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ELECTRIC RADIO

celebrating a bygone era

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Marvin Hatch, KØLZW

ELECTRIC RADIO

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Editor - Barry R. Wiseman, N6CSW
Office Manager - Shirley A. Wiseman

Electric Radio is published primarily for those who appreciate vintage gear and those who are interested in the history of radio. It is hoped that the magazine will provide inspiration and encouragement to collectors, restorers and builders.

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

Regular contributors include:

Bill Breshears, WC3K; Bob Dennison, W2HBE; Dale Gagnon, KW1I; Bob Grinder, K7AK; Jim Hanlon, W8KGI; Brian Harris, WA5UEK; Tom Marcellino, W3BYM; Ray Osterwald, NØDMS; Chuck Teeters, W4MEW; Bruce Vaughan, NR5Q.

EDITOR'S COMMENTS Barry Wiseman, N6CSW/Ø

As my fifteen year old daughter would say,"What a bummer". I'm referring to the FCC decision denying all three AM power petitions. I feel extemely disappointed. For the details on the recent FCC order read KW1I's report on page 3.

The latest development at ER is our entry into the 'book selling business',"The First Fifty Years: A History of the Collins Radio Company". (See our half page ad in the classifieds.) This all came about as a result of my trying to buy the book after having first seen it last year. When I first saw the book - Bill Stewart, K6HV, had loaned me his copy - I was mightily impressed. Like anything Collins' it is first class. I called Rockwell Collins and they told me they did not have any for sale and they had no plans to reprint the book. They also told me that they received inquiries regarding the book almost daily. It then occurred to me that I might approach Collins with a request to reprint the book. That didn't get anywhere. At about this time Jerry Brouwer, AB8U, entered the picture. He is behind Vista Technology Incorporated. He had been successful in acquiring the rights to reprint Collins' manuals so I told him about the potential I thought the book had. He agreed with me and approached Collins. To make a long story short we did not get permission to reprint the book but - perhaps as a result of our interest - Collins decided to reprint the book themselves and agreed to sell us 600 copies for resale. Their interest in re-printing the book is to use it for promotion - to their best customers and so on. They will be selling 200 copies to their employees but they do not have any for sale to the general public. So if you're interested in acquiring this 'classic' book check out our ad in the classifieds for the details. I should add that it is very unlikely that Collins will reprint this book again at any time in the future. I think that the 600 copies that we have represents the last supply of the book that will be available for some time. On to #20....

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Cover: Remember Homer Hatch, 9AHO, on last month's cover? Well, this is his son, Marvin, KØLZW. This photo was taken in 1958 when Marvin was 15. One thing that is interesting to note is that the meters used on this transmitter were salvaged from the transmitter shown on last months cover that his father built around 1930. For the "rest of the story"see page.17.

Reflections Down the Feedline

by Fred Huntley, W6RNC
POB 478
Nevada City, CA 95959

Every ham's first QSO is a memorable occasion, and for many, a thrill of a lifetime. For many of these budding Marconi's and Tesla's it was the start of something big – a lifetime career in communications and electronics.

In the 1950s, Charlie Short, an ex-ham, wrote some poems about his experiences as a seagoing commercial radio operator. His first trip aboard ship was during the early '30s. His misadventures should cause a lot of us to think back on our own first on-the-air effort at radio communications. Undoubtedly, many of these experiences would be of interest to us all - so write it up and submit it to ER. Maybe a combined article can be made out of a bunch of them.

Here are some explanations so that you will understand the whole poem: Para. 1 "Charlie Koster" was the "RI" (radio inspector) in Boston, Mass. for the FRC (predecessor of the FCC). Para. 2 "Yellow Sheet" was a commercial radiotelegraph operator's license. "Sarnoff" was David Sarnoff, president of RCA who started out as a wireless operator. Para. 3 "Eastern Crown" was the name of a cargo ship of the Sword Line. Para. 6 "BF" stands for marine coastal radiotelegraph station WBF of Hingham, Mass. "QRP" means reduce power.

Starting Out (by Charlie Short)

I had a brand new license
Which was won in Boston,Mass.,
On a test by Charlie Kolster,
And it was second class.

I thought I was a big shot,
Once I had this yellow sheet:
Soon I'd be as good as Sarnoff,
Passing up all those I'd meet.

The "Eastern Crown" I boarded,
From Japan fresh-built was she.
She had a spark transmitter
That was just ideal for me.

We're leaving Boston harbor,
And I'm feeling proud as any,
When they handed me the traffic,
Though the words there were not many.

This quenched gap spark would do it,
And 'twas working way up high,
When I started in a – sending,
Why! It almost lit the sky.

BF advised me Q R P
Which means "more power" -- no?
And so in goes another gap,
Oh! Man! Look at her go!

The F R C soon ordered me
To come in on the "mat"
And wished to know just what in hell
Had caused me to do that

For I was in the harbor,
And did not at once deduce,
When B F said Q R P
It meant I should reduce.

I argued with those five men
Until I was very tired,
The outcome? You've guessed it –
Discharged was I – yes – fired!

The moral of this story
Is – to never use high power,
Especially in the harbor,
Or your future will turn sour.

AM Power Issue Update

by Dale Gagnon, KW1I
9 Dean Ave.
Bow, NH 03304

FCC releases order denying AM petitions

On October 31, 1990, an order was released by Ralph Haller, Chief, Private Radio Bureau, denying all four of the AM petitions on file. The order noted that more than 820 comments had been received (generally) opposed to RM-7401, the petition proposing the elimination of AM and supportive of RM-7402-04, which petitioned for higher power levels of AM transmitters.

The bright side of this order is a very clear statement by the commission in support of AM."Deleting AM as an authorized emission still is inconsistent with the basis and purpose of the amateur service and our desire to offer amateur operators the opportunity to experiment with practically every conceivable type of emissions."

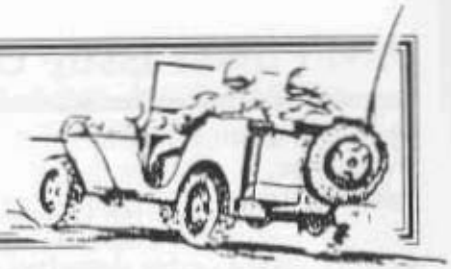
The order misrepresented the other three petitions in it's introductory paragraph by referring to them "seeking to promote AM by allowing amateur stations transmitting AM a maximum output two to four times greater than the power allowed stations transmitting any other emission type". In it's rational for denial the Commission included the following cryptic statement,"The petitions do not persuade us that there is sufficient justification to raise the power limit, as AM emissions continue to be an authorized form of amateur emissions." The order rejects the arguments for a separate power standard as the same arguments considered and denied previously and sites the Baxter versus the FCC court of appeals decision as affirming their rejection. The order also states," The petitioners have presented no reasons for us to revisit this matter, further, the petitioners have not shown that interest in AM operation today significantly exceeds the commissions 1983 estimate of the interest in AM or that the exploration of the higher power authorization to AM stations is having an unanticipated effect on these stations".

In summary the order states," For the above reasons the amendments requested by the petitioners would provide no significant benefits for the amateur service or the public and are not warranted".

I have included the above quotes to give a sense of the lack of concern and sensitivity, the lack of understanding and the arrogance of our regulators in Washington. The decision taken by the commission is no doubt in complete accordance with the administrative rulemaking procedures. It demonstrates how this government agency has lost touch with it's purpose of serving the citizenry and serves only it's own bureaucratic process. The order is being studied now to determine the feasibility of a petition for reconsideration for RM-7404 and whether there are any possibilities for legal action. Reactions have not been received from SPAM headquarters or the ARRL on their petition denials.

Thanks again to all those who sent in comments. It was very gratifying to see the AM community rally together. Next month we'll have more reactions on the petitions and recommendations for further action.

ELECTRIC RADIO IN UNIFORM



by Walt Hutchens, KJ4KV
3123 N. Military Rd.
Arlington, VA 22207

'The BC-222'

Phew. Another Saturday inspection finished, another hot dusty day begun. But that's the way summer is, in Kansas. Too bad you won't get a pass to go into town tonight... You'll be scrubbing those leggings with scouring powder to get out the dust your sergeant found on the laces and around the hooks. Then you'll start on your radio... he also found dust behind the tubes and inside the coils and front cover.

The Army's not always fun, but in 1938, you're glad to have a job -- there are still a lot of guys out of work, and a lot more who are digging ditches for the Works Progress Administration. But you've been lucky. On the strength of your ham ticket and top grades in high school, you got into the Signal Corps; now you're working with modern UHF equipment -- imagine radio frequencies over fifty megacycles! -- and in four years when you get out, you'll be all set for a well-paying job...

Your "modern UHF equipment" is the BC-222 portable transceiver, and it is the subject of this month's tour. It's hard to think of such a simple radio as a milestone, but it introduced the U.S. military to:

1. Operation above 20 Mcs
2. The transceiver
3. Single-knob control of both receive and transmit frequency, and
4. The 'walky-talky' concept; that is, two-way radio which can be carried by the operator while in use.

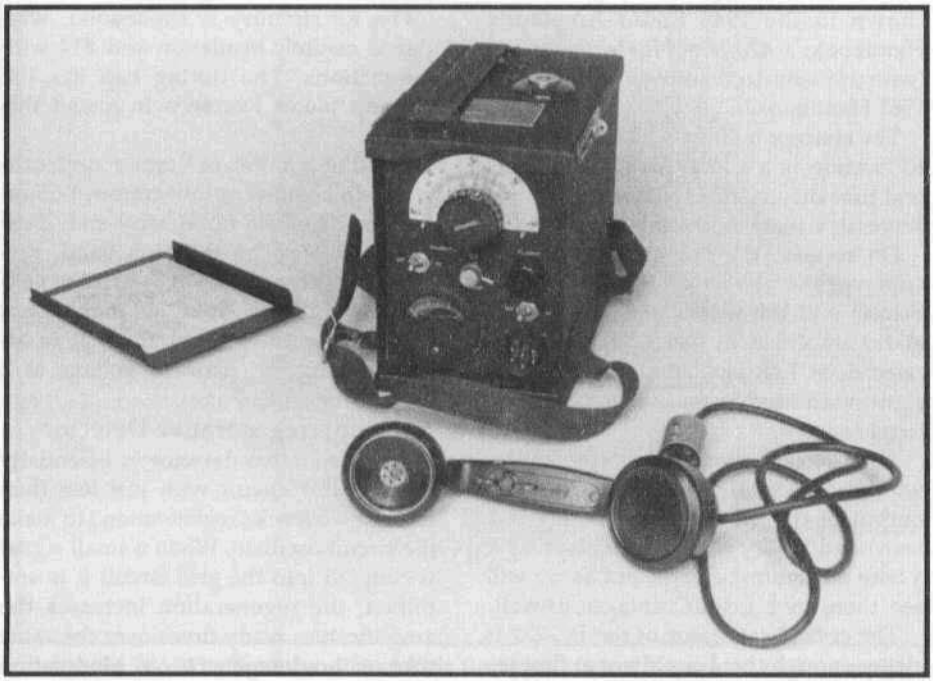
Because of the press of other activity this month, I have not been able to 'fire up' my set, but there's a lot to see even so.

