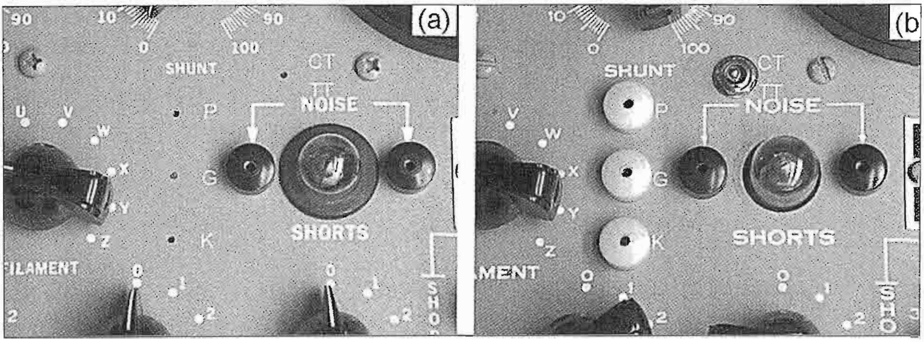

Figure 3. Mechanical locations of (a) holes, and (b) tip jacks and the 4PDT switch (above the neon lamp) for TV-7 modification.

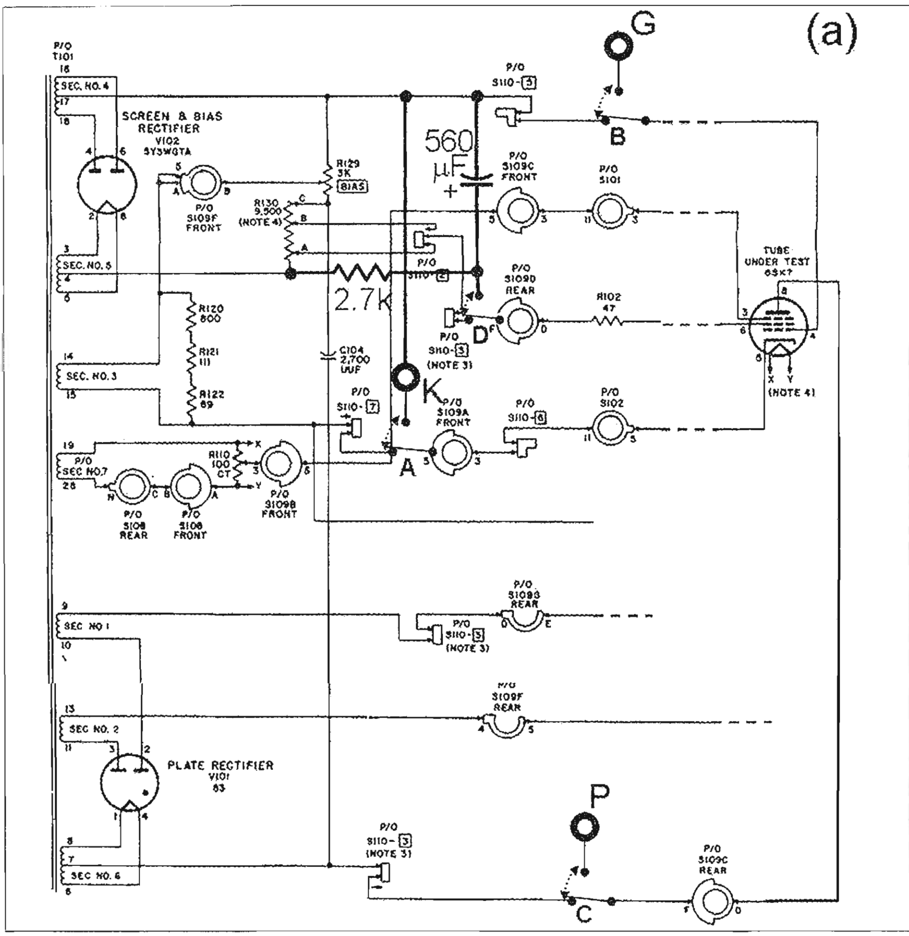

Figure 4a. TV-7 tube tester modifications. The TT connections on the switch (Figure 4a, next page) loop back to the terminals on pushbutton switches SW-7, SW-5, and SW-3 where the original wires to S109 were located.

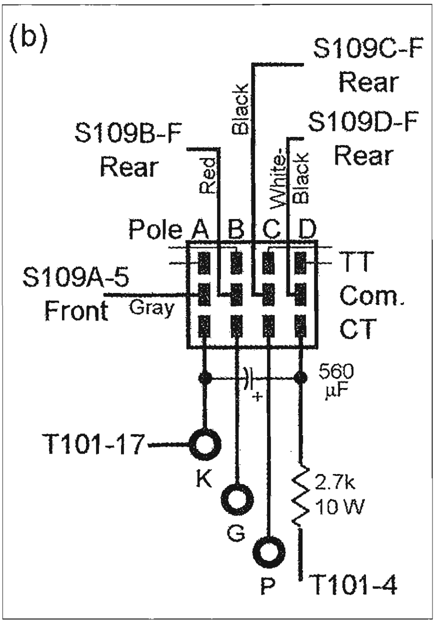

Figure 4b: 4PDT switch wiring. It may be easier to wire the connections to the switch before mechanical installation onto the TV-7 front panel.

switch (**Figure 3a**). After a larger drill was used for the jacks and switch, they were secured with nuts on the back of the front panel. Make sure there are no wires that will be cut when the holes are drilled. The diameter of the holes should be just large enough to permit the mounting of the three tip jacks and the one switch according to the locations shown in Figure 2. The finished added components are shown on the face of the TV-7 in **Figure 3b**.

Once the four components are mounted to the TV-7 face, the tube tester is wired according to **Figure 4a**. Care must be taken not to damage the existing TV-7 wires with the soldering iron. Push the existing wires away from the solder terminals as much as possible in the confined space.

Put the 4PDT switch with the handle down toward the bottom of the tube tester. This will be the TT (tube tester) position and the switch contact will be called the TT contact. When the 4PDT switch is pushed up, the switch commons makes contact with the CT (curve tracer) pins of the switch. The wiring of the switch is shown schematically in **Figure 4b**.

For the conversion process with a model TV-7D, the following steps have proven successful:

(1) Remove and retain the two screws with spacer, washer and nut holding the 7-pushbutton switch-gang (SW-1 through SW-7) on the left side of the face up TV-7.

(2) Set the TV-7 switches to AB-12345-D to check continuity for the cathode, control grid, screen grid and plate wires.

(3) Remove the gray wire from SW-7 that connects of rotary switch S109A-5, front, and connect that to the common of pole A of the new 4PDT switch. This is the gray cathode wire that has electrical continuity to pin 4 for the octal socket. Run a piece of hookup wire from the normally-closed TT (tube tester) contact on pole A of the 4PDT switch to the pin near the purple wire on SW-7 where the gray wire was removed.

(4) Remove the red wire from SW-5 that connects of rotary switch S109B-F, rear, and connect that to the common of pole B of the new 4PDT switch. This is the red control-grid wire that measures about 47-ohms resistance to pin 1 on the octal socket. Run a piece of hookup wire from the normally-closed TT (tube tester) contact on pole B of the 4PDT switch to the pin near the white/orange wire on SW-5 where the red wire was removed.

(5) Remove the black wire from SW-3 that connects of rotary switch S109C-F, rear, and connect that to the common of pole C of the new 4PDT switch. This is the black plate wire with about 47-ohms resistance to pin 2 on the octal socket. Run a piece of hookup wire from the normally-closed TT (tube tester) contact on pole C of the 4PDT switch to the pin near the red wire on SW-3 where the black wire was removed.

(6) Remove the white/black wire from

SW-3 that connects of rotary switch S109D-F Rear and connect that to the common of pole D of the new 4PDT switch. This is the white screen-grid wire that is connected to pin 3 of the octal socket through a 47-ohm resistor. Run a piece of hookup wire from the normally-closed TT (tube tester) contact on pole D of the 4PDT switch to the pin on SW-3 where the white/black wire was removed.

(7) At this point, the TV-7 will work normally if the 4PDT toggle switch is in the "TT" position.

(8) Using hookup wire, connect the CT pin of pole A for the 4PDT switch to the tip jack labeled "P."

(9) Using hookup wire, connect the CT pin of pole B for the 4PDT switch to the tip jack labeled "G."

(10) Using hookup wire, connect the CT pin of pole C for the 4PDT switch to the tip jack labeled "K." Also connect a wire between pin 17 of the transformer and CT pin of pole C.

(11) One end of the 2.7-k,10-watt resistor is connected to pin 4 of the transformer. The other end of the resistor is connected by hookup wire to the CT pin of pole D for the 4PDT switch. The positive side of the 560-µF electrolytic capacitor is also connected to the CT pin of pole D.

(12) Finally the negative side of the 560- µF electrolytic capacitor is connected to the tip jack labeled "K."

(13) Use an ohmmeter to check that all the connections match the schematic shown in Figure 2. With the toggle switch in CT position, tip jack K connects to octal socket pin 4, tip jack G connects to octal socket pin 1, and tip jack P connects to octal socket pin 2.

(14) Replace two screws for the 7-gang pushbutton switches and put the box over the face-down TV-7 electronics. Flip the unit face up and screw in the 12 fasteners.

(15) Make up three cables with tip-plug on one end and banana plug on the other end to match the jacks on the curve tracer.

The modified TV-7 is hooked up to the transistor curve tracer as illustrated in Figure 1. Single wires link the tip jacks (P, G, K) on the TV-7 with the jacks (C, B, E) on the curve tracer. With the toggle switch in the TT position, set up the TV-7 for normal testing of a selected vacuum tube. Plug the tube in the appropriate socket and make sure that it has the proper mutual conductance indication on the TV-7 meter.

Warm up the curve tracer and set the collector sweep from 0 to 100 VDC. The voltage steps for a FET gate should have 1 or 2-volt increments. Switch the TV-7 toggle to CT mode and select the C-B-E input with the curve tracer. The bias on the voltage steps will have to be adjusted to yield a full range of vacuum tube curves. To compare the characteristics of two tubes, use two modified TV-7's hooked to the right and left sides of the C-B-E inputs to the curve tracers. With this configuration, the plate characteristics of the two tubes can be easily matched for use in push-pull circuits.

Examples of Curve Tracing with the TV-7 Interface

The modified TV-7 will work with any transistor curve tracer. The primary limitation for the measurements is the range of collector (or plate) voltage and steps in the gate (or grid) voltage provided by the transistor curve tracer. The modified TV-7 has been used with the Models 571, 575, 576, 577, and 370A by Tektronix. Table II lists the capabilities of each transistor curve tracer. The TEK 575 is a transistor curve tracer that uses vacuum tubes. All the other models in **Table 1** use solid-state devices. The primary limitation on all transistor curve tracers is the small step voltage which limits the grid voltage range to 10 times this step voltage. Many larger tubes require grid variations of over 50 volts to characterize the full range of the tube operation.

The first example uses the TV-7 with the TEK 571 curve tracer. First, the tube is tested using the recommended settings

Table II. Characteristics of Tektronix Transistor Curve Tracers

Model #	Collector Voltage Range	Gate Voltage Step	Maximum Device Power	Display
571	0-100 VDC	1 VDC	100 W	CRT or Epson Printer
575 Mode 122C	0-400 VDC	1 VDC with External Resistor	400 W	CRT
576	0-1500 VDC	2 VDC	100 W	CRT
577	0-1600 VDC	2 VDC	100 W	CRT
370A	0-2000 VDC	5 VDC	3 kW	CRT or Plotter

for the TV-7 in TT (tube tester) mode. Then the TV-7 is switched over to CT (curve tracer) mode and the TEK 571 steps through both plate and grid voltages. The TEK 571 allows digital storage of one set of plate characteristics for comparison with another data set. For our tests, the two triodes in a 5670 miniature tube are compared over the 0 to 100-VDC range of plate voltage (**Figure 5**). The curves were made with the TEK 571 in N-FET mode with ten 0.5 VDC steps in the gate (or grid) voltage starting at negative 5 VDC. The plate maximum current in the display is 10 mA. The two triodes are not matched since the two sets of curves show significantly different V-I characteristics for the two triodes in the same envelope. A digital camera was used to record the traces in Figure 5, but hard copy may be provided with a graphics dump to an Epson printer.

The next example uses the TV-7D hooked to a TEK 577 curve tracer. A metal 6V6 tube was tested with normal settings on the TV-7 with the toggle switch in TT mode. The TEK 577 was setup so that the plate was swept from 0 to 100-VDC. The grid voltage was changed from –25 to +25 VDC with 5 VDC steps that were fixed for each plate voltage sweep. The C-B-E input from the TV-7D cables was selected and the toggle switch on the TV-7D was switched to the CT position. The resulting plate characteristic in **Figure 6** shows a typical pentode response is more constant in current at each grid voltage than is seen

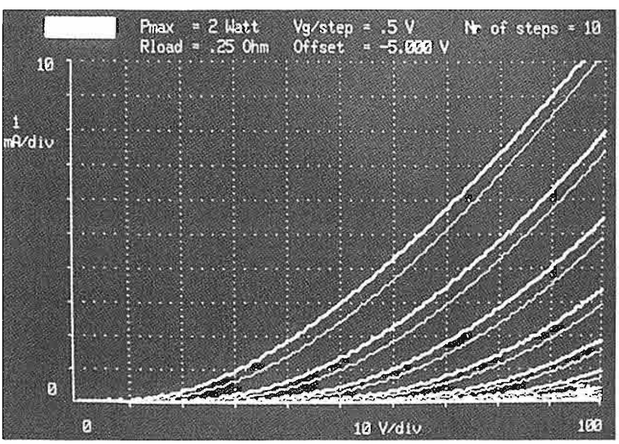

Figure 5. **Dual triode 6570 plate characteristic measured with a TV-7D tube tester and a TEK 571 curve tracer. The first triode in the 6570 (light curve) is digitally stored by the TEK 571 for comparison to the second triode (darker curve) in the 6570. The triode matching is indicated by overlap of the two sets of curves.**

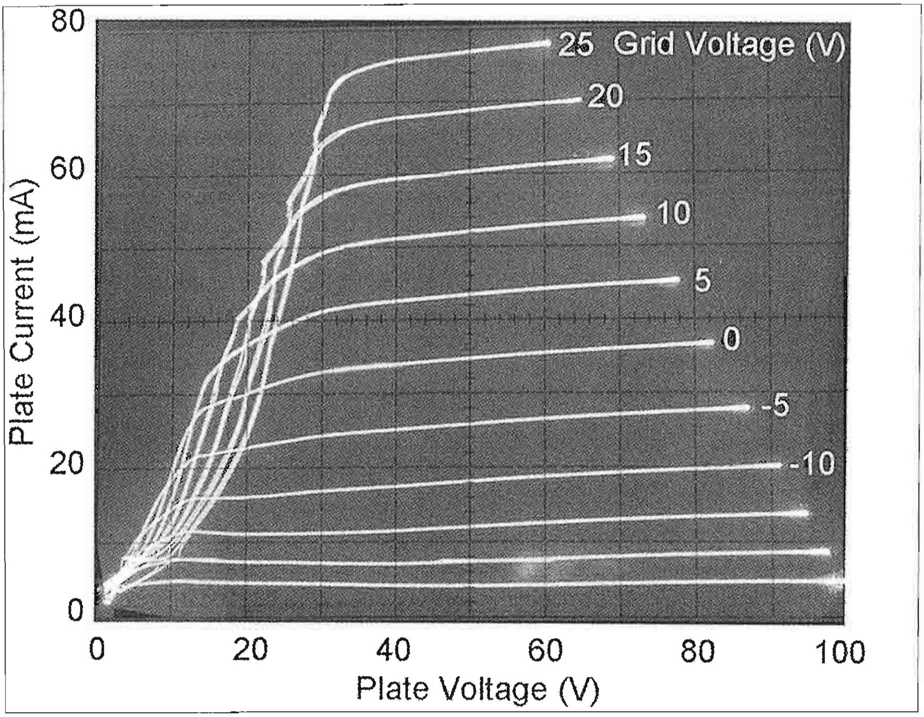

Figure 6. Plate characteristic of a 6V6 pentode using the TV-7D tube tester and a TEK 577 curve tracer. Ten 5-VDC steps starting at -25 VDC are applied to the control grid while the TV-7D holds the screen grid at 150 VDC. The numerical labeling on the figure was added using the computer.

with the triode curves of Figure 5.

In summary, a relatively simple modification to the TV-7 transistor tester allows a direct hookup to any transistor curve tracer where the three terminals of a FET (drain, gate and source) are replaced with the three terminals of a vacuum tube (plate, grid, and cathode). The TV-7 provides the functions of (a) powering the filaments and (b) given a fixed DC voltage to any screen grids of the tubes. Normal operation of the TV-7 in TT mode provides testing of the tubes for emissions or mutual conductance. By switching to CT mode, the full characteristic of the vacuum tube is graphed subject to the voltage and current limitations of the transistor curve tracer.

The primary problem of transistor curve tracers is the low range in voltage steps for the gates or grids (Douglas, 2000). As shown in Table I, the grid steps are between 1 and 5 Volts giving, with 10 steps, maximum excursions of the grid voltages between 10 and 50 Volts. This does not permit for full testing of many power tubes. The solution to this problem is construction of voltage amplifier that increases the voltage steps by a factor of ten. This high-voltage DC amplifier and its use for testing of high power transmitter tubes will be discussed in a future article. The simple interface described here, however, is adequate for testing many tubes found in common receivers and low-power transmitters used in amateur radio.

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ER

Hints and Kinks for Restoring Boatanchors

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The response from my previous ER article, "Restoration of a Central Electronics 600L Amplifier[1]" amazed me. I received many emails asking additional questions about restoration techniques and ideas. It is clear that there are many who are in the process of or are about to begin a restoration project. Wonderful! The process is enjoyable and very satisfying. The purpose of this article is to answer some of the questions I have been asked about the restoration process and to provide some additional basic restoration information. Please understand that the techniques and notes herein are from my own experiences in restoring many vintage transmitters and receivers but may not necessarily be what others do. There are many excellent restorers who may have alternate favorite techniques and no doubt you'll find your own favorite techniques. What is important is to start!

These are some of my favorite cleaning and polishing supplies. Note the toothbrush, a great tool for getting into corners for cleaning and polishing.

There are many ways to define restoration but there is no "right" way. Do what pleases *you*. Some want original and others–like me–want certain improvements based on what we have learned over the past 40-50 years. Personally, I like to make everything as cosmetically perfect as possible and I don't mind making changes to this end. Others may disagree. I'll also make some circuit changes too; for example, reducing the load on a power transformer or reducing heat buildup inside a chassis. Other changes might include a 3-wire line cord for safety. This list is endless, but again, there is no right or wrong. For just about any piece of gear someone will have info on recommended changes. Use Google and the various equipment reflectors to find detailed information. The knowledge base provided by users on the reflectors is awesome.

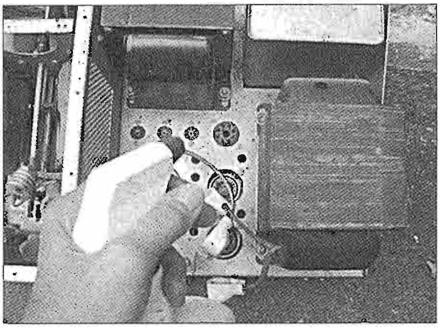
In most cases a restoration project will require troubleshooting and what you can do here is a function of your own expertise and available test equipment. If you lack knowledge in this area there are always plenty of folks willing to lend a hand. A note of caution: if you're new to repair and troubleshooting *PLEASE* remember that even a small receiver can kill you. Think ***SAFETY FIRST***. Don't work on anything if you're tired.

At the end of this article I'll provide a step-by-step restoration summary. Now, here are some answers to questions I have been asked:

1. "Did you say 'wash' the chassis? Can I do this without damage? What's the procedure you use?"

Cleaning is sort of an art and you learn as you proceed. Yes, you can wash most pieces of equipment without damage. Some precautions need to be taken, of course. Remove as many items from the chassis as possible (it's always easier to clean an individual part) such as tubes and their shields, any plug-in modules, knobs, meters, any delicate assemblies, indicator bulbs, tuning indicators, etc. I always (if possible) completely remove the front panel and any easily removable supporting hardware which makes getting into hard to reach areas much easier.

The cleaning technique is a function of the original condition of the chassis and



A good way to apply cleaning solution is with a hand sprayer. Don't be stingy! As you spray, use a small brush to work on the dirty areas, then rinse.

whether it's aluminum or steel (the chassis is usually cadmium plated).

The first step is to get rid of the major accumulated dirt and dust. Spray a mixture of 50/50 Formula 409® cleaner and ammonia on everything. Use heavier amounts on really dirty areas. Avoid spraying directly into IF cans and on open transformers. After letting it sit for a minute or two, scrub areas of heavy dirt with a brush. It's good to have a selection of various sizes and hardness. Now, rinse thoroughly with water and use plenty! Again, avoid spraying directly onto open transformers, IF cans, and other obvious items. If some areas are still dirty, repeat the process.

A compressor is a necessary restoration tool. When you're happy with the results of the wash, blow out excess water with compressed air and then let everything dry in the sun if possible. Anything washed in this manner should sit a few days before proceeding.

The chassis may now be improved by polishing, using various techniques. Be prepared to spend lots of time. If the chassis is aluminum, I use various polishes with my favorite being Wenol®. Apply it with an old towel, and use lots of elbow grease and then remove residue. I use water on a rag for this. If the chassis is steel it's tougher to deal with, but I use a combination of #0000 steel wool, metal polish applied with small nylon brushes and a Dremel® tool.

2. "What's a Megger or hipot tester? What are they, what are they used for? Also, when doing resistance checks on transformers, are you looking for shorts between primary and secondary windings?"

A Megger is an acronym for Megohmmeter, and is an instrument that is used to check insulation (leakage) resistance. A high voltage (usually around 1-3 kV) at very low current is applied between a lead and the case, and the resultant resistance is displayed on a meter. This is a mandatory tool for testing transformers and chokes. You are looking for shorts between winding(s) and between windings and the transformer case itself. A short between primary and secondary windings is easily detected with a common VOM. Hipot testers are fancy versions of the more basic Megger. Check this Internet URL for some more details:
http://www.tpub.com/doeelecscience/electricalscience2172.htm

You can find Meggers and hipot testers on eBay for very reasonable prices. I test every large transformer and choke as part of the restoration process.

3. "You spoke of carefully cleaning the front panel so as not to disturb any of the silk screening. Do you use anything (cleaning solvent) in particular?"

Here you need to be _very_ careful. Test a cleaning material using the mildest approach first, and take it **s-l-o-w**. Start with warm water; then maybe liquid hand soap, then window cleaner, then Formula 409®, etc. You get the idea. An excellent solvent is denatured alcohol which works quite well in many cases. What you end up using is a function of how bad the panel is when you start. Remove the front panel completely if possible – it makes it easier to work on. If you leave the panel in place, at least remove the knobs and clean them separately.

4. "You talked about 'bandswitch markings that had been rubbed off,' and that they 'were repaired with dry transfers and burnished into place.' Is this a difficult procedure? Is this something that can take place on any front panel negating the need for complete silk screening and repainting?"

A steady hand is required! Yes, in this case the *only* problem with the front panel was missing lines around the bandswitch. I used dry transfers (available from any number of sources) and selected a line the same width and color as what is on the panel. I carefully *cleaned* the panel (this is very important), applied the decal, and burnished it into place. The best burnishing tool is a soft ("B" or "1") lead pencil - one of my secrets. Now you know it. This technique can make an otherwise ugly panel look pretty good. Of course, if the panel is very poor with many markings and the lettering gone, then the panel will need to be scanned, artwork generated and a silkscreen made. The panel is then stripped, painted, and screened. This is somewhat expensive but the result is a perfect panel. (I have silk screens for a variety of panels. Contact me if you're looking for something!)

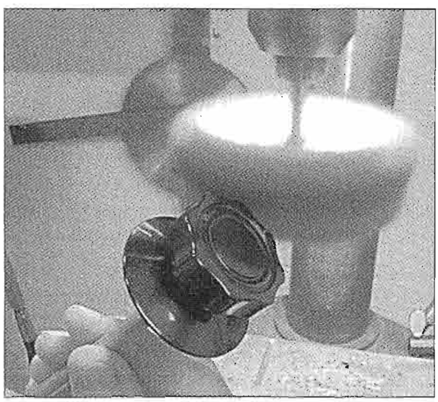
5. "You talked about giving a cleaned front panel 'a coat of furniture oil to give it a new look.' That really sounds great! Do you recommend any particular product, and do you have any precautions that might be taken during this activity? What about doing the case too?"

Use the oil sparingly! Wipe with a soft cloth. Any brand will do, I use Old English®. Don't do the cabinet unless it's a smooth finish. If the cabinet is a textured finish, use denatured alcohol to clean and leave it at that. I sometimes use a pure paste wax (such as butchers wax) which can make an old panel look quite good.

6. "Next, you talked about polishing the meter face (in my case, the whole meter just because I want the whole thing as nice as possible) and the knobs. I've tried several plastic polishes and none of them give the knobs that nice, shiny

Applying metal polish to a bakelite knob - use only a little!

appearance I'm looking for. Do you recommend another chemical that will indeed make my knobs sparkle? Also, I've been trying to do this with rag wheels on my Dremel® tool. Would you suggest another method?"



Polishing a knob using a small 6-inch buffing wheel in a drill press.

I have found only one good way to polish plastic knobs (most boat anchor knobs are bakelite). First, clean the knobs with soap and water and scrub them with a brush. You are removing years of dirt. Hold the knobs with a short length of ¼ rod. Then, use a buffing wheel running at about 1800 RPM because faster speeds might melt the plastic knob. A drill press is a good tool to hold the buffing wheel. Use a loose buffing wheel with a paste-type fine polishing compound. Remove excess polish with a clean, soft rag and your knobs will look better than new.

7. "You spoke of cleaning the chassis, metal, components, wire harnesses, sockets, and connectors with rags and cotton swabs. I'm not afraid of spending the necessary hours - I just don't know how to do it, and what to use to make things beautiful. I've seen pictures of equipment that has been restored to better-than-new condition, and I've always wondered what was done to polish the chassis, IF cans, filter capacitor's housings, etc."

In most restorations it's simply not practical to remove everything from the chassis. In the case of Collins (and others), rivets are used as fasteners- ouch! Remove what you can – tubes, meters, dial assemblies, etc. Cleaning takes time. Clean the dirt first using whatever solvent works – soap and water; the Formula 409® and ammonia mixture; etc. Use cotton swabs and a variety of small brushes for hard-to-reach areas. A Dremel® tool with a flex accessory and nylon brushes is great for getting into those areas. You will find your own favorite technique. See elsewhere in this article for more cleaning suggestions.

8. "You mentioned 'relay contacts were burnished and switches were cleaned with DeOxit®.' I need to get a good burnishing tool, and I ordered and received a 25-ml plastic bottle of 100% DeOxit® with a needle dispenser. When that's applied to rotary contacts, and other switches, is there any physical action that should be taken to further clean those contacts? Should the switches be taken apart (carefully so as to be able to put them back together again - HA!) to make sure the rings are cleaned on both sides? Or is this going a bit too far?"

No, there is no need to disassemble the rotary switches! What a job! DeOxit® will do the trick. Also, lube the switch detent with a dab of lithium grease. Oh, and after applying the DeOxit®, exercise the switch a few times. Use DeOxit® on all potentiometers as well.

9. "During restoration, you had the cabinet sent out for repainting. You spoke of custom auto-body shops as those qualified to do that kind of thing. Would you suggest a powder-coating procedure, or can an auto body shop match the colors properly, and bake the paint on satisfactorily? What about a wrinkle finish like that on my Viking II? Can this same body shop do that kind of thing as well?"