Overview

The BC-222 is a two tube transceiver covering the frequency range 28 to 52 Mcs in two bands by means of plug-in coils. It is 8" x 6" x 9" (H x W x D) and weighs 9 pounds; the battery, antenna, and handset would add about 15 pounds to that. The dial is directly calibrated in channels 1-25 on the low band and 25-60 on the high band; the channel interval is 400 kcs. There's a built-in crystal calibrator. A multi-section whip antenna screws into an insulator on the top of the case and a handset plugs into the front panel.

History

I have no source for the history of the BC-222. According to the nameplate, the set was designed by the Signal Corps Laboratories at Fort Monmouth, New Jersey. An almost identical circuit (even the same tubes) appears in the July, 1931 QST and is reproduced in the 1932 Radio Amateur's Handbook, so the electrical design must have been finished at about that time. Military radio collector Hugh Miller says that he has seen the BC-222 mentioned in U.S. Army records dated 1936. My set is s/n 8 of an early 1941 contract.



The BC-222 and handset. The nickel plated knob just below the tuning dial is used to calibrate the set at a crystal check point. There's a schematic inside the front panel cover.

Hugh Miller says that he (like me) had assumed that the BC-222 never left the U.S. during the war, but then he noticed that the picture on the back cover of the Time-Life Books volume on the Italian Campaign shows one in the canvas carrying bag. Any such use was certainly limited, as no other Army radio of that time could operate at these frequencies. The U.S. Navy had sets in this frequency range (the TBY, see E.R. for February, 1990, and the TBS) so there's some chance that the BC-222 could have been the shore end of a Navy-Army communication link for control of naval gunfire support. For reasons we'll see below, however, it would not have been very satisfactory for this job.

The BC-222 was used mainly in training and (perhaps) other non-combat roles. 5000 units seems a reasonable guess at production. After the war, they were dumped into the surplus market where -- although modulated oscillators had been banned below two meters -- they saw considerable ham service on ten meters. Hugh Miller knows of two contacts involving BC-222's at ranges of over 1000 miles (one was San Francisco to Ft. Monmouth, the other, Chicago to Mexico) and the gentleman from whom I got my set reported making "hundreds of (illegal) contacts" with it.

Design

The circuit of the BC-222 is the classic two-tube transceiver used by hams to open every band from 20 Mcs to at least 420 Mcs. The 1931 QST circuit is the earliest I have found. During the war, versions operating on 2-1/2 meters were used by the War Emergency Radio Service -- the Civil Defense radio system of the time. One 2-1/2 meter WERS design (a handy talky using miniature tubes) is

continued next page

shown in the 1945 Radio Amateur's Handbook; a 420 Mcs Nuvistor version (with transistorized audio) appears in the 1967 Handbook.

The concept is simple. The transmitter RF section is a triode oscillator. A second tube driven directly by a carbon mic serves as a plate modulator.

On receive, the oscillator becomes a superregenerative detector (discussed below) and the modulator becomes an audio amplifier. In the BC-222 a 3 pole relay does T/R switching, but ham designs often used just a two or three pole toggle switch.

This design gives you a transmitter with up to a watt or two of output (the output of the BC-222 might be about 1 watt) and a very sensitive receiver with a bare minimum of parts, but as we will see, there are big disadvantages, as well.

The crystal calibrator of the BC-222 is clever enough that I could not at first see how it works. It consists of a 3.5 Mcs crystal connected to a small rod next to the antenna circuit; the calibrator is 'on' when the crystal is shorted (for low frequencies) by a switch on the panel. It appears that the secret is that the rod picks up harmonics of the quench frequency (around 30 kcs) and these shock-excite the crystal which radiates a 3.5 Mcs signal; harmonics of this frequency are the calibration points. When the switch 'shorts' the crystal, it completes the 3.5 Mcs circuit.

The mechanical design of the BC-222 is a study in itself. It's a 'lunchbox' configuration, with a hinged top cover which gives access to the tubes, crystal, and coil. A removable front panel cover is secured by a snap slide. The battery is held on the bottom of the set by woven straps; it connects through a five pin plug.

To change bands you open the top, disconnect the antenna lead from a binding post, and pull the coil up off of three banana pins; the coil which is not in use mounts in a clip inside the case.

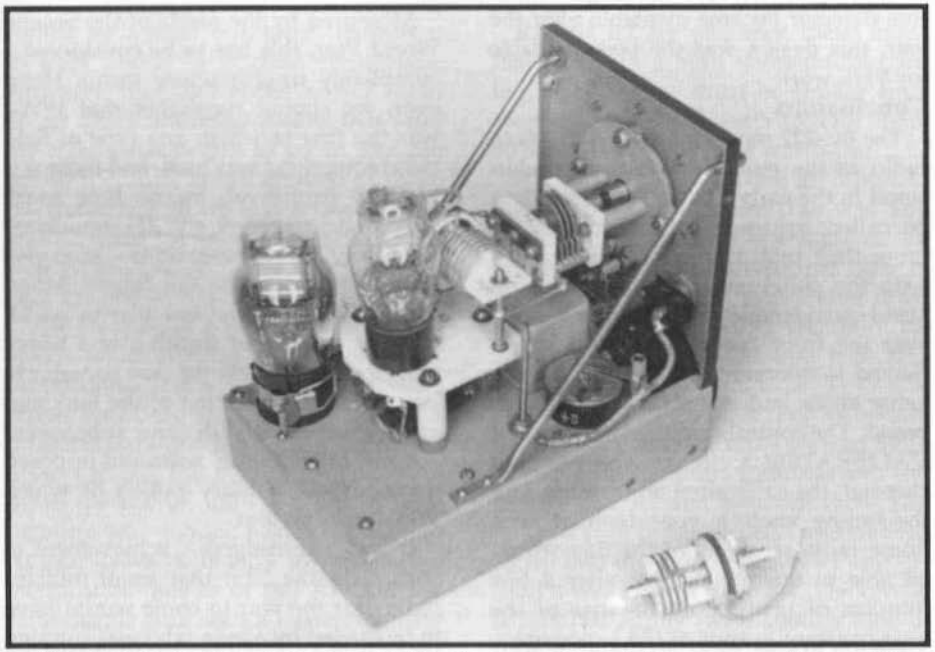
The RF circuitry is super-solid, with glazed ceramic insulation and #14 wire connections. The tuning cap has the heaviest plates I've seen in a unit this size.

The dial is a 'Velvet Vernier' unit, calibrated in channel numbers from 1-25 on the low band (28 to 38 Mcs) and 25-60 (38 to 52 Mcs) on the high band. Red marks indicate points at which the calibration signal should be picked up. There's a voltmeter and rheostat to allow keeping the filament voltage at 2 volts as the battery ages.

The Superregenerative Detector

A regenerative detector is essentially an oscillator circuit with just less than enough feedback ('regeneration') to make the circuit oscillate. When a small signal is coupled into the grid circuit it is amplified; the regeneration increases the amplification many times over the same tube without regeneration. Modulation can be coupled out of the plate circuit, usually by a transformer. Advantages are sensitivity and relatively good selectivity, since the effective 'Q' of the tuned circuit is increased by the regeneration.

It is difficult to keep a regenerative detector 'right on the edge' of oscillation where the best sensitivity occurs. If, however, feedback is increased until oscillation starts but the tube is somehow turned off before oscillations build up very far -- then the tube is turned on again -- (and so on) at a supersonic frequency, you have a superregenerative detector. The process of turning the tube off is called 'quenching' and the frequency at which it is done -- usually 30 kcs to 200 kcs -- is the 'quench frequency'. If the detector uses a large enough grid leak to allow building up cut-off grid bias when oscillation starts, the circuit is called 'self quenching'; this is the scheme used in the BC-222 and most other simple sets. More complex sets sometimes have a separate quench oscillator.



Inside the BC-222. The tube at the left is the type 30 modulator and audio amplifier, the other is the type 33 oscillator/detector. The calibration crystal is on the chassis at the right and is serial numbered to match the set.

Adjustment of a 'superregen' is not critical and sensitivity is amazing -- with headphones in the plate circuit you may be able to hear the thermal noise in the input tuned circuit. In addition, the circuit gives nearly the same output over a wide range of inputs -- in effect it has 'built in' AVC. Sensitivity to very short noise spikes is low, so there is also a 'noise limiter' effect.

The biggest disadvantage is that the circuit is effectively a pulsed oscillator. If the detector is connected right to the antenna (as in the BC-222) there's enough radiation to cause interference to nearby receivers (or for a military radio, to be picked up by a nearby foe) over a bandwidth several times the quench frequency. (The British No. 19 tank radio contains a superregenerative VHF set for communication among the tanks of a platoon; there is an elaborate drill for adjusting the quench frequencies of the sets so the mutual interference is tolerable!)

Radiation can be greatly reduced by placing an amplifier stage ahead of the detector as was done in the TBY. Even so, you can not operate two superregens on nearly the same frequency from the same location -- a real problem for a military radio.

Because of its sensitivity, simplicity, and ease of adjustment, the superregen dominated amateur VHF work throughout the 30's. The bandwidth of the input tuned circuit must be at least a few times the quench frequency so this detector can't be used much below 20 Mcs and can not (by itself) provide modern voice channel bandwidths -- 3 to 10 kcs. One popular receiver design converted the input signal down to a low IF frequency -- say 1500 kcs -- to get good selectivity and then converted it back up to a detector frequency of 20 Mcs or more. Until the high frequency remote cut-off tubes needed to build a good VHF superhetrodyne without an extremely sensi-

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ER in Uniform from previous page
tive detector became available after the war, this design was the best available for VHF work.

Conclusions

The BC-222 represents U.S. Army field radio as the requirements were understood in the early 1930's. The case might be called drip-proof, but certainly no more than that. It's solidly built and – with the panel covered – would withstand considerable knocking about; however the front cover plate must be removed to operate the radio and the Bakelite knobs and meter face are then exposed. The controls are the ON-OFF and CALIBRATOR switches, the filament rheostat, the calibration adjustment, and the tuning knob; anyone familiar with home radio receivers of the day would be able to operate this set after a few minutes of instruction. Because of the near-constant output of the superregenerative detector, no volume control is needed.