Auto paint shops are pretty good at matching paint. Powder coat is great if you can find someone to do it. The nice thing about powder coat is that you can add texture. Use this on the Viking II. In any case, be prepared to pay big dollars. It's expensive to paint one cabinet and the setup charges kill you.

10. "I don't have a Variac to bring my equipment 'up' with. I've designed something that seems to work, though. The photo is attached to this email. It is a plug going into 117 VAC, to a regular household on-off switch, one side of the electrical goes through a socket, and then to a double plug where the rig is plugged in. This picture shows the socket with a fuse in it, but as I bring up an old radio, I start with a 25-watt light bulb for a couple of days. Then I graduate to a 60-watt bulb, then 100 watts. If that procedure doesn't produce any smoke, I put in the fuse for a direct connection to 117 VAC. If something's shorted, the 25-watt bulb will glow brightly. If things are OK, it doesn't glow at all. The same with the higher wattage bulbs. I know this isn't

very sophisticated, but it seems to work. Is this satisfactory or should I just break down and get a Variac?"

Your setup is innovative but, *get a Variac*! They are cheap and absolutely mandatory! They are nearly always available on eBay at reasonable prices.

I hope my answers to some of the questions I've received are useful in your restoration efforts.

Here is a brief summary of a typical (if such a thing exists) restoration process:

1. Take a few "before" photos. You do have a digital camera, right? If you don't, now is the time. Take high resolution shots of ***everything***, especially lead dress and mechanical assemblies. Believe me, as you disassemble you ***will*** forget what goes where!

2. Disassemble as much as is practical. Use numerous small containers, well marked for future reference. Make drawings of mechanical assemblies as you remove them.

3. Wash and clean *everything* as detailed previously. Send out any items that will need painting or plating; panels, cabinet, etc.

4. Test all tubes and replace as necessary. When replacing tubes, place a dab of DeOxit® on each pin before inserting it back into the socket.

5. Replace all electrolytics and coupling capacitors and any others that look "suspect." I generally replace all paper (wax) capacitors as well. Measure resistor values and replace as necessary. Refer to the schematic to ensure resistance readings make sense. Replace any resistors that show evidence of overheating.

6. Test all transformers for continuity and leakage. Replace, or have them rewound as may be necessary. If any of the transformers or chokes are rusty, etc., remove them from the chassis, disassemble, then clean and paint. I use automotive paint in spray cans. Transformers are generally one of the first items installed during manufacture so lead removal can be very difficult. If it would be difficult to unsolder leads, the transformer may be painted in place by loosening or removing mounting screws; slightly lifting the transformer off the chassis and using painter's tape placed under the mounting tabs and body. This way, you can spray right down to the chassis. Protect everything else from overspray with paper, old towels, etc.

7. Make any suggested modifications and document the changes you make.

8. Clean and lube all switches and controls.

9. Lubricate mechanical assemblies and fans. Less is better. In general, I don't use anything on plastic or nylon gear assemblies and only a little dab of lithium grease on aluminum or steel gears.

10. Replace hardened rubber grommets.

11. As you begin reassembly, replace all rusty or otherwise ugly looking hardware with new stainless steel parts. Even though the stainless is not original, I replace all slotted screws with easier-to-use Phillips head.

12. Replace the line cord if necessary.

13. Power up with great care using a Variac. Before applying power, ensure there are no high voltage or low voltage short circuits.

14. Troubleshoot and repair as may be necessary.

Visit my website (http://www.isquare.com/personal_pages/ras-hardware.htm) for many photos and stories of my restorations. What you see may energize you to get you going on your restoration. Remember that old receiver you bought at a hamfest 10 years ago and stashed somewhere in the garage? Dig it out and get going!

1. Sullivan, Bob, WØYVA, "Restoration of a Central Electronics 600L Amplifier," Electric Radio #179, April 2004, page 22.

ER

The Heathkit Vacuum Tube Sideband Line

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The popularity of the Heath vacuum tube sideband equipment, then and now, is unprecedented. Sometimes the asking price of these classic rigs commands as much as used modern transceivers. But quite often, depending on condition, they can be obtained for a whole lot less. Several shown in the photos were purchased very inexpensively and with a little clean up, worked perfectly. Sadly, some of the nicest looking equipment can be DOA and not worth repairing.

Many people have actually modified the transmitters for AM, and the receiver sections of Heath transceivers can be made to receive AM as well[1]. So, if you find one in less than pristine condition, here is the basis for a super cool modification for AMers. We are going to describe the various pieces produced from roughly 1963 through 1984 and provide the time line of their production. See **Figure 1**. Other ER articles have given the AM modifications[1].

Heath's first really successful amateur transmitter was the AT-1 low power novice CW rig in 1953. The kit proved so popular that the classic DX-100 was marketed within about two years. It was quickly followed by the DX-35 (CW and carrier controlled AM), DX-20 (improved replacement for the AT-1), and the DX-40 (improved version of the DX-35). The various iterations of the DX-60/A/B (improved version of the DX-40) came just as Heath was sticking its toe into the SSB arena. This was 1960 and the DX 60 with carrier controlled AM modulation lasted well into the 1970s before sale of the kits ended.

This new infant SSB mode was just getting out of its diapers in the late 1950s. The Company started to develop the SB-10 side band adapter for the DX-100B. By the time it was marketed, the DX-100B was in its waning days and being replaced by the Apache TX-1. The Apache was specifically designed to use the SB-10 as an option. The matching receiver, the Mohawk RX-1, was designed for upper or lower only sideband reception in both the AM and SSB modes. Heath made provisions for the DX-100B to be fitted with the SB-10 and even offered the owners of the original DX-100s this opportunity. The first SSB transmitter was the Marauder, HX-10, which matched the Apache and Mohawk.

The First Heathkit SSB Transceivers

Surprisingly, the first units marketed were the single-band transceivers commonly referred to as the "Mono-Banders." They were a relatively inexpensive means to get on SSB--at least on 80, 40 or 20 meters--and very popular, at a cost of about one hundred and twenty dollars. At about the same time, 1963, the Mohawk, RX-1 was being replaced by the much smaller and lighter SB-300 receiver modeled after the Collins S line. (It is often said that the Heathkit SB series was the poor man's Collins.) Its matching transmitter, the SB-400, appeared about 6 months later. It actually makes sense that the company produced the simple one-banders first and then the more complicated 5-band units.

The mono-band units were true, complete single-band transceivers with 200-watt PEP transmitters and frequency matching receivers. The HW-12 covered 3.8 to 4.0 MHz using 14 tubes including a pair of 6GE5 TV sweep tubes in the

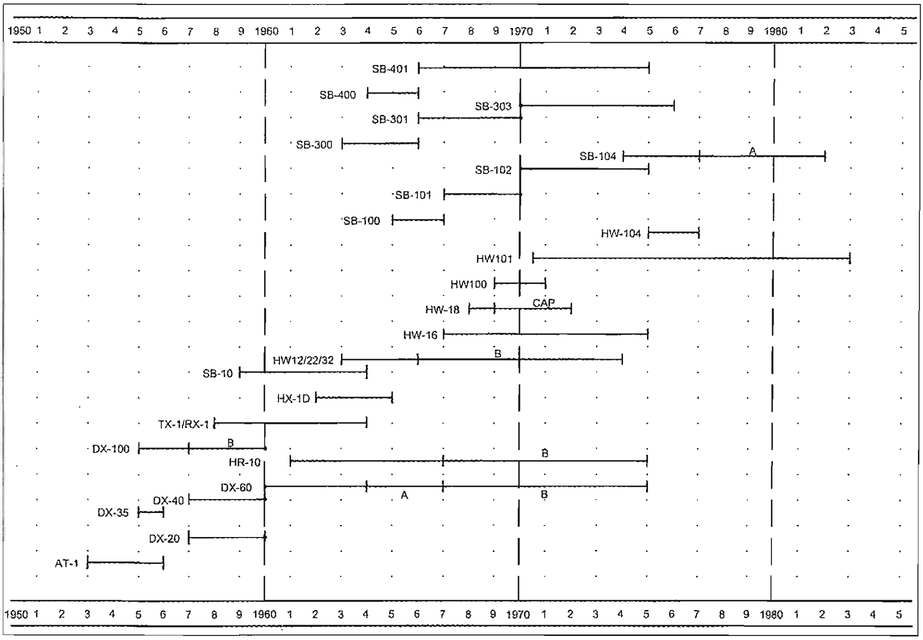

Figure 1: Time line of some significant Heathkit equipment.

final. Unlike the SB-10 that used phasing, the mono-banders used crystal filters at what was to become a Heath standard IF frequency of 3.395 MHz. The 5-kHz offset was used to avoid the 100 kHz calibrator signal blocking 3.400 kHz. The sensitivity was 1 µV and selectivity was 2.7 kHz at 6-dB down.

The front panel included the following functions: ON-OFF-PTT-VOX-TUNE, RF gain, with a pull-on switch for the calibrator. Rear controls include mike gain (for a high impedance mike), tune level and final bias adjustment. Rear-panel RCA jacks include the 50-ohm antenna, external relay (for an amplifier), 8-ohm speaker, and an octal power plug.

While many hams rolled their own power supply, the company sold the matching unit as the PS-13 (12 VDC) and HP 23 (120 VAC). The HP-23 had several variants (A/B/C) as time went one. The unit required 800 VDC at 250 mA, 250 VDC at 100 mA, -125 VDC bias, and 12 volts AC or DC at 3.75 amps. The other models HW-22 (40 meters) and HW-32 (20 meters) all had similar requirements, as did the other HW and SB transceivers.

Later, in the 1960s, a company called Dynalabs (and others) marketed a modification kit for these mono-banders permitting them to work on all three bands.

Three years later, in 1965, when the five-band SB-100 came out, the mono-banders were improved as the "A" model and reflected the style change with the SB-series of equipment. They now sold for one hundred dollars. In addition to the restyling, controls were changed around for easier operation.

The RX/TX Twins

The SB-300 ($265) is the first in the line of the 5-band units covering 80 through 10 meters. It was supplied with a SSB crystal filter (2.1 kHz @ 6-dB down) and had provisions for optional CW (400 Hz) and AM (6 kHz) crystal filters and converters for 6 and 2 meters.

The real magic of the SB series was its Linear Master Oscillator (LMO) which

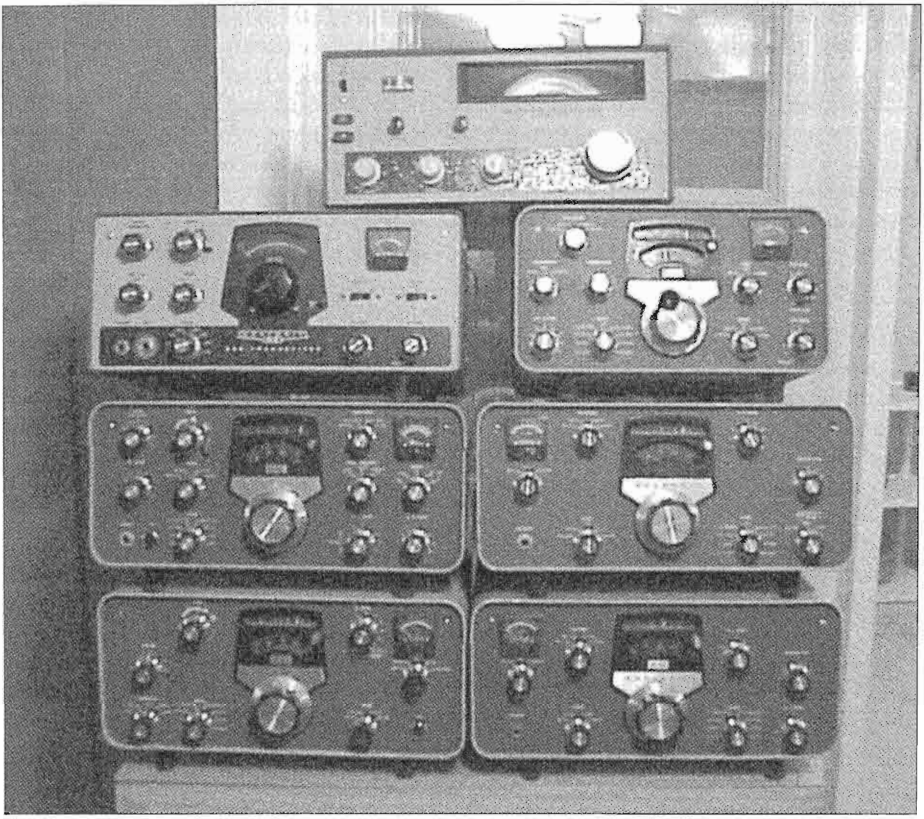

Figure 2: The HW-16 is on top of the pile of SB and HW-series rigs. Top to bottom in the left column is the HW-100, SB-101, SB-401 and in the right column is the SB-303, SB-301, and SB-300.

was very comparable to the Collins PTO used in Collins equipment in that era. The LMO was supplied as a sealed, already-built unit and was mounted on the chassis by the kit builder. The vast majority of these were produced by TRW. They were the second conversion oscillator operating from 5 to 5.5 MHz.

The first conversion is crystal controlled using 8 rocks to cover 500 kHz of each band and four segments of 10 meters. All HF transceivers, receivers, and transmitters in the HW and SB series used the same heterodyne scheme. Thus, all crystal filters and crystals are electrically interchangeable. There were two sizes of crystal filters. Earlier equipment used the larger filter. These filters are actually four-pole lattice using discrete components sealed within the units. I'll have more on this later.

The SB-301 (starting in 1966 and costing $260) added RTTY, WWV reception on 15 MHz, ANL and front panel controls to select the VHF converters. In 1970, the SB-303 ($345) became the first solid state unit and was often paired with the vacuum tube based SB-400/401 transmitters. To give the devil his due, the SB-303 is a fantastic receiver and highly regarded. SWL versions were the SB-110 and the solid state SB-313.

The SB-400/401 ($325/$285) transmitters were 180 watt PEP units using 6146Bs. While the matching receivers have operational AM and CW provisions, the transmitters only operate SSB and CW. Unlike the transceivers that required external power supplies, the supplies were internal to the transmitters. The 400 came with the heterodyne crystals and cables had to be changed within the transmitter to slave the transmitter frequency to the matching receiver. With the 401, crystals were optional. The 401 was expected to be slaved to the matching receiver's frequency and the cost reflects the missing heterodyne crystals. The switch between separate and slaved operation was now on the front panel. The 8 crystals were sold as an option.

The Five-band Transceivers

Perhaps, because of the tradition of separate units for transmit and receive, those pieces were marketed first. The popularity of the mono-banders and the upscale Collins KWM-2 dictated a five-band transceiver kit. The SB-100, using many of the same circuits, components, cabinets, and heterodyne scheme entered the market in late 1965. It combined the performance of the SB300/400 twins in one complete package with a striking resemblance to the Collins transceiver at one third the cost ($360).

The SB-100 operated CW and SSB only. It came with only the SSB crystal filter. Two years later, the SB-101 ($370) came out with the CW filter and the SB-100 owners were offered a retrofit kit. Three years later, in 1970, the last of the tube transceivers was introduced, the SB-102 ($380). All of these transceivers were huge success stories for Heath as evidenced by the large numbers still available. A completely solid state version was marketed in 1975, the SB104/A ($699.95), but it proved to be problematic. It was a definite loser and perhaps was an influence in Heath withdrawing from the kit market. Also, a six-meter only transceiver, the SB110/A ($299) was sold from 1965 through 1971.

With the popularity of the SB line, Heath turned its attention toward capturing as much of the ham market as possible by reducing prices. The HW-100 was the result. It was almost identical to the SB-100/101 and sold for $250 starting in 1968. Demand for these guys was phenomenal. The cost reduction was in the LMO. A solid state oscillator was used in a much simpler design. The biggest problem was the tuning dial, which had claims of wobble and backlash. Magazine articles of the period and individuals came up with modifications. (See the HW-100 in **Figure 2.**) Finding an unmodified HW-100 could be a real challenge, and the HW-100 did not include the CW filter.

The HW-100 sold for only two years. It was replaced by the HW-101 which now did include the CW filter and several improvements. The HW-101 is, without doubt, the most successful ham transceiver ever produced. Although the Heath sales records were destroyed, by 1983 it was claimed that over 30,000 HW-101 kits were sold. Many believe that the number is closer to 40,000. From their advertisement introducing the 101: ".... better that the 'Hot-Water 100" ..... and a nickel cheaper. .... a lot more rig for a little less money."

And yes, a solid state version, the HW-104 ($569.95), was introduced with the SB-104. It was the same basic design with all the problems of the higher priced SB-104.

The HW-18 Special-Purpose AM/ SSB Transceivers

Heath actually did produce three transceivers for different purposes that included the AM mode. Starting in 1968, the HW18- 1, 2, and 3 was introduced for CAP, MARS and 160 meters. These were crystal-controlled, two-channel devices and were based on the mono-banders. They required an external power supply and were advertised as producing 200 watts PEP and 40 watts AM carrier. The non-amateur units covered 4450 to 4650 kHz. Otherwise, they are identical. By

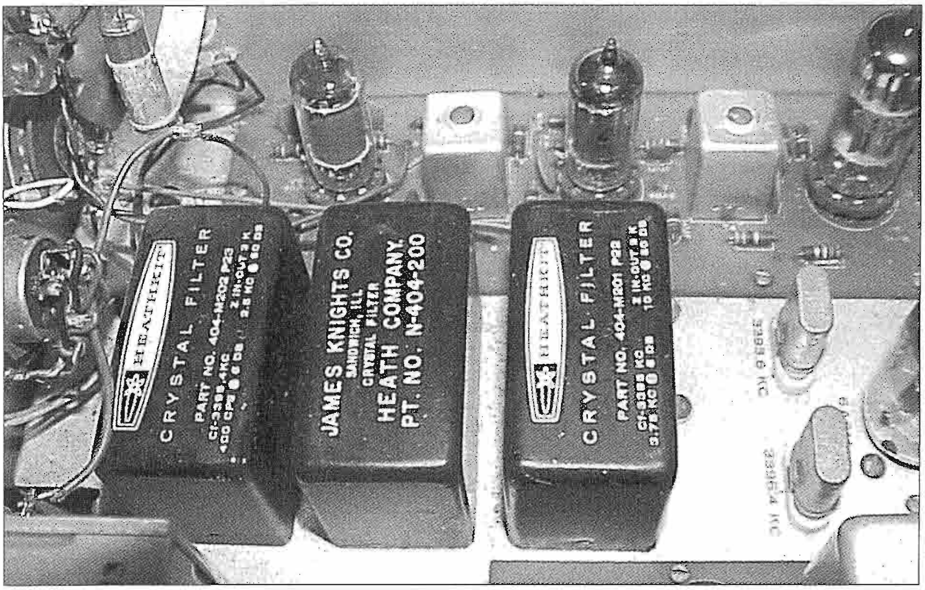

Figure 3: This is an SB-300 receiver that has all of the larger-style filters for CW and SSB installed.

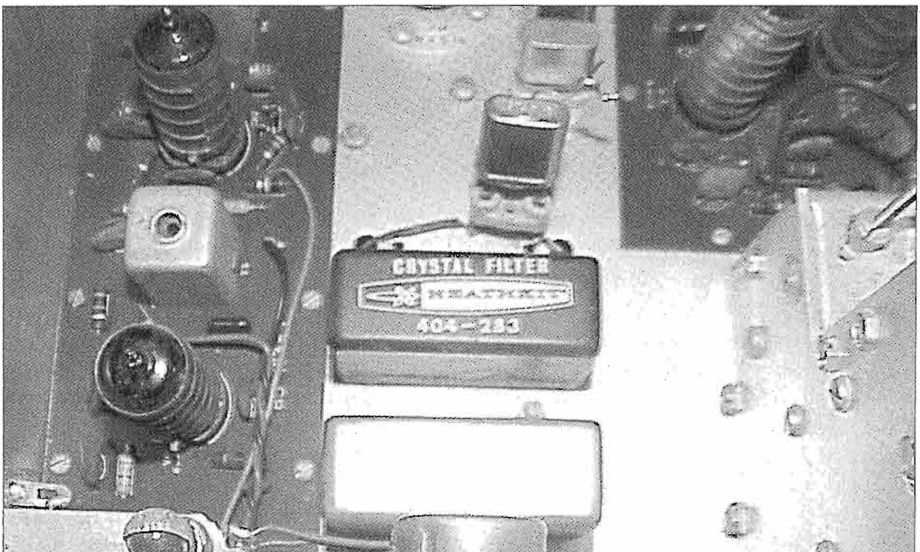

Figure 4: My SB-301 has the filters with a smaller case style, SSB above and a CW filter at the bottom. A previous owner, in a misguided attempt at installing a single-crystal AM filter, tried placing it just above the 404-283 2.1 kHz crystal filter.

Filters for the SB-100,300 and 400		
P/N	Type	Bandpass
404-200	SSB	2.1 kHz
404-201	AM	6.0 kHz
404-202	CW	400 Hz
Filters for the SB301/303/401and 101, HW100 and 101		
404-283	SSB	2.1 kHz
404-284	CW	400 Hz
404-285	AM	6.0 kHz
404-314	AM	Wide band used in SWL RX
404-328	SSB	2.1 kHz
Crystal Frequencies		
Carrier:		
404-205	USB	3393.6 kHz
404-215	CW	3395.4 kHz
404-206	LSB	3396.4 kHz
404-207	80	12.395 MHz
404-208	40	15.895 MHz
404-209	20	22.895 MHz
404-210	15	29.895 MHz
404-211	10A	36.895 MHz
404-212	10B	37.395 MHz
404-213	10C	37.895 MHz
404-214	10D	38.395 MHz

Table 1: Heathkit filters and crystals in the SB-line.

contrast, these oddities were a great idea which went nowhere. The MARS and 160 meters versions were withdrawn the following year and the CAP version may have limped along into 1975 because Heath had lots of unsold kits. Not many exist today, but they do occasionally appear. The fact that they do operate AM is confirmation that the HW and SB line can be made to operate AM.

The crystal frequencies and filters are listed in **Table** 1. They are readily available from Internet sources. The internal components of the four-pole AM filter are shown in **Figure** 5. It is possible to roll your own, but it is not economically practical. The AM crystal filter would be the easiest way to widen the IF for AM reception. An effective two pole crystal filter is very practical to make by reusing the SSB carrier crystals. They are 3 kHz apart at the IF frequency and give an almost perfect AM response.

I have used these SSB carrier crystals in the HW-16 Novice CW transceiver for AM reception. The HW-16 also uses the same IF and heterodyne scheme. All that is needed is to substitute the carrier crystals for the narrower CW ones used in the two-pole crystal filter.

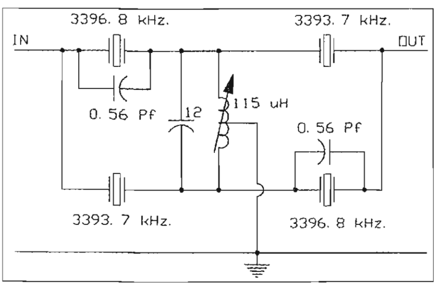

Figure 5: Schematic of a Heathkit AM filter.

An up coming ER article will elaborate further on the AM conversion for the HW and SB-line vacuum tube transceivers.

References:

1. Bill Breshears, WC3K (SK), "Add AM to the Heath SB-400/401 Transmitter," Electric Radio #139, December 2000, page 28.

2. Dave Kuraner, K2DK, "Cathode Modulation, History, Theory and Practical Implementation Part 2," Electric Radio #191, April 2005, page 12.

ER

Resurrection of a Heath HR-10B Receiver

By Bill Paschall, WD5DZG
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Linden, TN 37096

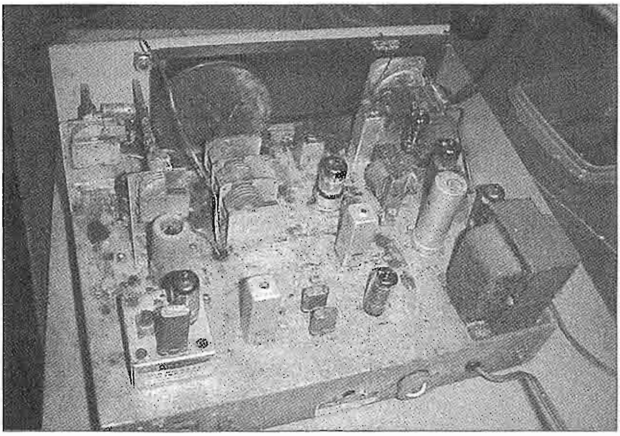
First let me state, I am not an engineer. I have no formal training in electronics and I do not fully understand hollow or solid state technology beyond the secret being smoke. What I do understand comes from years of experimentation, reading about what others have done and being willing to try and try again.

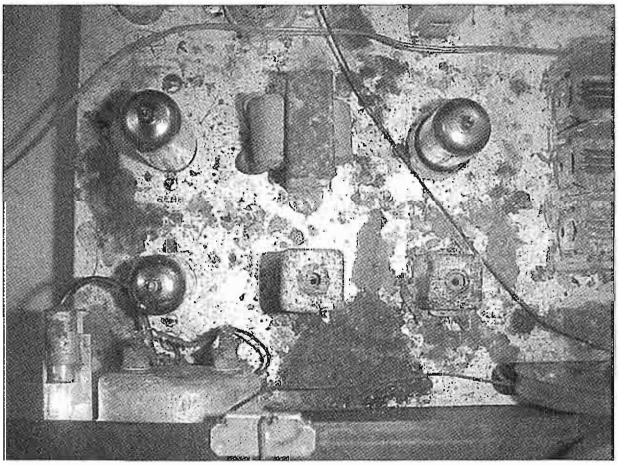
Sometime ago I purchased an HR-10B on line. Since I was pretty well time challenged at that point in time, I put it away until I could do it justice. Once I found time to inspect it, I was pleased by the honesty of the seller. It was all you would expect from a rig having been described as "untested, condition unknown, parts or repair rig." In short, it was a disaster. The outer case was marginally OK for a cheap radio (I didn't pay much) but inside it was filthy. Mice or rats had made long-term use of the chassis top as a bedding area. There were nut hulls, shredded cloth, feces and a pervasive smell of urine, rust, dead bugs and spiders, etc. The variable capacitors were rusty, gunky and difficult to turn. The dial lamp holders were rusty and didn't form a ground return. It looked like this thing had been literally been stored in someone's barn or cellar and rats or mice, or both, had dwelt therein forever.

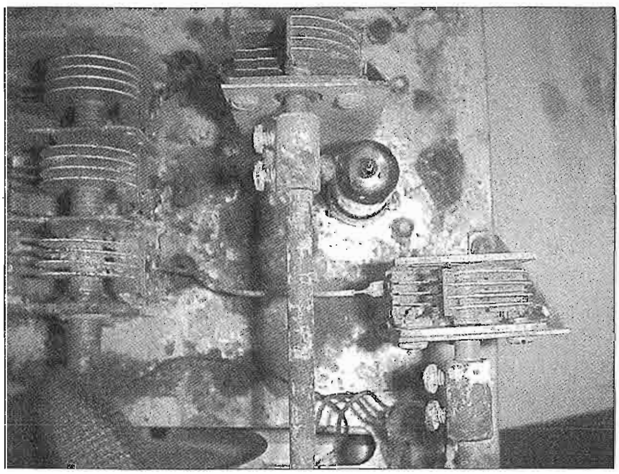
Usually, with older gear, I do a visual inspection, check and replace tubes as

Top-front view of the author's restored Heath HR-10B receiver. Designed as a 5-band, 7-tube, entry-level receiver that matched the DX-60 transmitter, it was available for 8 years, from 1967 to 1975.

Below: Three views of the HR-10B and the chassis before restoration.