The BC-222's simple electronic design leads to a number of problems. In addition to the radiation and wide bandwidth of the superregenerative detector, there are the problems of a modulated L-C oscillator: at these frequencies considerable drift will occur with changes in temperature, and because the operating conditions of the oscillator vary greatly over the modulation cycle, FM is severe. (In fact, few modern receivers have enough bandwidth to copy a modulated oscillator set!) Since the operating conditions change when the RF tube is switched from oscillator to detector, the receive and transmit frequencies are slightly different – in effect, you don't get all the sensitivity of which the detector itself is capable.

Under field conditions, the range of the BC-222 might be a mile or more from hilltop to hilltop, a few hundred yards in any sort of cover, and (like the TBY) near-nill among wet leaves due to severe detuning of the set.

Measured by the needs of the Second World War, this has to be considered a completely unsatisfactory radio. However, we should remember that WW-I was the first in which any type of field radio equipment was used, and those sets were so primitive --buzzer-type spark sets, crystal receivers, and 211 modulated oscillator/TRF receiver units – as to give little useful data for the future. Moreover, WW-I was the last war in which (mainly because of trenches and heavy machine guns), 'defense' was superior to 'offense'. The perfection of the tank and airplane made WW-II (and subsequent actions) into 'offense' wars and imposed demands on military radios of which WW-I gave no hint.

It was a considerable achievement to realize (in the 30's) that small military radios for the war to come would have to be carried by a man who was running and used without 'setup'. The next step would have been to realize that a running man can't protect his gear from rain and mud or keep away from wet leaves, but that was not to come until another 389 BC-numbers had gone by. The resulting radio is so innovative that it is patented – yep, the whole design, as well as the many ideas needed to make it work. We'll take a look in a future column...

Crystals In The Oven

Even quartz crystals change frequency with temperature; from at least the 1930's, large crystal controlled commercial and military radios often had a thermostatically controlled 'oven' to hold the crystal(s) at a constant temperature. In the late 40's as ever-higher frequencies and narrower channels made stability a problem for even smaller sets, crystals mounted in small plug-in ovens were part of the solution.

The 500 kcs and 250 kcs oscillators in the ARC-38 (E.R., October 1990) use crystals mounted in small plug-in ovens which have a 10 watt heater element con-

trolled by a fixed bimetallic thermostat to hold about 75 degrees centigrade. However, this high heater power (used to get quick warmup) means that after the thermostat begins to go on and off, the temperature varies enough to make the frequency go up and down by several hundred cycles at 15 meters. That's well within the ARC-38's specs, but for ham use one would like to do better.

The solution is a temperature control system which supplies an amount of heat proportional to the difference between actual and desired temperatures. As a proportional oven warms up, the heater doesn't go off, but instead gradually reduces the power, until at the final temperature only enough heat is supplied to replace losses. It is easy to replace the thermostatic heater of the ARC-38 500 kc oscillator with such a heater; the new circuit fits in the old oven without external changes and requires only about $6 worth of Radio Shack parts. This change could also be applied to the calibration crystals in the R-392 and similar sets and it probably could be adapted to greatly improve many of the cheaper frequency counters which don't have temperature controlled time base oscillators.

R1 and R2 are one watt metal oxide resistors with a high temperature coating; substitutions must be similar since they handle about 8 watts each for about 30 seconds at the start of warm-up.

R1, R2, RT1, and Q1 are all mounted on a copper plate about the size and thickness of a quarter – I soldered together two layers of the copper plate in the original heater. Q1 is mounted at the center of the plate using standard T0-220 insulating hardware and heat sink compound (R.S. # 276-1373); R1 is pressed against the plate near its bottom edge and R2, near the top. I worked blobs of heat sink compound around and under R1 and R2 and between them and Q1; and then connected RT1 and pushed its tip into the glop between R1 and Q1 until it was against the plate. The crystal is clamped firmly (with another blob of compound) to the other side of the plate.

Q1 is an FET and does not conduct until the gate electrode is about four volts positive with respect to the source. A few more volts of gate bias makes Q1 effectively a closed switch.

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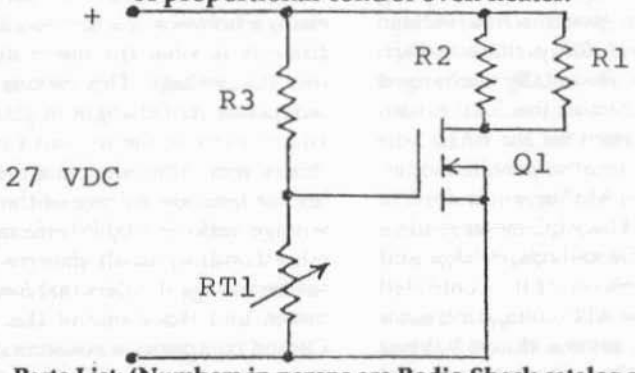
A proportional control oven heater.



Parts List: (Numbers in parens are Radio Shack catalog nos.)

R1, R2 - 100 ohm 1 watt metal film w/high temp coating (271-152)
R3 - 13k 1/4 W
RT1 - Thermistor (271-110)
Q1 - IRF511 FET (276-2072)

IMPROVING THE COLLINS 32S-1

by Bill Kleronomos, KDØHG
POB 1456
Lyons, CO 80540

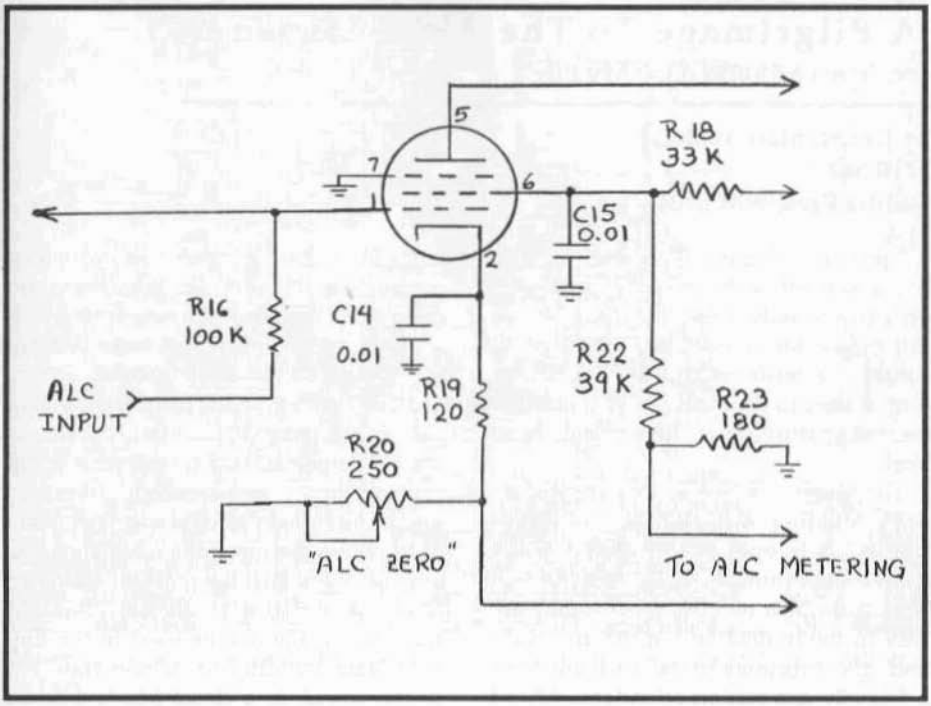
To a hard core tinkerer like myself, one of the joys of using older equipment is that one can occasionally spot a problem overlooked by the designers that allows - in fact almost cries out-to be fixed by the resident household technical genius. The first S-Line transmitter, the 32S-1, has one such problem that I found quite annoying during extended periods of operation. It seemed that I could not keep the ALC meter zeroed once the rig had warmed up. After a period of time, it seemed, the meter would sit idle not at zero but at perhaps 2 or 3 dB on the scale. I tend to be a perfectionist regarding how my equipment works, so I started investigating this situation and discovered the cause and cure and learned quite a bit in the process.

The basic ALC circuit in the 32S-1 consists of a 6AL5 diode rectifier which detects the presence of excessive grid current in the 6146 finals. This detected ALC voltage is applied to both the 6AH6 predriver and the 6DC6 IF amplifier. Collins uses a combination of capacitive coupling and RC circuits to give this ALC voltage a fast attack/slow decay characteristic. This circuitry was essentially unchanged in the later versions of the S-Line such as the 32S-3, except that the 6AL5 was replaced with a pair of solid state diodes.

Metering of the ALC action is done in the IF amplifier. The ALC meter reads a combination of the cathode voltage and the screen grid voltage of the controlled IF stage. When the ALC voltage increases (going negative), several things happen to this IF stage. Since the tube is being driven towards cut-off, it pulls less plate and cathode current. Since the cathode bias comes from a resistor, the cathode voltage rises. Also, the screen current decreases which increases the screen voltage, but not in the same proportion that the cathode voltage changes. Collins uses a combination of resistors in the screen, cathode and metering circuits to produce a voltage that is proportional to system gain reduction in decibels as the ALC voltage changes. This voltage is displayed on the meter when in the ALC position.

This metering scheme is in balance and the meter reads zero at only one set of tube operating conditions. Anything that causes the cathode or screen currents of the IF amplifier to change will upset the balance of the circuit and cause a change of meter reading at zero. My goal was to find out what was changing after the transmitter had operated for a while. I eventually determined that the metering drift had two sources - one was that of component changes with respect to temperature and the other was that the characteristics of the 6DC6 IF amplifier were changing as the tube was operated.

As I mentioned, the proportional change between the screen and cathode currents is what the meter indicates as the ALC voltage. This ratio is relatively independent of changes in plate voltage, which is one of the reasons Collins used this system rather than just merely reading the cathode voltage of the tube. The voltage ratio is highly effected, on the other hand, by small changes in the resistive voltage dividers that feed the ALC meter, and that's one of the problems. Carbon composition resistors can have a tremendous temperature coefficient, or value change with temperature. That would be well and good if they all changed in the same direction by the same proportional amount, but they



don't. A resistor with a high value in the -kilo or -megohm range will have a different temperature coefficient than one of a few hundred ohms or less. And the problem becomes worse as resistors age or are affected by humidity. I suspect that the engineers at Collins did not anticipate that the S-Lines they designed would still be in use some thirty years later and/or the effects of aging and humidity on the critical balance of values required in the ALC metering circuit.

Once I became aware of this problem, the solution was easy. I replaced the resistors associated with the screen, cathode and metering circuit with 1/2 watt carbon film types. This type of resistor has a temperature coefficient a fraction of that of composition resistors. They are readily available from almost any electronic supply house or mail order catalog such as Digi-Key. At a slight increase in cost, you could even use metal film types, which are the ultimate in stability, but the carbon types are plenty adequate. You want to replace R18, 19, 22 and 23 in the 455 Khz IF amplifier. Remember, you're working on a classic piece of radio equipment! Use solder wick to remove the old solder and try to dress the new components as the originals were. I would also recommend the replacement of R20, the ALC zero potentiometer R20 with a similarly sized cermet or non-carbon type. Cermet is a type of resistance material that is quite stable with respect to temperature.

With the replacement of the above mentioned components I found a considerable improvement in the stability of the ALC meter. Where it would drift some 3 dB before, the drift was reduced to 1/2 dB or less. If the drift in your 32S-1 is now acceptable, call it good. In my case, I was not completely satisfied until I had totally removed all perceptible drift, and I then turned my attention to the 6DC6 in the IF amplifier.

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A Pilgrimage To The AWA Museum

or, "How I Sparked Up My Life"

by Jim Hanlon, W8KGI
POB 581
Sandia Park, NM 87047

It was late August 1988, and my wife had taken off with her father and aunt on a trip to Italy. I felt like doing something nice for myself, so I decided to combine a business trip to New Jersey with a visit to the Antique Wireless Association Museum in Bloomfield, New York.

The Museum shares an old, three story brick building with the local historical society. It is open at scheduled hours during the summer and by appointment during the rest of the year. I found my way to Bloomfield late in the afternoon and got directions to the museum from a friendly gas station attendant. After I had dinner at a restaurant across the street from the museum I camped out on the front doorstep and waited for the Curator, Bruce Kelley, W2ICE, to arrive.

Bruce came a little past the nominal 7 o'clock opening time, probably not expecting any visitors since it was the last day of their season. But he was happy to find me waiting for him, and he gave me the grand tour.

The AWA Museum covers the broad spectrum of commercial, entertainment and amateur radio 'wireless' with some pre-radio equipment as well. Bruce showed me all sorts of wonderful goodies. In the first floor vestibule was an RCA TK10 first generation black and white television studio camera, just like the ones I used to wheel around at WCPO in Cincinnati in the '50s. Upstairs in the main exhibit area I saw a well stocked '20s radio store, early landline and undersea cable telegraph offices, all sorts of remarkable and historically significant vacuum tubes, and an exhibit of early TV including pre-war sets with only a few channels and 252 scan lines and even some mechanical flying spot gear.

Along radio lines, there were samples of all sorts of broadcast receivers, from old TRFs with glowing tungsten filament tubes and many dials to the first plastic transistor portables. I saw several spark transmitters, a non-synchronous rotary and a quenched gap. I saw a Titanic era shore wireless station and a Marconi ship station. In one display cabinet, Bruce had Major Armstrong's original 1933 FM transmitter, the one he used in the Empire State Building to demonstrate FM to the world. In a closet (that's where I got my inspiration for my new ham-shack!), he had a whole bunch of National receivers including HRO's from the original through the 50 and the 500, a rack mount AGS, an FB7 and it's preselector, SWs 3, 5 and 54, NCs 101X, 125, 173 and 240, a TV booster, a Select-O-Ject and more that I can't identify now from my photographs.

But the best was yet to come; several times. Upstairs in the third floor attic, Bruce has a real, live, Kilowatt synchronous rotary spark gap transmitter, plus an FCC license to fire it up once an hour for ten seconds for demonstration purposes! Never have I seen, heard or smelled anything so wonderful! Talk about real radios glowing in the dark; this one shatters the spectrum from audio to RF to light, and generates ozone to boot. Just those few seconds brought a thrill that no amount of working DX on Japanese transceivers can ever approach.

Museum curator, Bruce Kelley, W2ICE, tuning up the rotary spark transmitter at W2AN

As I was coming down from that thrill, Bruce offered yet another. Under a clear plastic cover was Hiram Percy Maxim's personal hand key, a beautiful, massive brass job on a marble base. Just imagine how I felt putting my hand right where 'The Old Man's' had been on his very own key.

And there was still more. Bruce next locked up the museum and took me over to the AWA warehouse nearby where they store the many items for which they have no exhibition space. It was better than the best flea market I have ever seen or dreamed about! There was every type of amateur gear you have ever seen, antique and post-war 'classic'. There were almost unlimited parts, old magazines and retired equipment from manufacturing vacuum tubes. Best of all, over in one cluttered corner was Jim Millen's rack mount HRO and his homebrew transmitter. I recognized them from a picture of his rec-room station in the 1938 ARRL Handbook. Seeing and feeling Millen's own HRO, the product of his own personal engineering genius, was yet another thrill I shall never forget.

For all of this, the best I could share with Bruce was a cup of coffee and a piece of cake at a little diner in nearby Holcomb, where he lives. I hope his wife understood his being late that evening. He had certainly given me the time of my life. Fittingly, I spent the night in a motel outside Bloomfield that must have been the set for one of Laurel and Hardy's 1930s movies, and then it was back to the real world. But what an experience. If you are ever near Rochester, New York, you've got to go to the AWA museum.

Editor's Note:

To become a member of the AWA and to receive their excellent quarterly "The Old Timer's Bulletin", send $10 (check made out to AWA) to Joyce Peckham, Box E, Breesport, NY 14816.

Don Spreeman, WA9ZOR, Kaukauna, Wisconsin, with some of his gear. On 160 he uses the T-368 with a SP-600 or R-390. His antenna on 160 is a 85 ft. base-loaded vertical.

Pat Keogh, WB9GKZ, Green Bay, Wisconsin, with his Viking II and 75A-3. Pat operates AM 10 through 160.

E.F. Johnson vfo Modifications

by "Doc" Metke, K6HLO
7775 Sierra Dr.
Roseville, CA 95661

1. Remove side cover of vfo. (left hand side)

2. Remove V-2. (OA2 regulator)

3. Locate and remove 18 K 2 watt resistor. (R-3)

4. Install a 5 terminal soldering strip under the chassis.

5. Install a jumper wire from the 300 volt source to terminal 1 of the terminal strip.

6. Install a jumper wire from pin 5 of the socket of V-2 to terminal 5 of the terminal strip routing it through the rubber grommet in the vfo compartment.

7. Install a 18 K 10 watt resistor from terminal 1 to terminal 5 of the terminal soldering strip.

8. Install a 150 volt 5 watt zener diode from pin 5 of the terminal strip (cathode end) and install the anode end to terminal 3. (ground)

9. Install a .01 @ 500 volt disc capacitor to terminal 1 of the terminal strip to ground.

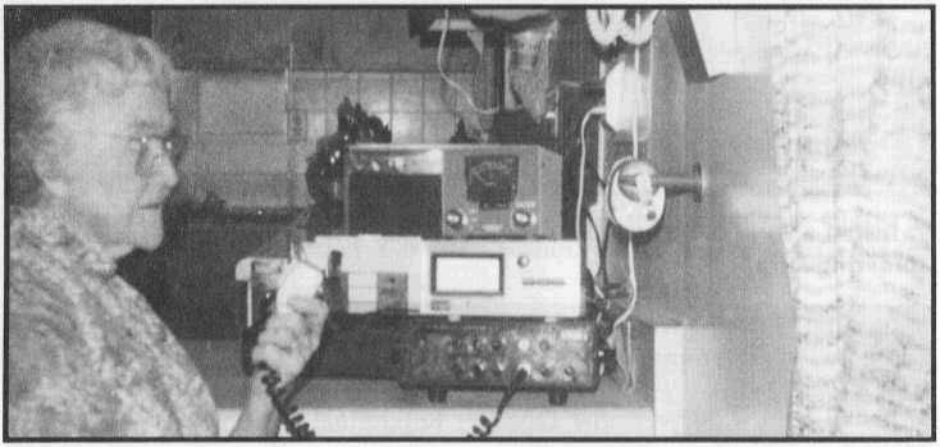
10. Install a .01 @ 500 volt disc capacitor to terminal 5 of the terminal strip to ground.

11. Reinstall the side cover of the vfo and warm up the transmitter for an hour or so and recheck calibration of the vfo. Recalibrate if necessary.

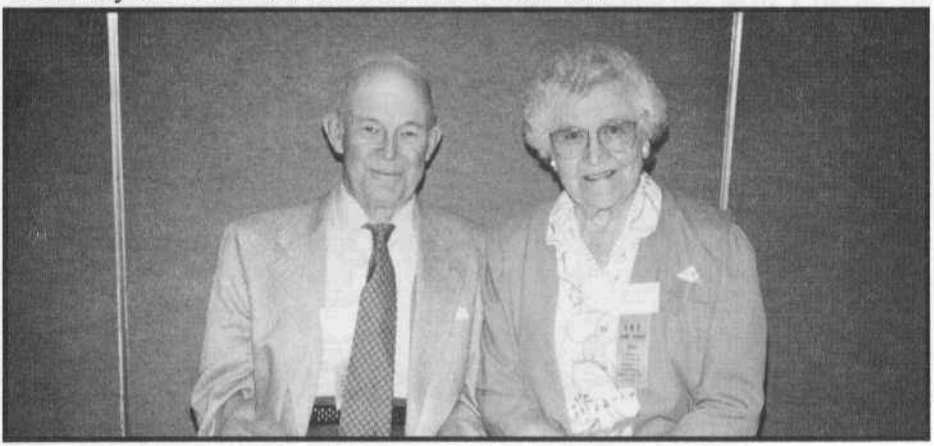
12. This modification will help reduce heat in the vfo compartment and make the vfo more stable.

Parts List
1 - 18 K 10 watt resistor
1 - 150 volt 5 watt zener
1 - 5 lug terminal strip, center lug mount

Homer operating his present station...note the absence of anything 'hollowstate'



Bonnie Hatch, WØBUN, operating a Brimstone 144 that the family manufactured in the early '70s. She was first licensed as 9BUN in 1926.



Bonnie and Homer Hatch at a recent reunion

9AHO...."the rest of the story"

by Barry Wiseman, N6CSW/Ø

The story started while I was preparing last month's issue. Everything was about wrapped up, but I did not have a good photo for the cover. While I was looking through Lee Faber's (W7EH) archives I came across a photo that I thought would look good. It had Homer Hatch, 9AHO, written across the bottom of it. To get a caption for the photo I called Lee. I asked him what he remembered about Homer. He said that all he could remember was that he worked him many times in the late '20s and early '30s and that ,"He was a real nice fella". Lee also said that,"He's probably passed away by now". Well, I used the photo.