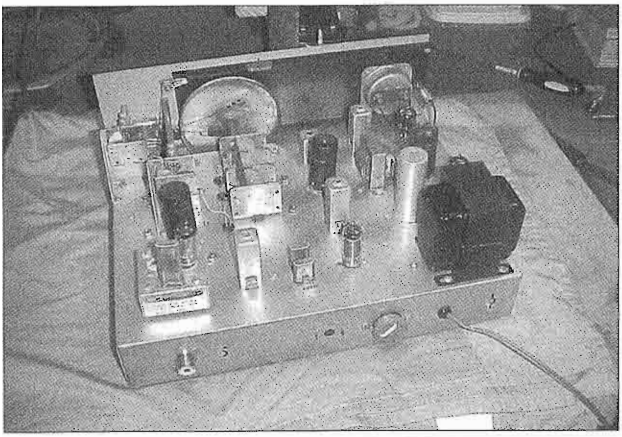


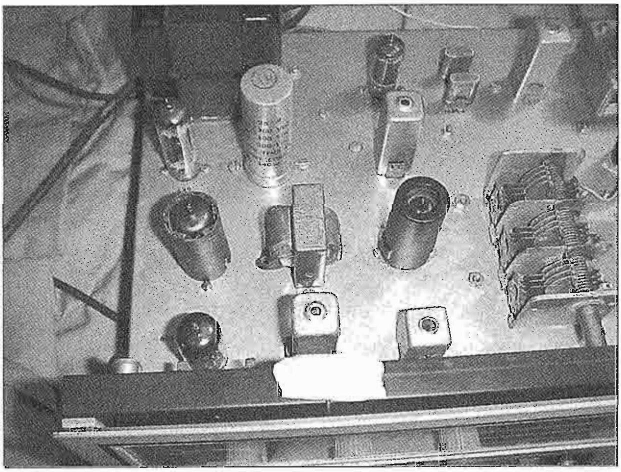


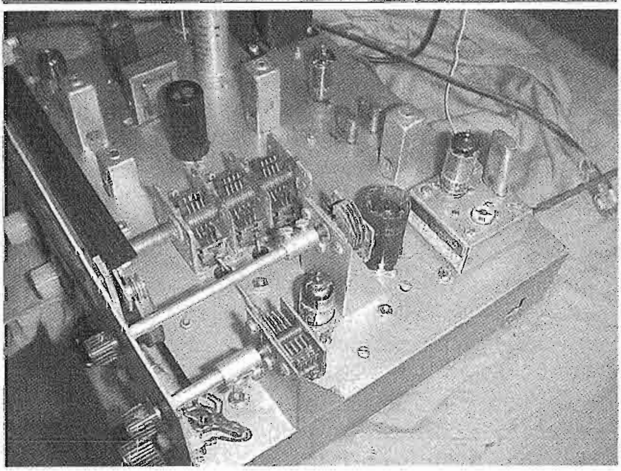


needed, then bring it up slowly on a Variac or use a dim bulb tester. I then replace out of tolerance components and do an alignment. This has worked well for me with several pieces of gear and my original plan had been to do so with the HR-10B. It was obvious in this particular case that even if I could get it to work in its present condition, it would at best qualify for the ugly duckling prize. Some preliminary testing showed that six of the tubes were OK. Luckily, I had a replacement for the bad one. I brought it up slowly with a Variac, no smoke, no shorts and no function. A quick review of the manual showed that a necessary plug for the accessory socket was missing. My junk box yielded a suitable plug base and I made a jumper, installed the plug in the accessory socket and gave it a try. The radio showed some signs of life. I could detect a signal by injecting a 1600 kHz signal on the stator of the tuning condenser. Weak, but detectable. There was not a trace of a 60-Hertz hum so apparently the filter capacitor reformed OK. After spraying the band switch with some cleaner, I worked the band switch back and forth and was able to detect signals in each band. Intermittent switching led me to

Below: Similar views, only now showing the restoration results!







suspect a problem with the band switch. I suspected gunk buildup or oxidation on the switch contacts. The band switch would have to come out to be sure. Further checks revealed that the IF gain, the volume control, the send/receive and the BFO circuits were functional but all needed help if this receiver was to again perform as designed.

Over my career as a ham radio nut, I have worked on some really dirty and rusty monsters, but never one quiet as far along the road to the dump as this one. The most likely solution appeared to be to do a chassis-off restoration, if I dare borrow an automobile term. Many of the components needed major physical restoration. The only practical route was to disassemble the entire rig, refurbish or replace all the out of tolerance parts and build the receiver again as if it were a kit. Others have referred to this process as re-kitting. I had a manual with building instructions included so that problem was solved. Now the only question was whether my skills were up to the test. I figured what the heck, if those guys on TV can do an entire car on camera in one week from scratch, I should be able to do a fairly simple receiver given enough time and no camera looking over my shoulder.

I have made the mistake

of taking electronic equipment apart, putting all the parts in a pile and trying to sort then out again. I didn't want that headache again so a first step was to divide a cardboard box into sections and label each as to its contents by circuit. The front panel was the first assembly to be removed. It was straight forward and no problems encountered. Next to go was the band switch assembly. It took some patience, but finally it came out as a unit. I seem to remember that Heathkit offered this particular assembly already wired, but I could be wrong. In any case, the switching assembly looked like it had been put together with a torch. Not a pretty soldering job at all. Next were the variable capacitors on the chassis deck. They were very rusty and dirty but removal was straightforward.

The tube sockets and associated components were a pain to remove. Patience and attention to detail worked, but even so, several of the sockets were so badly damaged as to be un-salvageable and needed replacements. Removal of the power transformer, audio transformer and various inductor cans was not difficult.

During the disassembly I found two modifications not in the manual. A previous owner had devised an IF pick-off and added an RCA plug to the back and a small speaker had been added. I felt that both mods were not desirable to me, so out they went.

With disassembly of the HR-10B completed, I was able to check the individual components. The underside of the chassis was not too bad, but the top was rough with many large rust spots, the worst of which had cratered the chassis metal. I made a drawing of all the lettering for later use, and treated the rust spots with Navel Jelly, filled the craters with auto body putty and sanded it smooth. I wanted to use a spray Zinc coating (used to be available from auto parts dealers, but not so anymore) but was unable to locate a source. Finally I decided to try aluminum paint with a clear coat as a hardener (I wouldn't want to try this anywhere that making a chassis ground was needed). The restored and painted chassis now looked decent and very different from its freshly stripped condition.

I cleaned and painted the transformer cases and buffed out aluminum cans. The capacitors were cleaned and lubricated and the shafts were sanded and painted with aluminum paint. The brackets were sanded and painted as well and then reassembled on the chassis. Sorting and testing of the individual parts was very time consuming. Several of the resistors had tested way beyond tolerance on my VOM, and I decided to replace the lot of them. Luckily, I had replacements, except for two values, one of which was within tolerance. For the other, I was able to parallel two values and make a replacement. The HR-10 is packed with .005-μF disk ceramic type caps rated at over 1000 volts and they all checked good. I did have to replace one electrolytic in the audio section, and a .1-μF disk was damaged so it too was replaced.

The band switch assembly was a real challenge to troubleshoot. The wafer contacts are made of a phenolic material and are not the strongest feature of the assembly. It was very difficult to tell whether or not the contacts were making good contact. I gave the assembly a good bath in warm soapy water, which removed a lot of dirty gunk and used a compressed air source to dry the assembly. I sprayed the contacts with contact cleaner and moved the switch assembly back and forth several times. Mechanically, the assembly worked much better now. The only question remaining was whether it would it work electronically.

Reassembly was not difficult. I could have used the schematic as a guide, or lacking a schematic, worked from drawings. Since I had the manual I decided to do it step-by-step in the Heathkit fashion. Although I worked carefully and paid attention to detail (I thought), I did learn that I can still make mistakes and found myself having to walk away, clear my mind and recheck the work. Some real goofs were found, too. I won't trouble you with those since they tend to make me look like an idiot and add little to this account.

After assembly was completed, I found some things I had not noted before. According to the manual, the crystal filter was supposed to have a passband between 1600 and 1700 kilohertz. This one was located closer to 1800 kilohertz. A check of the filter crystals in my homebrew crystal tester showed them to be as marked. Perhaps the Filter coil pulled the filter center that far but that seemed excessive to me. I decided to see if it worked before becoming alarmed.

Alignment was a challenge to say the least. Not one of the bands was anywhere near factory settings. Three of the bands were aligned on totally different frequencies and one of them on an image frequency at that. I am not sure how much of the variance came as a result of my disassembly, and cleaning and adding fresh components. Those definitely had some effect, but I suspect that someone got diddle stick happy before the rig was stored. Careful alignment by the manual instructions resulted in 80 and 40-meter bands lining up correctly. 20 meters was more difficult. The oscillator seemed to be dead. An RF probe on my counter showed some oscillation, so I carefully aligned 20 meters again. 20 meters came alive. Alignment of the remaining bands was uneventful.

Attaching an antenna allowed me to receive signals on 80 through 20 meters, and my signal generator could be heard on the higher bands. But there was distortion. CW signals seemed to have a raspy note and sideband sounded like a duck with a throat ailment. Changing out the audio tube seemed to take care of the problem. I now had a partially restored radio. As of now, I still have not stripped and repainted the case but, that too, will happen eventually.

I used the rig for several days on the air and it seems to perform fairly well. It is not a top-of-the-line modern receiver by any stretch, but it is about what one would expect from an entry-level receiver and as good as most from that era. It will be a fun novice station if I ever get around to redoing that DX-60 companion transmitter, but that is another story.

Would I do another restoration of this difficulty? The answer is probably "yes," if the rig interested me.

Is it easy? No, but it is within the reach of the average ham, provided that ham is given basic tools, a measurable learning curve, a reasonable degree of patience, and is willingness to do some basic research.

Is it worth the effort? Only if you get a thrill from being able to preserve and extend the life of a real basket case and save it from going to the city dump.

<u>ER</u>

(Comments, from page 1)

There are some minor errors in language that will be fixed before the rules become effective. Once the rules are published in the Federal Register they will become effective. This is expected to happen later this fall, 2006.

I've had conversations about these rules changes with many longtime AM operators and regular contributors to Electric Radio whose opinions and advice I greatly value.

Among these conversations, Dale Gagnon (KW1I) mentions "... The recent FCC Report and Order in WT Docket 04-140 has expanded phone sub-bands on 75, 40 and 15 meters. On 75 and 15 the expansion is substantial. While this will be discouraging for the users of other modes, AM enthusiasts may have a unique opportunity to informally claim time/frequency slots as other mode individual and net operating practices undergo changes. But, it will take regular use by AM stations to turn target frequencies into an 'AM window' or a 'de facto AM sub-band.' The new rules will be effective 30 days after the Report and Order appears in the Federal Register later this fall...."

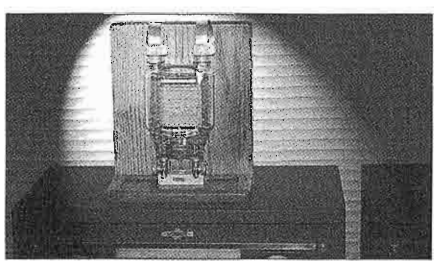
Paul Courson (WA3VJB) pointed out several facts that I wasn't aware of. For example, Paul mentions the "...cohesive, effective influence we [AMers] had on the FCC in its Report and Order [that will be] expanding the phone bands. There are many individuals from the AM community who are cited in footnotes the FCC used in establishing their decision:

Steve Joachim, KL7OF
Bill Kleronomos, KDØHG
Dale Gagnon, KW1I
Dave Humbertson, W3NP
John Fitzsimmons, W3JN
Don Chester, K4KYV
Mike Wingfield, W8MW
Paul Courson, WA3VJB
Jim Wilhite, W5JO
Paul Goodman, K2ORC
Tony Cypert, W5OD

_No_ other identifiable group, including the ARRL, can claim that much of a positive role....With Mike Dorrough's excellent article in ER, calling for a new gathering point for AM [ER #203], we have an opportunity to take a leadership role by coordinating our activity on these expanded phone bands. By voluntarily congregating our stations years ago when SSB was struggling for acceptance, we eventually led the ARRL to acknowledge our leadership in their Considerate Operator's Guide. The strong interest in vintage equipment and AM proves it's a fascinating specialty. The FCC, by taking our suggestions, must see us as responsible, active members of ham radio who have earned the expansion of space to operate."

These rule changes should really take the pressure off of the crowded 75-meter band for all operators. Once 15 meters returns as the sunspot numbers start going up again, we will see the same positive advantages. Let's all work together to establish a positive presence on the bands that is attractive to other hams who might be looking for something new!

2006 Heavy Metal Rally



I'm hoping for a large turnout for the 2006 Heavy Metal Rally that was mentioned in last month's issue. The winner's trophy (shown above) will be a great addition to anyone's shack, and it will have an engraved brass plaque with the winner's name and call sign on it. This award will be well worth the time it takes to win it.

73, and Keep Those Filaments Lit!
Ray, NØDMS

A CW Transmitter from the 1930s

By Bruce Vaughan, NR5Q
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nr5q@aol.com

"The indefatigable pursuit of an unattainable Perfection even though it consist in nothing more than in the pounding of an old piano, is what gives meaning to our lives on this unavailing star."
—Logan Pearsall Smith (1865-1946)

Introduction

A look through any issue of Electric Radio reveals articles written on radio as it existed years ago. Upon reading such articles, one might well question why the author spent his most valuable possession, time, building obsolete circuits, and then invested even more time, money, and energy writing and photographing his project to share with others.

The answer is complex, but I am sure the primary motivating factor is striving for perfection. It is human nature to want to do better—improve your golf score, reach the Honor Roll of the DXCC, speak more effectively, or build a better radio than the one you last built. When completed, we like to share our work and ideas with others and receive their opinion and approval.

Writing for ER carries many unexpected side benefits. One of prime importance to me is the new friends you make as soon as your articles start appearing in print.

Dave Ishmael's name is familiar to everyone who reads ER. His rebuilt classic radios and original creations defy comparison. They are about as near perfection as it is possible to get.

Dave and I have been email friends for years. We often exchange letters and photographs of our newest building efforts. The odd part of this friendship is the totally different approach we pursue when building. I doubt that there are two people in existence whose building techniques differ more. One might say that we are 180° out-of-phase. This diversity of building methods is probably why we enjoy sharing our experiences via the Internet.