A couple of days after the magazine went in the mail I received a call from Wayne Steiner, NØTE. He told me that Homer was "alive and well"living on his farm in Burlington, Kansas. I called Homer and we had a 'great' conversation. I sent him copies of ER and he responded with photos and a nice letter.

Homer, who's 79 now, says that he was 17 at the time the cover photo was taken in 1929. The transmitter in the photo was the first "high power" rig he built. It consisted of a pair of Cunningham CX 310s in a Hartley oscillator circuit, modulated by another CX 310 with a 201A speech amp. From Homer's letter:

"The microphone was a telephone mic or transmitter as they called it. The telephone company manager was a good friend of my family and he kept me supplied with any parts I could use! We did not have central AC electric service at that time. My Dad had a 32 volt Delco system for electricity. So I had several banks of 24 volt lead acid storage "B" batteries for high voltage power. That is the reason for the rows of double pole double throw switches in the picture. I could throw the switches up and charge the batteries and pull them down, put them in series, and get about 300 to 350 volts plate voltage. Later as I 'wore' the batteries out I bought a 500 volt generator from 5GG in Mississippi which I hooked up to a 1/2 hp 32 volt motor for my high voltage. Used that until 1940 when we got the rural electric ac power line built to our farm. Those DPDT switches were only available at the Kress store in Emporia for 25 cents each. As they only kept about three or four in stock I would buy some every time I would get up to Emporia. Emporia is about 30 or so miles NW of my QTH. So if they did not have any on hand when I was in town I would call on Bonnie (then 9BUN, my present wife) and leave a dollar bill with her. She was going to college there at the time. The inductance coil was wound with #8 solid copper wire, burned so it would be soft, on the coil built from three embroidery hoops with light pieces of wood notched to hold them spaced. I could clip on the coil anywhere I needed to 'tune up'. I could clip down about halfway and tune up on 80 meters.

"I cannot count how many transmitters and receivers I have built in the last 63 years. The first transmitter was a 201A oscillator and 2021A modulator with two 45 volt dry 'B' batteries. There were 5 or 6 other hams using the same rigs in our locality without licenses! Many used their initials for calls. Like GR or AA and I used just 9! That was in November of 1926. I received my license on Jan. 14, 1927. Most of those "bootleg" hams went

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Amateur Radio And The National Electrical Code

by Art Rideout, WA6IPD
2235 Gum Tree Lane
Fallbrook, CA 92028-0901

The National Electrical code (NEC) specifically refers to amateur radio, but amateur radio publications generally ignore the NEC. Should you?

There are probably only two occasions when an amateur might be concerned with the NEC. First, if the local building inspector inspects your antenna tower or that new ham shack you just constructed. Second, when the insurance adjuster refuses to pay your fire claim because the fire started in your ham shack and your installation did not meet the NEC.

As might be expected the NEC is generally concerned with good ground and antenna construction/installation practices. Let's review them in that order.

Grounding

Metal towers and radio equipment must be grounded. The grounding conductor must be continuous and unspliced, it cannot be smaller than #10 copper or #8 aluminum stranded or solid. If possible it must run in a straight line, it must be securely fastened, it must be protected where exposed to damage, and it must be connected to an approved electrode system by an approved connector. Approved connectors may be obtained from electrical supply houses.

An approved electrode system consists of one or all of the following, if available at the site:

1. A metal underground water pipe in direct contact with the earth and at least 10 feet in length. Never attach to a gas pipe.
2. The metal frame of a building where the building is connected to a low impedance ground.
3. A ground ring consisting of at least 20 feet of bare #2 copper encircling the building or structure and in direct contact with the earth at a depth of 2-1/2 feet.

Each of the above electrode systems, if available, must be interconnected with #6 bare copper to make up the electrode grounding system.Where any of the above are not available a 5/8 inch x 8 foot copper rod or a 3/4 inch x 10 foot galvanized pipe may be used as the ground electrode. However, the objective is to have a ground system of 25 ohms or less. Whatever electrode system is selected it must also be interconnected with the electrical service ground by a #6 copper conductor.

Antenna Construction/Installation

Antenna wire must be size #14 for spans of 150 feet and #10 for longer spans. Note this: All antenna wire must be solid hard-drawn copper or copper-clad steel insulated or uninsulated. No stranded wire or invisible antennas are permitted by the NEC.

Antennas and feeders must not be supported by utility power poles or any electrical service mast entering the home. They must also be kept well away from power lines to avoid the possibility of accidental contact. They must not pass under or over power lines and never run closer than a 2 foot parallel separation.

Open wire feeders must be of the same construction and size as antenna wire with the exception of small spans of less than 35 feet, where soft-drawn copper may be used. Clearance from any structure must be 3 inches or more. Entry into the ham shack must be made via an insulated bushing, drilled window pane or an opening of such size to permit a clearance of at least 2 inches.

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AM FREQUENCIES

2 Meters - 144.4, calling freq., activity in most cities; **6 meters** - 50.4 calling freq. **10 meters** - 29.0-29.2 operating window; **12 meters** - 24.985 calling freq.; **15 meters** - 21.385 calling freq.; **17 meters** - 18.150 calling freq.; **20 meters** - 14.286 for the nightly SPAM net starting at 5:00 CA time; **40 meters** - 7160, 7195, 7290 are the main freqs. Westcoast SPAM net every Sunday afternoon ,4:00 PM on 7160; **80 meters** - 3825, 3850, 3870 and 3890 are the main freqs. Westcoast SPAM net Wednesdays nights, 9:00 PM on 3870. Northeast SPAM net Thursday nights, 7:30 PM on 3885; **160 meters** - sporadic summer-time activity but during the winter signals can be heard anywhere on this band.

10 Meter Contest Big Success?

Sunday night, after the 10 meter contest had ended, I called John, WA6ZJC. I had heard stations working John all weekend and if anyone would have a valid opinion on how things went, it would be him. He said that he worked 120 stations despite the fact he had S-7 line noise all weekend. But he also noted that there were few 'contesters' and that the level of activity was not up to his expectations. He said that band conditions were 'good' but not 'great'. However, he did work some DX - a VK, a JA, a station in Great Britain and a large number of Canadians.

John had a couple of observations that I think have merit. First of all he felt that I did not advertise the contest well enough in advance. He thinks that if I had given a couple of months notice, more people would have allocated the weekend for the contest. He also said that it might have been a good idea to have had the contest listed in QST. Something else he noted that was that in other contests we were right in among the sideband operators and that a lot of them switched over to AM just to try the mode.He missed that this contest.

Bill Owen, KFØIE, in Minneapolis, Minn., reports that during the contest he worked LA1DBA, in Norway and EI8EQ in Ireland. He says that he was the first AM contact for the Norway station who was running 10 watts. Bill worked these stations running 4 watts output with his Hallicrafters HT-40 into a 3 element tribander.

Please get your logs in as soon as possible. Next month we'll have a full report on the contest along with the names of the winners.

160 Meter Contest, Dec. 28 -29

The next ER contest (and some people don't like the word contest) is on 160 meters and will be on the week-end of December 28 and 29th; that's a Friday and Saturday. Again the rules are 'loose', the contest begins early Friday evening and ends Sunday morning.

How does a 400' broadcast tower work as a ham-band antenna?

Halloween night I had an opportunity to find out. In a word it is 'awesome'. I worked stations on 20, 75, and 160 from about 6:00 PM local, when the day-time station closed down, until about midnight. I can say categorically that, "Every ham should have a tower like this one". It worked out very well on 20, absolutely outstanding on 160 and better than any other antenna I've ever used on 75. Bill, KDØHG, up in Boulder, said my Viking II sounded like a kilowatt! The best report I got on 160 was from Dewey, WØZUS, in Edgemont, SD.... 50 over...I suggest you consider a tower like this when you're shopping for your next antenna. You won't be disappointed!

LETTERS

Dear ER

Your October editorial highlights the link between economic recession and Amateur Radio's health in a very valid way -- affordable operating. There are signs the ARRL is preparing for the impact of such a downturn, and it has affected their view of AM based on interpretation of some events in recent months.

Our community reacted with glee earlier this year when a QST Product Review of some new rig included actual operation, transmit and receiver, with amplitude modulation! Sources in Newington indicated there was some sentiment among the more progressive League officials that the ARRL should shift away from its long-held anti-AM stance. Such a shift was possible as the League struggles to tap as much of the Amateur community as it can for support. It was in their interest to consider embracing the rising number of AM operators who view the mode in a warm nostalgic way that many are calling "Classic Radio".

Some within QST's Editorial Staff were favorable to a proposal for an overview article that would have provided an even-handed treatment of AM as but one of the many enjoyable specialties in the hobby. It could have encouraged enthusiasm if not participation in the mode long shortchanged for attention in the mainstream Amateur press. But some of the older and more conservative League administrators reportedly threw cold water on the idea, reviving the obsolete argument that "AM is bad", variations of which need not be repeated here. The first results of this return to a negative mood about AM turned up in the League's narrowly focused comments on the power restoration petition, which dealt only with protecting Amateur rights. The League also refused to go on record in opposition to the petition to outlaw AM.

Such a posture feeds well into word the League is worried about early signs of declining Amateur equipment sales, which could in turn hurt QST revenue from falling display advertising. It becomes very understandable why officials in Newington would now refuse any significant support for AM, which from their perspective involves no new equipment sales, goes against their denials that the mode is viable, and risks provoking others who hold leftover combativeness from the days when SSB was struggling for acceptance. It will continue to be up to AM operators, reaching out in friendly ways to the mainstream community, to develop broadbased support for the mode we find so pleasurable.

Paul S. Courson, WA3VJB

Dear ER

As a devoted AMer I feel compelled to set the record straight on the National NC-300 and NC-303 ham receivers in view of the Vintage Product Review article by Bill, KDØHG. [Oct.,1990, Issue #18]

The fact of the matter is that these receivers suffer from unwanted, i.e. spurious responses on the 20M, 15M, 11M and 10M bands because National decided to use second harmonic mixing in those ranges. In other words, the receiver HFO operates at one-half the desired mixer injection frequency; the 6BA7 mixer serving as a frequency doubler. The engineers evidently decided to do this because a more stable and linearly-tuned oscillator could be built at the half-frequency for the higher bands without adding another main tuning capacitor.

In any event, the presence of the fundamental oscillator, i.e. the half frequency, causes the following spurious responses that I have observed in all of these receivers:

1. 19M shortwave on the lower end of 10M
2. 25M shortwave on throughout the 15M band
3. 31M shortwave on the lower end of 20M depending on how well the 9.5 Mhz trap was adjusted.

The aforementioned trap confirms that National knew it had a problem. The RF stage is not selective enough to suppress the out-of-band responses because of the small ferrite RF coils used in the higher bands which do not have adequate Q.

If the antenna system is selective, e.g. a tri-band beam or a tuned transmatch, the level of these unwanted responses is reduced; but certainly not to the levels claimed in the specifications. Images may be down but the unwanted responses are there. Incidentally there are also spurs in the 11M band.

I tried adding series-tuned traps on 10M and 15M since there are spare positions on the band switch to do so. However, the traps did effect the RF tracking in other positions of those bands. The problem could probably be fixed by adding a push-pull doubler (6J6 dual triode) or a solid state phase lock loop modification. I have tried neither, but did try replacing the 6BA7 with a solid state 'tube' consisting of a dual-gate MOSFET transistor mixer which has a true square-law characteristic making it a better choice for second harmonic mixing. This modification reduced the spurious responses and improved the overall noise figure.

Another problem with the NC-300 can be fixed by installing an aluminum shield across the RF amplifier compartment. Without this shield the receiver's noise level jumps up on 40M and 80M when the RF gain is advanced to maximum. This is caused by feedback from coils in the mixer compartment to the coils in the RF amplifier compartment. A poorly aligned receiver or one with weak tubes will not need this treatment.

What is really surprising about the mixing plan of the NC-300 is that Hallicrafters uses basically the same approach in the SX-101 to get the desired high stability and bandspread.

Nevertheless, I will state at least two things I like about the NC-300. The way that big weighted-dial spins across the band and the pleasure of finally owning the contest "dream receiver" that I could never afford to buy back in 1955.

Sheldon Rubin, KT2L

Thanks for the excellent follow-up on the last vintage product review. You've pointed out one of the 'occupational hazards' of evaluating unfamiliar equipment in a brief period of time, one of not observing significant characteristics or bugs in a design of a particular item. The NC-300 that was tested was used in conjunction with a high Q parallel resonant link coupled antenna tuner which undoubtedly provided sufficient pre-selection to render any spurious responses unobservable during on the air tests. It just goes to show you that even with the best test equipment one can miss something unless you know exactly what you're looking for. Keep the cards and letters coming!! **Bill, KDØHG**

WHERE DOES THE STEAM COME OUT?

THE CLASSIC HRO AND IT'S EVOLUTION

by Jim Musgrove, K5BZH
4217 Buckeye
Fort Worth, TX 76137

On October 23, 1914, a small New England company incorporated as The National Toy Company. Who would have guessed that in less than 20 years they would establish themselves in the field of high-frequency communications receivers and then in 1934 introduce the 'Rolls Royce' of receivers, the National HRO. The National Toy Company was highly successful. They did very well with such items as their 'talking machine toys' that were used on record players. It was soon realized that the company could branch out into other areas and that perhaps the 'Toy' should be dropped from the company name.

In the early '20s, George Q. Hill, a Cardwell representative, started looking for alternative sources for variable condensers in order to meet the large demand. He approached some acquaintances at National to convince them that they would be a natural to manufacture variable condensers. In 1922, National began supplying condensers to Mr. Hill. This placed National into the radio components business.

During the mid-'20s a young mechanical engineer enters the picture. His name was Jim Millen. This young man had already established a good reputation in the radio field due to his magazine articles. The company officers apparently decided to enter the radio business about this point in time and were looking for the right person to help do it. Warren Hopkins, William A. Ready and Walter Balke (the principals in National at that time) met Jim Millen in 1924 and were favorably impressed. Jim Millen graduated in 1926 and started consulting for National. He joined National full-time in 1927. This young man would lead National into the radio business. The SW-5 'Thrill Box' came about in 1930. The SW-3, a cost reduced version, was in production a year later. One needs to understand that at the start of the '30s commercial short wave receivers were very basic. The Super Pros, Skyriders and HROs had yet to arrive.

In 1932 General Electric was working on a contract with the Civil Aeronautics Authority (forerunner to FAA). They needed a supplier for communications receivers. GE approached Jim Millen of National to design and manufacture receivers for the Aeronautics ground stations. This resulted in the 1932 National AGS. It would set the stage for the HRO. The AGS was a 9 tube superheterodyne with AVC. It had one stage of RF pre selection and two stages of IF amplification at 500 Kcs. The National type 'N' dial was used for the tuning mechanism. The receiver had 3 plug-in coils accessible from the upper part of the front panel.

During this same period of time (early '30s) Herbert Hoover Jr. was employed as a vice-president at Western Air Express in charge of communications. He was engaged in work on air to ground communications. Hoover recognized that the AGS, while satisfactory at the time, would need to be upgraded soon. In the latter part of 1933, Hoover contacted Jim Millen and proposed that National consider designing a new receiver to meet the future needs. This receiver would need 2 stages of RF preselection and a crystal filter. If plug-in coils were util-

The first HRO, 1934

ized, they would have to be ganged together. A better tuning mechanism would also be desirable. Millen accepted the task and the end result was the National HRO. It was introduced in late 1934. This receiver also included features that would be attractive for the more affluent radio amateurs. Production units were being delivered at the start of 1935.

To help the reader understand the state of technology available at this point in time let me mention some of the receivers advertised in the January 1935 QST. The National SW-3 was available for $19.50. Bill Halligan had already introduced the Hallicrafters SX-9 Super Skyrider at $79.50. The RME-9D was $112.50. Patterson PR-12s were being sold for $83.70. RCA had an ACR-136 for $69.50. Silver 5C's were listed at $74.70. National introduced the HRO at $139.80 (this did not include the power supply or a speaker).

The HRO was a rush order. The folks at National were pushing to release the new receiver as quickly as possible. Truthfully it was a "helluva rush order". National appropriately named their new 9 tube superheterodyne receiver the "HRO". Another interesting piece of trivia is that Jim Millen was in the process of changing his call sign at the time the HRO was being developed and someone in the FCC had agreed to issue him the call sign W1HRO. Somehow an error was made and Millen's new license had the call W1HRX.

Dana Bacon was the electrical engineer and his assistant was Cal Hadlock. Needless to say, several people were involved in the development of the HRO. Pete Hoover (Herbert Hoover, III) told me that as he recalled, his Dad, Herbert Hoover, Jr., was involved in testing the prototypes.

Early HROs were available with a choice of tubes with either 2.5 or 6.3 volt filaments. The 2.5 volt filaments were recommended due to a noticeable hum level that occurred above 14 Mcs on the 6.3 volt models. In the forties this ceased to be an issue due to the improvements made in the newer tubes.

continued next page

HRO from previous page

The PW tuning dial was a wonderful creation that is still admired by many of us today. It has 5 slots which reveal numbers that change as the dial is rotated. This scheme allowed a logging scale of 0 to 500. Each division is approximately 1/4 inch apart. The effective scale length is 12 feet. This is the type of thing one expects to find on a laboratory instrument. Unfortunately I'm not sure who the designer was. I have been told that Bill Larkin, a mechanical design engineer, was the creator of the mechanism. I have also read that Graydon Smith was the designer. The PW stands for parallel worm though. The NPW on the perpendicular drive unit stands for non parallel worm.

The coil sets were designed in such a fashion that one could select general coverage or hambands only (bandspread) by changing the position of 4 screws. For example, coil set 'D' has general coverage of 1.7 to 4.0 Mcs. In the bandspread position it covers 3.5 to 4.0 Mcs. The calibration was designed so that the hambands start at 50 and end at 450 on the dial giving a small amount of overlap. That requires 8 turns of the dial which equates to about 9.5 feet of bandspread. On 80 meters the average tuning rate is 62.5 Kcs per revolution. The 20 meter rate is 50 Kcs per revolution. Ten meters is 250 Kcs per turn.

HROs were delivered with four coil sets that covered 1.7 to 30.0 Mcs which included bandspread on 80, 40, 20 and 10 meters. The 15 and 11 meter hambands didn't exist in the '30s. Additional coil sets to cover the broadcast band and low frequencies were available as options. The supplied coil sets have the serial number of the receiver stamped on them. One should realize that these coils were calibrated to that specific receiver and will not perform well on another set unless they are calibrated for that specific receiver. When optional coil sets were purchased at a later date, they also needed to be calibrated for optimum receiver performance. Coil boxes were supplied to hold the coils sets not in use. The standard coil box was made of oak and held 3 coil sets. They also made a 5 coil wooden box. Metal coil boxes were available for the rack mounted receivers. They were made in different configurations such as 5 coil and 6 coil boxes.

Sensitivity was great and stability was excellent. After a reasonable warm-up period these receivers would hold to less than 500 cycles per hour. On the lower bands they were even better. Remember that the synthesizer was not in use in those days. For amplitude modulation and CW this was very satisfactory.

The new receiver included the James Lamb variable bandwidth crystal filter. There are two controls associated with this circuit. The upper knob controls the selectivity. The lower knob controls the crystal phasing and is also used to bypass the filter. When the filter is bypassed, the selectivity control is used to peak the IF for maximum signal strength.

The other controls are the audio gain, RF gain and BFO. The BFO control contains the on/off switch for the BFO and the range adjustment. There is also a S-meter switch, AVC switch and B+ switch.

In 1936 the HRO Junior, a cost reduced version of the HRO, was introduced. The S-meter and crystal filter were deleted in this version. The bandspread option was deleted from the coil sets. Only one coil set, the 14.0 to 30 Mc range, was supplied with the Junior. Other coil sets were available as options. It should be mentioned that this coil set was not aligned to the particular receiver as was the case of the standard HRO coil sets. The resulting cost was significantly lower and the price became attractive for many customers. From this point the HRO was referred to as the 'HRO Senior' by most hams although NATCO never officially assigned the 'Senior' to the nomenclature. They referred to the HRO as the 'standard HRO'.

HRO-5A1

There were several revisions made to the HROs prior to the introduction of the HRO-5. The first units are referred to as the "pearl button HROs". These were made for about 3 months. These units had a white push-button switch for the S-meter switch. The skirt on the micrometer dial was silver in color and the calibration scales on the coil sets were black with a white background. The next units had a push-pull S-meter switch. The tuning dial skirt was black and the calibration scales were white with a black background. As the revisions continued most changes were more subtle. The IF cans were changed from round to rectangular sometime in 1936. Small changes were incorporated in the PW condenser. The S-meter cases and scales were changed. Changes in the resistors were noted. For example earlier units had values written on the resistor bodies. Later units had stamped values. The basic receiver was the same though.

Jim Millen left National in 1939 and formed The James Millen Company. They became well known for components and the Millen grid dip meter. This certainly had an impact on National; however, they continued to do very well. The war years were arriving.