Dave approaches his projects as any good engineer should. He does his math so there is no doubt as to the values of any resistor, capacitor, or inductance in his circuits. Everything is exactly as it should be. Then the parts are laid out on paper to scale. When Dave starts drilling his panel and chassis he has every hole precisely placed, and the size of hole indicated to a very close tolerance.

My approach is less structured. Most of my projects are conceived when I find something interesting in a book, or with the acquisition of a new supply of parts at a hamfest. This 1936 transmitter is the first radio I began building without a fixed idea of the end result. I thought my story might be of interest to others—though I do not necessarily recommend this method of building. In this particular case it worked out fine, but it could have ended much differently.

Before I get into the actual construction of my current CW transmitter, let me tell you exactly how it evolved. I will begin by saying that Christmas holidays are one long nightmare for me. I am offended by the 8 weeks of constant advertising. I dislike crowded stores, Christmas parties, addressing cards, and hunting for gifts. I detest climbing ladders and hanging strings of cheaply-built outdoor lights across our front porch. I dislike assembling artificial Christmas trees, and trying to get at least 80% of the poorly-built bulbs to give off their warm Christmas glow. I am tired of watching "It's a Wonderful Life" on TV for the 35th time. I'll admit it—I am Scrooge

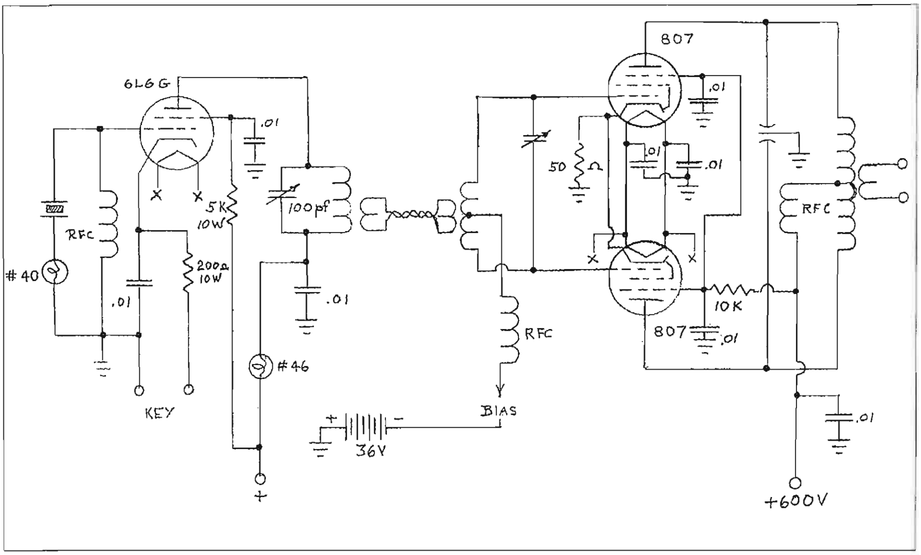
Here is a rear view of the RF deck on my recreated 1936 CW transmitter.

incarnate. By the time last Christmas was over, I was depressed and had a foul disposition.

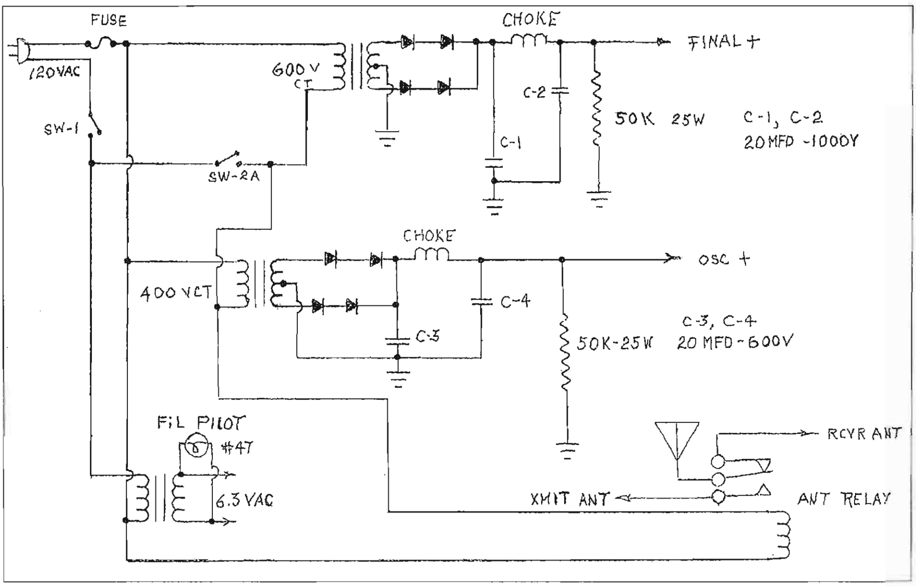
Fortunately, I know how to handle this problem, having been here many times before. For me, the very best cure for a sour outlook on life is to start a sizeable building project in my shop. It can be a radio receiver, transmitter, or even a woodworking project—almost anything as long as it is moderately time consuming. Once building starts, my world is good—sunshine returns once again. OK, I know the answer to my problem, but what will I build? My requirements are that it be relatively inexpensive (cheap) to build, that it brings back a lot of pleasant memories, and when finished will resemble the radio gear of my youth. You know, look the way radios used to look.

The best place to look for such a project is in my 1930 to 1940 files of QST, and numerous old handbooks. Somewhere in my search I came across a transmitter built in an all-wood, desk-size 19" rack. I really was not interested in the writer's transmitter, but in the rack itself. That beautiful wood rack really caught my eye. I could see it now—a wood rack with three panels. Instead of trying to make hardboard look like Bakelite, I would go for the natural wood look against a rack painted in satin black. I decided to keep the dimensions close to the standard sizes available in the mid-1930s. At this point, a transmitter of some sort was planned—one with a pair of T-20s, 10s, HY-25s or even 6L6Gs would be nice. Parallel or push-pull was not important. Looking at those two tubes sitting side by side was the important thing. I decided to proceed with the rack—the exact use of which could come later.

Before the rack building was started, I needed to know the exact dimensions of my panels. Rummaging around in my lumber storage bin (an area behind a



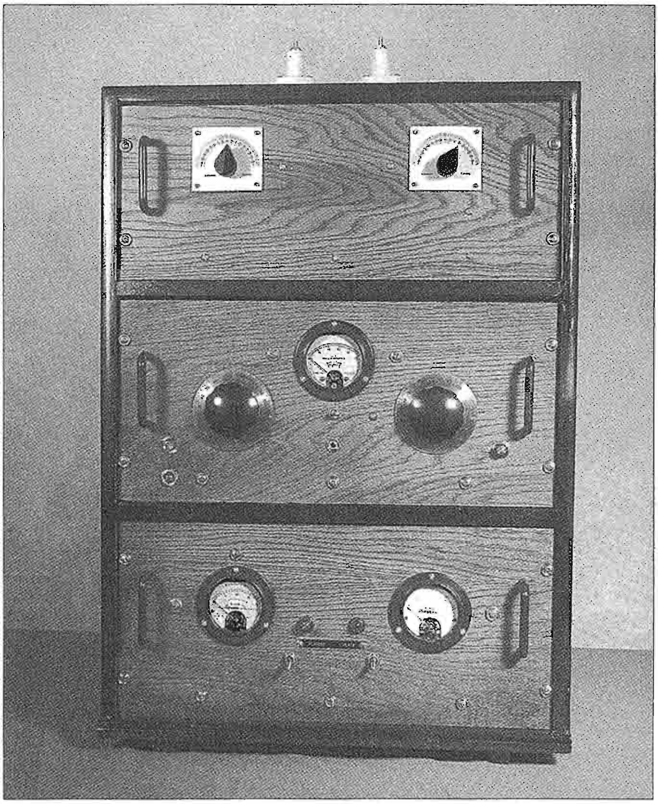
RF schematic for the 1936 CW transmitter



Schematic of the power supply stage for the 1936 transmitter

stack of cardboard boxes) some nice oak veneer was found. The scraps on hand would determine the dimension of each panel. I ended up with two 8 ½ inch by 19 inch panels, and one 7 ½ inch by 19 inch panel. Three panels were cut and finished before starting the rack. If this rig were being built in 1935, there would probably not be money enough to purchase metal chassis pans—so two chassis were built, using plywood for the tops of each chassis and ¾ inch pine for the sides and ends. Both were made the same size, 10″ by 17″ by 2″. Now, I could safely proceed with the rack to hold them. Why only two chassis? I intended to panel mount the few components needed to properly tune the antenna—whatever they might be—on the smaller panel.

The price of output tubes was checked. T-20 tubes are over $40.00 each—if you can find them. Hytron HY-25s are hard to find, and two 6L6Gs go for the price of good receiver back in 1936. I discussed my project with Ray, the ER editor. He informed me that another ham was also building a transmitter from the same point in time[1]. This did not deter me in the least because the chances of our transmitters being similar in appearance and construction was nearly zero. That's when I decided to move up a year and use a pair of 807s, a tube introduced in 1936. Several good 807s were in stock. After all, 1935 transmitter, 1936 transmitter, what difference would it make?



The homebrew CW transmitter was made from custom-finished wooden panels. At the top is the output tank, with homemade dials. The RF stage is in the center and the power supply is on the bottom.

All the time, decisions were being made about the circuit as the project continued ahead full speed. I kept building even though it was not known exactly what was being built. After more rummaging in the junk box, I came up with something forgotten—20 and 40 meter B&W plug-in tank coils, in nice condition, with a center-mounted link. Now you see how these things work out as you go along. I was more or less committed to a push-pull final, using a pair of 807s, link coupled to the antenna. I did not start drilling holes in the RF deck at this time. Instead, work was started on the power supply deck.

My old Elmer, W5BQI, would never think of using a transmitter without a separate power supply for the oscillator. I found a transformer that looked ideal for building a 375-volt, 100-mA power supply. This should work out fine in a power supply for my oscillator plate.

Further junk box searching turned up a big, sturdy, 6.3-volt filament transformer. I was sure it could handle two 807s, an oscillator tube, and the pilot bulbs.

For the push-pull final, I found a fine surplus transformer from WWII. The transformer was in NOS condition and delivered around 600 volts at 150 mA. I searched for, and found, two nice National chokes. I could now start work on the power supply deck. Though I wanted to stick with 1936 construction practice, I am not a purist. There is simply no way I am going back to tube rectifiers when I can buy excellent, solid-state rectifiers at almost any hamfest for as little as ten cents each. I use full wave rectification and, as most diodes are unmarked, I always double my rectifiers—that is, tie two in series.

Of course I like meters in my transmitters. It is comforting to know everything is as it should be, down there in the power supply. In my meter supply box I found two Triplett 0-20 VDC meters, and one 200-mA meter. The latter would be ideal to read the final plate current, and the other two meters would keep me informed as to the health and well being of both plate supplies. When the power supply was completely wired I checked it out using both my Hickok and Simpson meters. Series resistors were inserted, changing both of the 0-20 DCV meters to read 0-2000 VDC. Stickers reading X-100 were placed on the meter faces. Now, both oscillator and PA plate voltages can be read with reasonable accuracy. Would the readings on the meters be linear across the entire scale? I have no idea, but they are very close on voltages from 400 to 1000 volts.

As is my usual practice, the power supply was run for several hours to check for any excessive heating. I expected none, of course, as no load was attached. It is my belief that this initial cook-in of power supplies is of value. The bleeders present a small load on the power supplies resulting in a mild warming of components. This small amount of heat dries out any accumulated moisture in transformers and chokes. This may sound weird to some builders, but it seems to work for me.

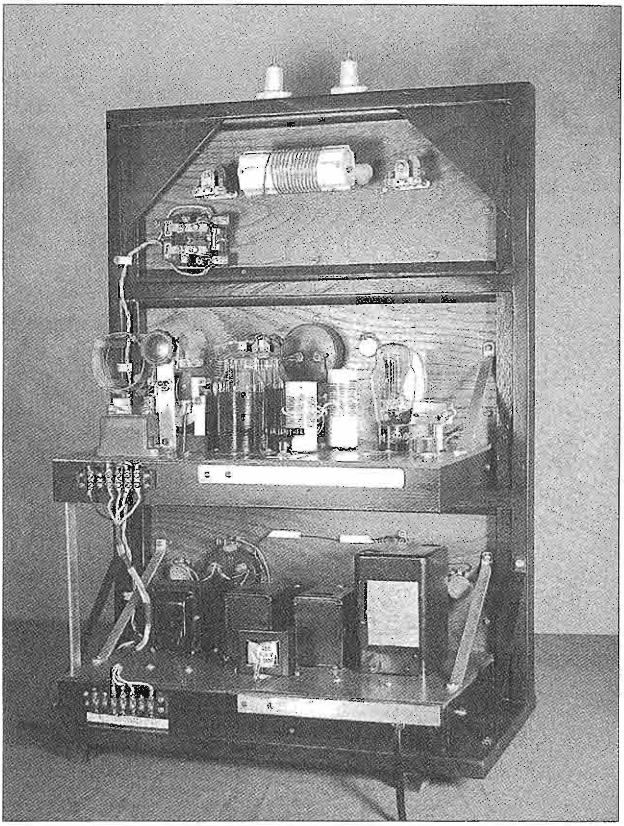
With the power supply stage completed I turned my attention to the RF stage. To build it properly, a split-stator capacitor was needed. I found two of them–one would handle 500 watts with ease, but the capacity was marginal for use on 40 meters and ideal for use on 20 meters. Due to the cost of crystals today and my limited supply, I decided to forego operation on 17 and 15 meters. Most of my crystals are ground for 40 meters, heavy in the 7000 to 7030 range, so I can double into 20. I chose to go with the larger capacitor. For one thing, mounting was easier with the bigger capacitor. Eventually both capacitors had to be used in a piggyback arrangement with a switch. Fortunately, at only 50-watts input this was no big problem.