The HRO was drafted into military service in the late '30s. England liked the receivers. One of the reasons was the low LO injection. Of course the U.S. military forces put them to good use. By the end of the war 90 per cent of the Navy ships had HROs aboard them. Germany liked them too. The German 'KST' was an almost exact copy right down to the 'NC' symbol on the IF transformers. A lot of these were used in their submarine service. Japan didn't overlook the HRO either. At a glance the Japanese copy didn't resemble the HRO except for the dial. Electrically it was very similar. HROs and HRO copies were everywhere!

The HRO-5 appeared in 1943. The coil sets, like the HRO-Junior, did not include bandspread. The crystal for the filter was

continued next page

HRO from previous page
now installed inside the filter box and the S-meter switch was changed from a push-pull type to a toggle switch.

The HRO-5A was introduced in 1945. This model was intended for civilian usage and incorporated the bandspread feature again. The HRO-5A1 models that appeared in 1946 included a noise limiter which increased the tube count to 11. Some of these receivers have round S-meters and others have square meters.

In 1947 the HRO-7 series was introduced. It still had the outboard power supply but was in a modern cabinet with round corners. The cabinet was noticeably larger. Coil sets no longer had the familiar handles. Levers were incorporated in the receiver to ease the job of exchanging coils. The coil scales were changed from the familiar X-Y charts to a slide rule type of a scale (minus the pointer). A voltage regulator was added which set the tube count to 12.

The HRO-50 was introduced in 1950. The power supply was now incorporated into the receiver. Crystal calibrators were available as an option. Fifteen tubes were used in this receiver due to the now included rectifier, a phase splitter and push-pull output. The '50' also had a calibrated slide rule dial that was coupled to the micrometer dial instead of using the coil set calibrations charts like previous models. This change was probably due to a lot of folks not liking the idea of not having direct calibration. The screws that changed the coil sets from general coverage to bandspread were now changed to small rotating levers. This probably eliminated the problem of hunting for a screw on the floor although I can't imagine many people changing the position to general coverage.

The HRO-50-1 came about in 1951. A third IF stage was added and the IF transformers were cascaded to increase the number of tuned circuits to 12 so that a better selectivity curve could be achieved. It also drove the tube count to 16.

The HRO-50-2, which included dual conversion (above 7.0 Mcs), was introduced in 1952 as the HRO-60. This was the last of what I consider to be the real HROs. The number of tubes increased to 18. The HRO-60 was discontinued in October of 1964, almost 30 years after the introduction of the 'granddaddy HRO'.

In late 1964 the HRO-500 was introduced. This was a drastically different receiver, possibly an outgrowth of National's WRR-2 they built for the Navy. Linear calibration was here. So were product detectors and passband tuning for sideband selection. This was a solid state receiver and was in a smaller package. It still retained the micrometer dial. The only HRO-500s I recall seeing were at a NASA site in Fairbanks, Alaska. The $1560 price tag and common usage of transceivers probably kept them out of most hamshacks.

The HRO-600 was released somewhat later. Gone was the familiar dial mechanism that was the HRO trademark. I have a 1979 National brochure that describes it. The price was a mere $5600. This was the last 'official' HRO. I've never seen one!

There was also a HRO-M and a HRO-W that were manufactured during the war years. The principle difference between the HRO-M and the HRO-5 was that the 'M' had glass tubes. Apparently the HRO-W was a HRO-5 with the military fungus proofing treatment. These receivers did not come with bandspread coil sets. Many new units were sold as surplus after the war at attractive prices. Of course it didn't take much ingenuity to bandspread the coil sets.

The HRO manufacturing process is another item that is of interest. It was labor intensive. No automation existed in those days. Every employee was quality conscious. During the '30s and '40s the vendors were tightly coupled with National. Each knew the expectations of the other.

The shipping and receiving people had some technical expertise. They were able to read color codes, interpret drawings, etc. These folks also served as an early day inventory computer.

NATCO had an incoming inspection. People were assigned to specific types of testing such as tube testers. Bridges with standards were used to check condensers, coils and resistors. Mechanical inspectors had their flat surfaces and gauges. The inspection rates varied depending on the established quality.

Parts were then routed to a central store room. The assembly area would submit parts lists to the storeroom for builds. Requisitioned parts would then be sent to the appropriate line supervisors.

A chassis would be punched and painted. Tube sockets and standoff insulators would be installed and star washers used with each rivet to assure a good contact through the paint. Next the tuning condensor, IF cans, crystal filter, condensers and resistors were installed. Point to point wiring was inserted as the components were inserted. Assembly girls had parts bins and location charts for each of their items. The number of parts they installed depended on the complexity.

There were process inspection stations along the line. Upon completion, the radio was final inspected. I understand that at least one production foreman had friendly bets with the wiring girls. He paid for no errors. They paid for two errors.

Completed receivers went to the 'pretest' area where they were powered for the first time. Some people think of this as the "smoke" test. Yes, wiring errors did occur. DC voltages would be checked. A 1 volt 456 Kc signal would be fed to the IF amplifier to check for functionality. A local broadcast station was used to check the RF amplifier. These technicians would troubleshoot the simpler problems and route the more difficult problems to a higher skill group. Repairs were done by radio mechanics. They would follow directions written on forms by the pretesters and troubleshooters.

The receivers were aligned at the 'final test' stations. The alignment process for an HRO, with a standard set of 4 coil sets with bandspread, was reported to be 4 hours. National used crystal controlled sources and a General Radio signal generator for this process.

Next the set went to 'production test' which was conducted in a shielded room. All of the necessary measurements were made to ensure the receiver performed as advertised and documented. A record was shipped with the receiver.

To check packing for shipping there was a shock test room with a vibrating table and also a drop test. National was going to make certain that the customer received a perfect radio.

Designated quotas existed, even for troubleshooting. A difficult radio was put under the bench and used for fill when a technician had a good day with easy units.

Old as the basic design is, the HRO is still an excellent receiver. For some time it has been my contention that a radio is at least 50 percent mechanical. National obviously believed that. They combined the best of electrical and mechanical engineering with an outstanding production team to deliver a Rolls Royce class receiver.

William A. Ready retired in the early '50s. He served as President of National for about 40 years. This gentleman is described by many as a people-oriented manager that had everyone's respect. He is credited with knowing all of the employees and their families. Hank Cross assured me that Mr. Ready was an excellent mechanical engineer. William Ready certainly deserves some of the credit for the excellence of the HRO.

continued next page

HRO from previous page

In doing research on National and the HRO it has become apparent to me that the employees of National worked very well together and had the utmost respect for each other. The alumni of National still have an annual party. It was originally established by Mr. Ready as the company Christmas party and has in recent years been moved to the latter part of October so those that migrate to Florida in the winter time can easily attend. Over 50 people attended this year's party. Folks, that is what you call team spirit!

Collins radio introduced the receiver in 1947 that would pave the way for the next generation of great receivers. The 75A had a linearly calibrated permeability tuned oscillator that was calibrated with one Kc dial increments except on 10 and 11 meters where 2 Kc increments were used. The approach of down converting to feed a variable IF was also included. In the early '50s, Collins introduced the mechanical filter. This feature was included in the 1953, 75A-3. The 1955, 75A-4, included passband tuning and a product detector. Next came the 4:1 vernier for the tuning knob which resulted in a 25 Kc per revolution tuning rate. Single sideband was demanding a receiver of this type. The 500 Kc mechanical filters with their steep skirts were absolutely great on CW too. The end of the famed HRO was growing near.

As a point of interest it should be mentioned that Herbert Hoover Jr. used the HROs until the introduction of the Collins receivers. Pete Hoover claims his first real ham receiver was a HRO-7 that he continually modified. Unfortunately, it was destroyed in a flood while he was away on vacation.

As a youngster, I could not afford the Collins 75A or National HRO. I started with a Hallicrafters S-40B and later upgraded to a SX-99. The Collins 75A receivers were introduced to me early in my ham career. I thought that this was 'the receiver'. Sometime later I discovered the National HRO. I presently own 7 National receivers; five are of the HRO family. One is a 1936 rack mounted HRO-senior, another is a HRO-5TA1 and I also have an HRO-7T, an HRO-50R and an HRO-50T1.

A lot of technological changes have occurred over the last 30 or 40 years, but I'd bet that after trying any model of the vacuum tube HROs you too will be impressed. Think about adding one to your collection of vintage equipment. It's a piece that you will be proud to display.

Special thanks to:

Bill Bartell, W1PIJ
Sam Beverage, W1MGP
Ernie Brown, W5FYZ
Hank Cross, W1OOP
Bill Doyle, W1TV
Pete Hoover, W6ZH
Vic Jarvis, W1KXQ
Ken Robbins, W1KNI
Redmont Sheets, W1SYA
Ted Smith, W1TPB
Harry Snyder, WØRN
Tony Tortorella, W1SAC
Ed Harrington, W1JEL

Editor's Note: The author of this article, Jim Musgrove, K5BZH, was first licensed in 1955. Presently he is employed as a senior test engineer at Motorola in Fort Worth, Texas

HRO-60, introduced in 1952. The last of the 'real' HROs

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Improving the Collins 32S-1 from page 11

According to the RCA tube manual, the maximum rated plate and screen voltage for this tube type is 300 volts, and my power supply, even with the original 5U4 and not a silicon replacement, was still putting out some 325 volts to the 6DC6 at 121 line volts. Obviously this was creating a problem as the tube's characteristics would drift after the B+ was keyed in transmit for a few minutes. I tried several approaches to solving this problem including putting resistors in the plate supply of the 6DC6 to reduce this excessive voltage. The results were not entirely satisfactory. My next approach was to try different tubes, so I grabbed my box of spares and started trying different tubes. The results were most interesting, to say the least. Some brands of 6DC6s would cause the ALC reading to drift up, and some would cause a downward drift! Unfortunately, none had zero drift. I then tried some other tube types - bingo!

Among other semi-remote cutoff miniature pentodes, I tried the 6CB6, 6CF6 and 6BJ6. The 6CB6s were no improvement, but the 6BJ6s had no discernible drift whatsoever. Their slightly lower transconductance required an increase in the mic gain. The optimum tube type turned out to be the 6CF6 - note, not the type labeled 6CB6/6CF6. The 6CF6 had comparable gain to the original 6DC6 and all the ones I tried exhibited very small amounts of ALC drift.

I was quite pleased with the performance of my transmitter after these changes. I recommend these improvements if your 32S series transmitter exhibits an unstable ALC meter action. This is also a good opportunity to examine the inside of your rig for burned, overheated and other 'well aged' components. What a pleasure it is in having a wonderfully working S-Line!

9AHO from page 17

ahead and got their licenses. Practically all of them are silent keys now.