After locating a base for the B&W coils the RF deck was pretty well under control. Parts mounting for the final was started. I build mostly out of my skull, but find it convenient to have a schematic to refer back to from time to time. A search of my entire QST file never turned up a push-pull 807 amplifier. Odd, because many circuits were found using a pair of 807s in parallel. To heck with it—I'd go ahead and mount the parts. Before running into the need of a schematic, Dave Ishmael sent me one on the Internet. He found it in an old tube manual.

While mounting parts, I realized that a bias supply for the 807s would be needed. I don't like pulling bias off my regular power supply. Why? I don't have a reason except it was the way my old Elmer taught me to build transmitters. Anyway, most rigs back in the '30s used battery bias. The life of a battery used in a bias supply is very near the battery shelf life. Four 9-volt batteries purchased from the Dollar store worked just fine.

At this point in construction, no decision had been made as to what was going to drive the 807s. Digging in my tube supply, I found two 6L6Gs that had been overlooked when hunting for final tubes. They looked and tested good, so I decided to use one of those as an oscillator, keeping the other as a spare. Any conventional oscillator circuit would do just fine, but I really wanted to incorporate a bit of history in my rig. After looking through my QST file, it was decided to go with the well known "Economy Forty" circuit. Fred Sutter, W8QBK, really started something with his little "QSL Forty," a 6L6, 40-watt, transmitter built on a chassis so small it could sit on a QSL card. It even had a meter for the plate current. Then, in an effort to lower the price, Fred came out with his "Economy Forty," and eliminated the meter. (April 1939 QST, page 18)

This circuit appealed to me because it is simple, uses very few parts, and does the job. I especially like the idea of using a #46 pilot bulb as a tuning indicator. Just tune the oscillator for maximum brightness and the oscillator is tuned. In this transmitter, the #46 glows at about 50% brightness when the circuit is tuned to resonance.



Here are the constructional details at the rear of the transmitter. Notice the wooden chassis with metal bracing and the neat wiring harness.

Link coupling was used between the oscillator tank and final grid. My first capacitor in the final grid, an 80-pf midget variable was not large enough to load the oscillator. It was replaced it with a 140-pf capacitor; sufficient drive was obtained.

Have you ever tried to couple a push-pull amplifier, using a center link, to a dipole fed with coax? Well, it is about as practical as the proverbial windshield wiper on a duck's nose.

My intended antenna tuning panel was left blank, knowing that some experimenting might be necessary. A coupling circuit from the 1936 Frank C. Jones handbook was tried at first—a coil of the same inductance as my tank coil—link coupled to the final tank coil. Capacitors between each end of the antenna coil and the coax lead tuned the antenna. Of course, Mr. Jones was feeding a 600-ohm line into a dipole. I assume his antenna tuner worked—mine did not. The antenna could be loaded up to about 20 watts—30 watts short of my hopes and dreams.

The next step in my cut-and-try engineering was to bypass my antenna matching circuit and feed the link directly into a commercial transmatch. You know something, I never realized SWR could go that high! The two Johnson 200-pf capacitors used in my first attempt were reconnected in series with the coax and my transmatch. This showed some promise. I noted that both caps were at absolute maximum capacity for the best match and highest RF output. It don't take a genius to figure out more capacity is needed.

Out came the two brand new, bright and shiny Johnson capacitors. They were each replaced with ancient, tarnished and corroded two-gang capacitors. The old caps were long on capacity but short on appearance. With both sections tied together there was a maximum capacity of around 700 pF each. That did it. Now the SWR was 1:1 and my output was a steady 50 watts. I would simply have to live with the tarnished, junky-looking capacitors until something better could be found. They worked very well.

Now came my moment of truth. I flipped the B+ switch, called CQ for one minute and received a call from a W5 mobile in south Texas. My report was 599. I was concerned about chirps as they sometime show up when keying the oscillator. The OM assured me that none were present.

I had absolutely no idea of the final configuration of my rig when construction was started. More or less, the thing evolved as construction went along. After the power supplies were up and running and work started on the RF deck, I decided to key the oscillator only. I still use a Vibroplex Bug, and need a side tone when sending CW. My receiver would have to double as my sidetone source. Another decision was made to add a husky antenna changeover relay. Not that I really needed a husky relay. But as young people today would say, "Hey man, you know, it's like what I had in my junk box—know what I'm saying?" There was ample room for the relay on the antenna tuner panel.

I have included a schematic of the rig for those who might be interested. Everything in this rig is right out of the handbook, or past issues of QST. Even though you use conventional circuits you still have a few options especially in construction of the rack, chassis, and panels. I think the photographs pretty well show my construction. I could have stayed within my 1936 time frame and still used different materials such as hardboard for panels, and old bed railings for the rack.

Let's go back to the crystal oscillator. A standard octal socket was used for the crystal socket. The octal socket will hold two crystals. A SPDT switch was added in the crystal circuit. Now, there is a choice of two frequencies. The switch was mounted on the chassis because panel mounting would have upset my more-or-less symmetrical front panel arrangement.

The shields for the 807 tubes were made using simple material and tools—a pair of old scissors, a pop rivet tool and a bit of aluminum flashing material sold at all home supply stores.

I have tried to keep everything in the 1936 era, other than rectifiers. Initial tune-up was done with a 12-volt auto tail light bulb and a single loop of wire. With the HV disconnected, and the 6L6 driving the grids of the 807s to the maximum of my oscillator power—I detected no parasitics at all. I credit the parasitic suppressors in each 807 plate lead, plus ample-height tube shields with this happy state of affairs. No suppressors are used in the grid circuit.

Subsequent QSOs seem to confirm that the 1936 transmitter is doing great. Total outlay of cash to build this transmitter was slightly over ten bucks—plus a very well stocked junk box. One cannot be a ham for seventy years without accumulating a lot of parts. Would the set have worked better if it was carefully planned it? I don't know. Certainly it could have looked better, been more compact, and perhaps put out a few watts more. Would I have had more fun building? No way. The important thing is to keep trying and to enjoy what you are doing. That's what this whole hobby is about.

1. Halverson, Gary, K6GLH, "Martha's Breadboard Deluxe: Homebrewing in the 1930s, Part 1," Electric Radio #201, February 2006, and Part 2, in #202, March 2006.

ER

High Altitude Amateur Radio

By Rod Perala, W5CZ
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Indian Hills, CO 80454
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One of the most unwelcome sounds to come from one's power amplifier or RF deck is electrical arcing, which is sometimes followed by component damage. One scenario observed by the author and others is that equipment that did not have this problem at a low altitude has the problem when operated at a higher altitude.

The objective of this article is to describe the effects of altitude on high voltage arcing.

The voltage required to cause a discharge between two large planar electrodes is described by Paschen's Law[1] which shows that the arcing voltage depends only on the product Pd, where P is the air pressure and d is the distance between the electrodes.

For example, this means that if the voltage required to arc across a gap at standard air pressure is, in example, 1000 volts at sea level, then the voltage required at one-half this pressure is 500 volts.

Paschen's law also says, for example, that the voltage breakdown for a ¾-inch gap at standard air pressure is the same as that of a 1-½ inch gap at one–half of the pressure.

Paschen's Law usually assumes constant air temperature as a function of pressure. In reality, however, the law is more correctly stated in terms of air density, which depends upon both pressure and temperature.

Altitude effects for practical use therefore can be described in terms of the air density at various altitudes and is summarized in **Figures 1 and 2**. This table shows the relative air density as a function of altitude, normalized to sea level. The relative air density shown is based on a standard atmosphere that includes both pressure and temperature as a function of altitude above sea level.

As an example, if a piece of equipment would arc over at 1 kV at sea level, at

Altitude, feet	Relative Air Density
0	1.00
1,000	0.97
2,000	0.94
3,000	0.92
4,000	0.89
5,000	0.86
6,000	0.84
7,000	0.81
8,000	0.79
9,000	0.76
10,000	0.74
11,000	0.72
12,000	0.69
13,000	0.67
14,000	0.65
15,000	0.63
16,000	0.61
17,000	0.59
18,000	0.57
19,000	0.55
20,000	0.53

Figure 1: Altitude in feet vs. relative air density. The peak breakdown voltage expected should be multiplied by the relative air density above to arrive at the effective peak breakdown voltage. The air gap in inches needed to prevent arcing at sea level can be determined with Figure 2.

W5CZ (7,400 feet, with the relative density factor about 0.8) the arcing would occur at approximately 800 volts, a significant difference.

Paschen's law is usually presented for the case in which the two electrodes are large flat plates, so that the electric field between them is uniform. In reality, most arcs in RF decks etc. occur between relatively sharp electrodes such as fasteners, coils, and wires. In this case, the arcing voltage can be significantly less than that for planar electrodes, but the altitude effects are the same.

If one is confronted with such an arcing problem, there are some fixes available. First of all, one may be able to increase the distances between the arcing electrodes by moving some components, but this is often not possible with an existing configuration. Another possible fix is to apply RTV, silicone sealer, or corona dope to the offending electrodes.

USUAL BREAKDOWN RATINGS OF COMMON PLATE SPACINGS

Air-gap in inches	Peak voltage breakdown
.030	1000
.050	2000
.070	3000
.100	4000
.125	4500
.150	5200
.170	6000
.200	7500
.250	9000
.350	11,000
.500	15,000
.700	20,000

Recommended air-gap for use when no d-c voltage appears across plate tank capacitor (when plate circuit is shunt fed, or when the plate tank capacitor is insulated from ground).

D-C plate voltage	C-W	Plate mod.
400	.030	.050
600	.050	.070
750	.050	.084
1000	.070	.100
1250	.070	.144
1500	.078	.200
2000	.100	.250
2500	.175	.375
3000	.200	.500
3500	.250	.600

Spacings should be multiplied by 1.5 for same safety factor when d-c voltage appears across plate tank capacitor.

Figure 2: Chart of recommended air gaps for tuning condensers in power amplifiers at sea level. (From Bill Orr, W6SAI, editor, the 14th edition of the Radio Handbook, 1956)

Sometimes the arc involves surface tracking across dielectric surfaces, in which case a carbonized path has been created. This is much more difficult to solve, and may require replacement of the dielectric material.

More complex solutions include creating a pressure vessel around the offending region, and replacing the air with a gas such as sulfur hexafluoride (SF_6). Its gas molecules have an affinity for electrons, and therefore the gas has a much higher ionization potential than air does.

The interested reader can find out more about Paschen's Law and ionization potentials from the literature (e.g., Reference 1), and much information is available from the Internet.

References:

1. J. D. Cobine, "Gaseous Conductors, Theory and Engineering Applications," Dover Reprint, 1958.

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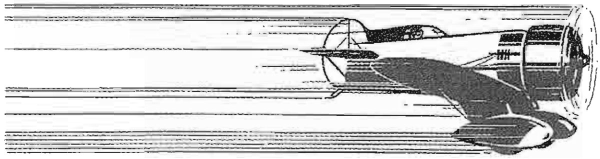
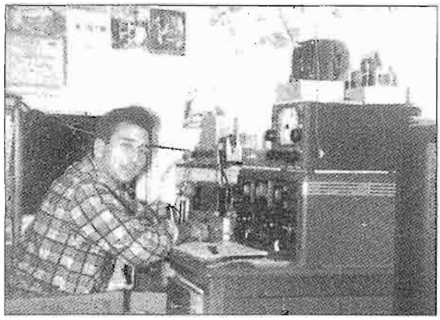
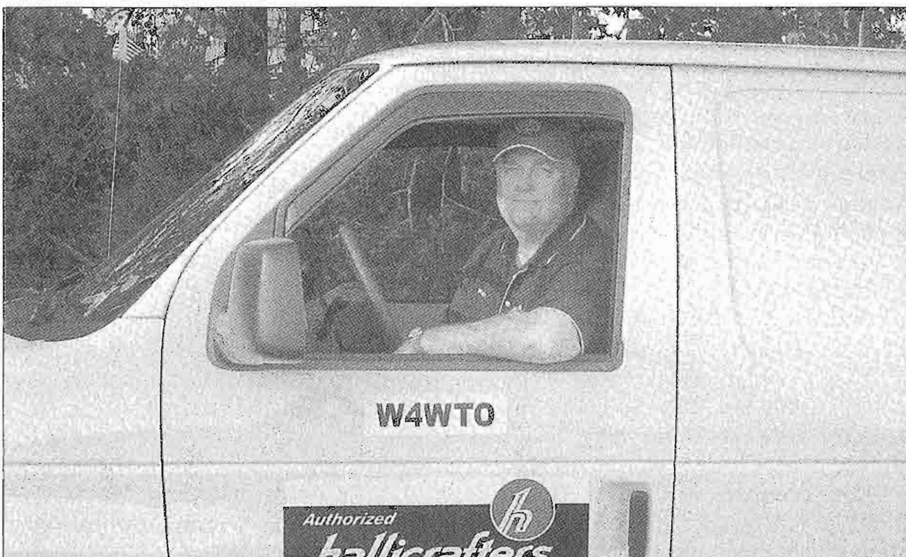
PHOTOS





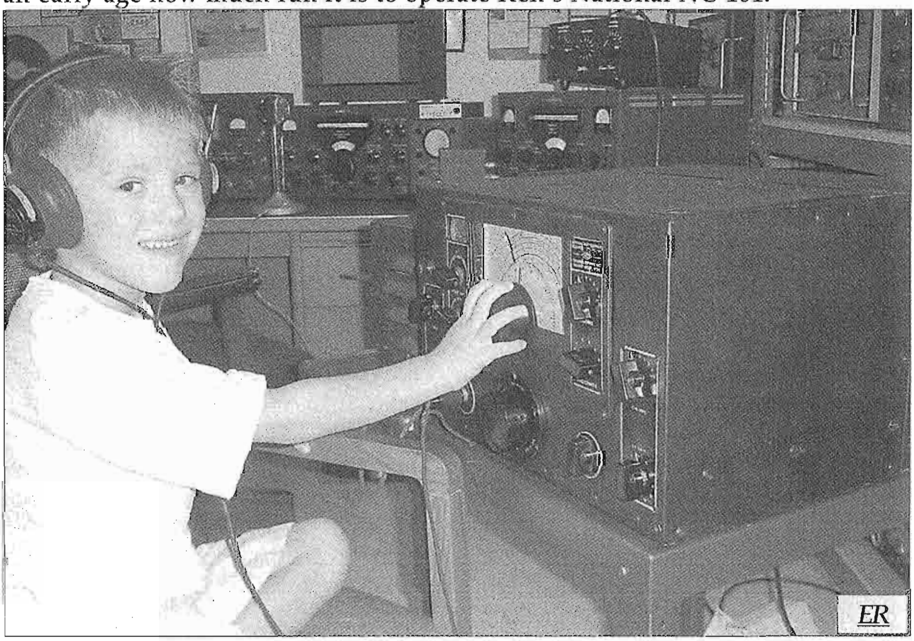


Bob Harmon (W4WTO), the author of this month's article on Hallicrafters' facilities in Chicago, has a van that is fitted with Hallicrafters service logo on the doors. This would surely attract attention at a hamfest!

To the left is John Tyson's (WØRQ) vintage shack that was fired up during one vintage event earlier this year. Notice the glowing PL-175A filaments in his Johnson Viking Thunderbolt amplifier in the right foreground!

Page 44, top left column: This photo shows ER author Tom Marcellino's (W3BYM) first ham station about 1955. The TX was a 6AG7 xtal oscillator and 6L6 final. The RX was a Hallicrafters S-39 AC-DC set that he paid 10 bucks for in the early 1950s. (The kid at the controls is Tom's younger cousin.) In the right column is Tom in his second shack during 1957 while in high school. This was his 6-meter AM station. The RX was a Hallicrafters SX-28 tuning the broadcast band with an International Crystal down converter ahead of it. The transmitter was another HB with a 6146 in the final, modulated by two 1625s and was also crystal controlled. He still had the S-39! The window to his left was access to a hand-rotated, two-element beam.

Below: Jack Blevins is Ken Pfister's (WØHRO) grandson, and Jack is learning at an early age how much fun it is to operate Ken's National NC-101.



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

FOR SALE: DRAKE TR-7/TR-7A/R-7/R-7A service kit. Includes 13 extender boards and digital jumper card. $63.85 includes postage. See http://pweb.amerion.com/~w7avk, Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net 509-766-7277.

FOR SALE/TRADE: Manuals: Collins, National, Hammarlund, Drake, B&W, Johnson, Multi-Elmac, WRL, Hallicrafters, Gonset, Swan. NI4Q, POB 690098, Orlando, F1 32869 407-351-5536 ni4q@juno.com

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

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

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

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

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

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

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

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

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

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

FOR SALE: Tubes tested good globe 224 $6, 226 $8, 227 $9. Write or e-mail: tubes@qwestnet for price lists or see www.fathauer.com. Slightly weak tubes guaranteed to work in early radios 1/2 regular price. George H. Fathauer & Assoc., 123 N. Centennial Way, Ste. 105, Mesa, AZ 85201. 480-968-7686 or toll free 877-307-1414

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

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

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

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

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

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

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

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

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

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

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

WANTED: Echophone Comm., Mod EC-3 parts set or a good one. Ed Allison, 5525 20th Ave, Sacramento, CA 05820 916-454-1788

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

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WANTED: Power supply for Navy receiver RBM 4-5. Should be CAY20086. George, AC7YF, 928-289-3461

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

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

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WANTED: Tuning/band change knob for Collins R-388/51J-3; Top dust cover, bottom cover & ID tags or scans of same to make dupes. Ward Kremer, KI4 JHA, 1179 Petunia Rd., Newport, TN 37821, Ph/fax: 423-625-1994, Email: witzend99@bellsouth.net

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WANTED: Need two Westinghouse RT35 0-1 RF amps, 3-1/2" round Steve Bartkowski, 1-708-430-5080

WANTED: Holtzer-Cabot Megger model ZM-14A/PSM-2 in good condition, please contact Mike at: mike46@shaw.ca

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WANTED: Collins mechanical filter P/N 526-8636-010, please email Mike, VE7MMH, at: mike46@shaw.ca

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WANTED: 60 cycle frequency meter for monitoring single phase power generator. J.I. Lillie, POB 128, Onondaga, MI 49264, 517-628-3531 BEFORE 9PM Eastern.

WANTED: Spinner knob as used on some RBL receivers or similar. Ideally 2-1/4 to 2 3/4" max diameter at skirt, stubby spinner. February 1996 73 magazine, complete issue. JeRB, K8WPI. 269-226-8873: oldbugger@earthlink.net

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WANTED: EICO 460 oscilloscope parts set or power transformer and 5UP1 CRT. Jeremy Punsalan, KH7CN, 1509 Komohana St., Hilo, HI 96720, 808-756-5702, punsalan@hawaii.edu

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WANTED: I am looking for one large black binding post cap that fits a Clapp-Eastham Ferron crystal detector. It's black, 11/16 diameter, with an arched top and knurled edges. The thread is 10-32. Thanks. Craig, W6ADV, cpitcher@verizon.net 408-307-4255

WANTED: Manual for SECO model GCT-5 tube tester. Ed, KE7DOL, 3575 SW 86th Ave, Portland, OR 97225, 503-292-0612

WANTED: Hallicrafters SR500 console, any condition considered. Eddie Hatcher, KV5I, 2618 Heatherwood, Dallas, TX 75228 eh54@sbcglobal.net 214-320-5835

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WANTED: Schematic and/or service info for Panoramic Indicator Model IP-835/ MLQ-29, Serial #6, mfg by American Electronic Laboratories, Inc. Alan McChesney, n2zhs@arrl.net, 518-382-3204

WANTED: CQ Magazine, May and June 1945 to complete my collection. Lynn Stolz, N8AJ, 614-885-5428 n8aj@yahoo.com

WANTED: Dial Pointer for Zenith Transoceanic G500. Patrick Marineau, K9HF, 3188 Bates Rd., Madison, OH 44057 wa9sui@mybluelight.com

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

WANTED: Hallicrafters R-42 Speaker and a Mon-Key Electronic Keyer from the early 1950s. Please call me at 858- 560-8989, or email dickmorris39@earthlink.net

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

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

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WANTED: Subminiature vacuum tubes or old equipment utilizing them, any condition, for personal collection. Johnny Umphress, 1415 Moore Terrace, Arlington, TX 76010, 817-915-4706, www.jgumphress@yahoo.com

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

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

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

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

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

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

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

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

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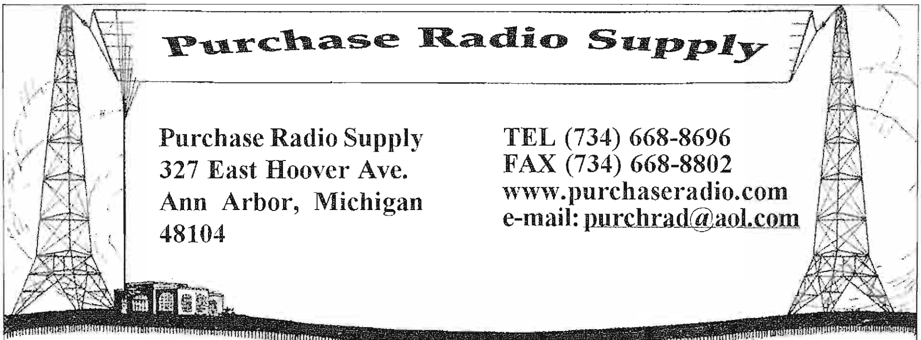
WANTED: National NTE-30 Transmitter. Any condition, any price! I love National. Sylvia Thompson, n1vj@hotmail.com 33 Lawton Foster Rd., Hopkinton, RI 02833. 401-377-4912.



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

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

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

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

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

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

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

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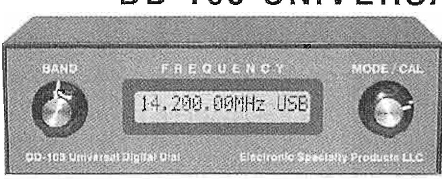

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WANTED: Searching for RME CT-100 or 3R9 xmtrs and info about them. David Edsall, W1TDD, 156 Sunset Ave., Amherst, MA 01002. 413-549-0349, dedsall@crocker.com

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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: 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: 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

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

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

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

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

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

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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

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

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

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

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

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

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

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

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

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

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

WANTED: Radio correspondence course lessons by National Radio Institute (NRI) of Washington, DC. George Reese, 380 9th St., Tracy, MN 56175, 507-629-4831

WANTED: Circa 1963 (?) issue of Electronics Illustrated magazine concerned with Command receiver control center. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

PARTING OUT: Collins 32V-2. Contact me for your needs. Cliff, N6ZU, 209-477-1235.

WANTED: Veeder-Root counter assembly P/N 15148 from the T-368 exciter unit. My counter has a broken gear. Please call Ray, NØDMS at ER, 720-924-0171 or Ray@ERmag.com

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WANTED: Parts for SCR-178: Insulator IN-85, GN-37 generator, LM-18, side mounts for IN-85. Robert Forte, rvforte@frontiernet.net 518-696-2400

RESTORATION HELP NEEDED: Can anyone give me suggestions or the name of someone who can restore a raised letter brass nameplate? I am trying to restore a rusty brown color nameplate on a BC-14A WWI crystal set back to its original brass letters against a black background. Thanks for any suggestions. Craig, W6ADV, cpitcher@verizon.net

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WANTED: R 390, R 390A and R 392 receivers dead or alive or parts/ assemblies. Any condition considered. Will pickup if you have enough items. Glenn, WA4AOS, 864-684-2956

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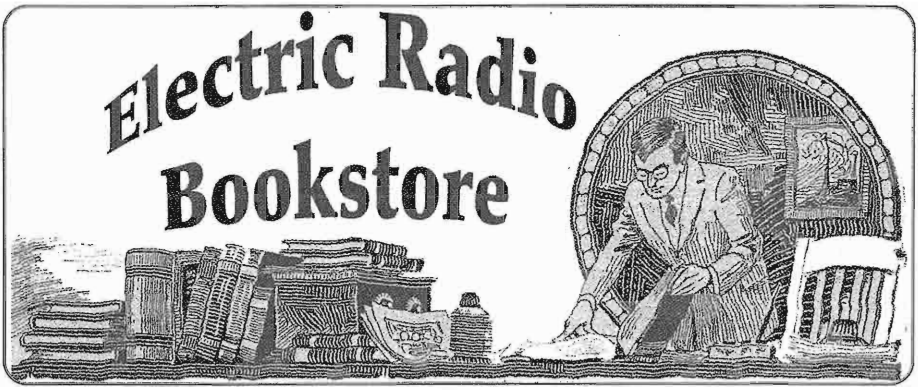

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Collins S-Line, KWM-1, KWM-2, KWM-2A Service Modification Compendium: 260 pages, $45.00 plus $6.00 S&H.

Collins KWS-1, 32V series, and 75A series (A1 thru A-3): 43 pages, $15.00 plus $5.00 S&H

— BOOKS —

A. Atwater Kent, The Man, the Manufacturer and His Radios: This 108 page paperbound book describes Atwater Kent's biography, and his rise from a saleman and inventor of electrical equipment to become one of America's foremost radio manufacturers and a household name. There are historic photographs and diagrams on nearly every page, and color plates with vintage AK advertising, by Ralph Williams and John P. Wolkonowic. -- **$25.95 - 10% = $23.35**

A Pictorial History of Collins Amateur Radio Products: Jay Miller's (KK5IM) classic volume describes the amateur radio products produced by the Collins Radio Company. It has high-quality historic photographs on nearly every page, and the text is backed up by Miller's personal research. --**$39.95 - 10% = $35.95**

A Family Affair, The R.L. Drake Story: The complete story of the R.L. Drake story, as told by John Loughmiller, KB9AT. 273 pages all about the history of the company, product descriptions, technical repair tips, and great shack photos make a must-have volume for Drake users and collectors. -- **29.95-10% = $26.95**

Arthur Collins, Radio Wizard: 394 pages by Ben Stearns tell Arthur Collins biography from his early years until retirement. Stearns is a professional journalist and was employed by Collins from 1962 to 1977. Many historic photographs and stories from former employees.
-- **$18.95-10% = $17.05**

Collector's Guide to Antique Radios, by John Slusser. The 6th edition in 320 pages with hundreds of photos and descriptions of long-gone companies and products from 1920 to 1950.
---**$24.70 - 10% = $22.45**

Communications Receivers, The Vacuum Tube Era: 1932-1981: This is the classic136 page volume that has much invaluable information about vintage receivers in one handy volume. By Raymond S. Moore, 4th edition -- **$19.95-10% = $17.95**

Crystal Clear: Crystal Sets, Crystal Detectors and Crystals: A 282 page guide to crystal sets and related US-made equipment from 1920 to 1955, by Maurice Siever---**$29.95 - 10% = $26.95**

Early Development of Radio in Canada: 154 pages of Canadian radio history by Robert Murray, excellent illustrations on nearly every page covering the early wireless days and the start of radio broadcasting and manufacturing! --$26.95 - 10% = $24.25

Heathkit, A Guide to Amateur Radio Products: This is the new revised second edition including some 30 additional products, a tube chart, sales data, a separate ER article index, a completely new introduction, and a new section devoted to Heath's CB equipment. The book is 75 pages larger than the original. By Chuck Penson, WA7ZZW--$29.95-10% = $26.95

Heath Nostalgia: Written by Terry Perdue, K8TP, an ex-Heath employee, this 124-page book is a great history of Heath and the Heathkits that we all remember. ------ **$14.95-10% = $13.45**

SPECIAL DEAL! Heath Nostalgia *and* Heathkit, The Early Years CD both by Terry Perdue--**$27.00**

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Hiram Percy Maxim: Published by Electric Radio, this is the complete biography of HPM, the famous founder of ARRL, by Alice Clink Schumacher, 216 pages. ----- **$19.95-10% = $17.95**

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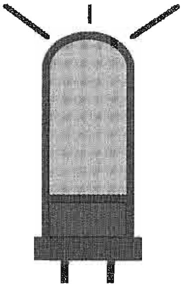

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