"My oldest son Clark, WØBT, and my youngest son, Dennis, WAØWAB, designed and built the first synthesized, two meter transceiver. [Brimstone 144] With my financing the deal! They finally had to give up as the Japanese soon came on the market and we could not compete with them price wise. I still have three of the rigs.

"The rig in the photo with my other son, Marvin, KØLZW, [on the cover] was built by him and his older brother, Clark, WØBT. The upper cabinet is the driver stage - vfo and crystal controlled. The bottom cabinet is the power amp and power supply for the amp. The power amp consisted of 2 811s.

Recently I called Lee Faber and told him about Homer. Lee was absolutely delighted to hear that Homer has had such a long, happy, productive life and that he's still active in ham radio. My next project is to get them together on the air. I think I'm going to be 'eavesdropping' on that conversation. It should be pretty interesting; after all, the last time they had a QSO was over 60 years ago! I'm wondering what they're going to talk about; tubes or transistors.

Editor's Note: Just before I took this issue to the printer I called Homer to confirm some of the details in the article. We had another long conversation and I learned that not only are his three sons all hams but they are also all employed in electronics/radio fields. He also has a grandson (Tim Hatch, WBØWUQ) that is also a ham and he is also working in the electronics field. I suggested to him that I would like to organize a 'on the air' reunion for him and Lee. Hopefully that will happen this weekend.

ER in Uniform from page 9

RT1 has a resistance of about 10k ohms at room temperature; its resistance falls with increasing temperature, being about 2k at the desired oven temperature of 75 degrees centigrade. Starting at room temperature, the temperature of the plate reaches 75 degrees centigrade in about 30 seconds; it then swings slightly above and below over the next minute. After 90 seconds, there's less than 0.1 degree of variation in temperature.

I built three of these heaters; all held the temperature between 73 and 76 degrees with the parts values shown. This design assumes constant input voltage; if yours isn't, then use a zener diode to regulate the voltage to R3 so the temperature won't vary. With adjustment of the resistor values, the design should work for any supply from 10 to 50 volts DC. For AC operation, a full wave bridge could be used to rectify the supply; filtering should not be necessary. Below ten volts, try using a Darlington transistor such as the R.S. # 276-2068 in place of Q1, with corresponding bias changes.

A Note on Fair Radio Sales

I'd like to expand slightly on a point made by Bill Kleronomos ("A Visit To Fair Radio Sales", E.R., August 1990): namely that they have a lot of stuff which isn't in the catalog. While very little of the 'extra' is complete and desirable sets, there is an almost unimaginable variety of parts sets, subassemblies, odd connectors, loose parts, and the like, often only one or two of a kind. One of their staff recently estimated that they have five to ten times as many different items as are in the catalog!

This stock of rare parts makes 'Fair' an invaluable resource for the military radio collector; they have provided critical 'missing pieces' for nearly every set described in the" In Uniform" series --the rack for my ARC-38, connectors, extra modules, and other parts for the ARC-58, a battery pack (dead, for rebuilding) for the PRC-25, missing cover plates and knobs, replacements for burned up transformers, and other items. However, since this stuff isn't cataloged, you must depend on someone there remembering first that they have the item, and second, where to look.

Only by luck would you get the right person on the phone. To maximize your chances, write a letter. Give as much information as you can -- nomenclature, description, any measurements which apply, a sketch, etc., For parts of a set, give not only the circuit symbol but the location on the chassis -- they may have a 'junker' set but no documentation. For connectors always give a sketch of the pin configuration, male or female, chassis mount or cable, set or sets with which used, and so on.

Amateur Radio/NEC from page 18

An antenna discharge unit must also be installed to drain static charges. Feeders and antennas must be installed to make accidental contact difficult.Coaxial feed lines have no restrictions other than being securely supported.

There you have it.Fortunately for amateur radio operators the NEC is very limited in scope for amateur installations. As for living up to these requirements let your conscience be your guide. But if you do everything in accordance with the code and your shack still burns down you will have that warm comforting feeling knowing that it met code.

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Art Rideout, WA6IPD, is a registered professional engineer and a licensed electrical contractor.

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WANTED: TU61 used in BC-610 (160 meters); schematic for T4/FRC transmitter. Ozzie Diaz, WB6ICM, 6221 Roblar Rd., Petaluma, CA 94952. (707) 795-1642

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WANTED: Very old or unusual Hallicrafters equipment, entire 1934 "H" and "Z" line of Silver Marshal, parts, memorabilia and manuals. Chuck Dachis, "The Hallicrafter Collector", WD5EOG, 4500 Russell Drive, Austin, TX 78745.

WANTED: Large ceramic capacitor, approx. 0.01 mf at 15 to 20 Kv; rack mounting SP-400. Robert Enemark, Box 1607, Duxbury, MA 02331.

WANTED: Eldico TR75TV transmitter; National SW-54 receiver. Don Temple, 9724 E. Crestline Cir., Englewood, CO 80111. (303) 779-0923

FOR TRADE: ARRL Handbooks. Have 1932, 56, 58, 63, 73, 75 and 78. Need 1931, 35, 37, 38, 39, 40, 41 and 42. **WANTED:** Utah Junior transmitter manual and/or schematic, circa 1938. Bob Mattson, KC2LK, 10 Janewood, Highland, NY 12528. (914) 691-6247

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FOR SALE: Drake 2NT, 2C, 2CQ - $160; Heathkit AT-1, VF-1, modulator, ant. tuner (long wire), Q-multiplier, A-3 receiver - $125. **WANTED:** Manual or copy for Knight R-100-A; Greenlee punches. Don Soule, KA1KDS, RR#2, Box 2510, N. Dexter, ME 04930. (207) 924-3220

FOR SALE: Magazines: QST; CQ; Radio News; Radio Electronics; Radio and Television News; Electronics World; Radio Craft; Popular Electronics; Radio Jobbers News. Charles Stinger, W8GFA, 404 Ross Ave., Hamilton, OH 45013. (513) 867-0079

WANTED: Cabinet for Collins 51S-1 receiver (30L-1 or KWM-2 cabinet may also fit). Van, ZS6LW, Box 838, Germiston, South Africa.

WANTED: Collins PTO, model 70E-8A, for 32V2 transmitter. Need good to mint cond. unit to get rig back on air. Paul Courson, Box 73, W. Friendship, MD 21794-0073.

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FOR SALE: Used technical books: radio, electronics, math, military, magazines, etc. $1 for large list. Stamps OK. Softwave Communications, Dept. ER, 1515 Sashabaw, Ortonville, MI 48462.

WANTED: Geloso receiver, model G-250. D.H. Moore, POB 521, Palo Alto, CA 94302. (415) 322-2728

WANTED: Front panel and knobs for BC-794B, military Hammarlund Super-Pro; Philco Tropic 41-788 8-band table radio; G-E A-82 All-Wave (Sentry Box Tuning); early SW and BC QSL cards or letters. Lloyd B. Zimmerman, 8448 No. Harding Ave., Skokie, IL 60076. (708) 674-0345

WANTED: Mint 75A4 or NC-300 or any other ham bands only tube receiver. Howie Jack, W2NRM, 1311 NW 107th Terr., Gainesville, FL 32606-5446. (904) 332-1897

FOR SALE: Stoner transmitter, 2 - 15 Mhz - $40; Knight T-150A transmitter - $40; HQ-150 - $40; DX-60B w/HG-10B vfo - $35; 10 and 12 meter amp., sweep tubes, low drive, 200 watts - $150; DeVry scope - $10; RT-70 6 meter FM w/ps - $30. Michael Nichols, KE9FK, 105 N 4th St., Fort Atkinson, WI 53538. (414) 563-2825

WANTED: Need schematic and/or service info for TV-7D/U tube tester (not the operators manual). Will pay appropriate cost. Thanks. S. Kiraly, 51 Ramon Blvd., Freehold, NJ 07728.

WANTED: Round or square meter for the Millen 90800 exciter in good condition. James T. Schliestett, W4IMQ, POB 93, Cedartown, GA 30125. (404) 748-5968

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WANTED: E.F. Johnson Navigator; Speed-X bug; WRL 755 vfo and manual; 1930's ham receiver. Brian Roberts, K9VKY, 3068 Evergreen Rd., Pittsburgh, PA 15237. (412) 931-4646

FOR SALE: HRO-60 (repainted but excellent appearance), A-B-C-D coils, manual - $150; Boonton 160-A Q meter - $50. Both pick-up only. Ira Lipton, WA2OAX, 8 Rose Hill Rd., Suffern, NY 10901. (914) 357-8282

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WANTED: Type 6000 electron tube for T-368 transmitter. Bill Mills, KC5PF, 1740 Tonys Court, Amissville, VA 22002. office: (703) 818-3955 home: (703) 937-4090

FOR SALE: 75A-4 - $295; R-392 - $125; SX-28 - $60; 6kc filter (75A-4) - $85; Viking I - $45; Viking 122 vfo - $25; 4D32 - $20; 4CX-250B new (?) - $35. Plus shipping. George Babits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147 after 5 PM MST

FOR SALE: HQ-170A - $135. **WANTED:** Collins 32S3 round; round S-Line; 75S3C round; 55G-1; KWM-1; 51S1; 312B3; 312B4; 75A-4; 270-G; F455FA05; any National HRO receivers, coils or accessories. Larry Chapman, NE8V, 9307 Worley Mill Rd., Hillsboro, OH 45133. (513) 981-2462

FOR SALE: Antique meters: Jewell pattern 57, 0-8 and 0-200 volts; Weston model 687 0-2, 0-10 and 0-50 volts. Working condition. $15 each plus UPS or both for $25 and I ship. Wes, W5DPM, 1950 Chevelle Dr., Baton Rouge, LA 70806.

WANTED: Military BC-604/684 crystals: channels 68-333, 334-345 and 360, white on top. Sam Hevener, W8KBF, 3583 Everett Rd., Richfield, OH 44286. (216) 659-3244

WANTED: SP-200X speaker and manual; RME 69 manual; receivers SX-100, RME 99 and Howard 490. Craig L. Zitterich, 1725 Oak Hill, Corinth, TX 76205. (817) 497-3639

FOR SALE: Resistors: 1/4, 1/2 and 1 watt. Large selection cut from new reels. 100 for $1. Also pots. SASE. Stuart T. Carter, II, W4NHC, POB 033177, Indialantic, FL 32903-0177. (407) 727-3015

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WANTED: Hallicrafters receiver models S-22R, SX-28A, S-36, S-37, SX-62B and catalog 36B (copy ok). Any condition, advise prices. Chris Cross, 115 W. Olive St., McConnell, IL 61050.

WANTED: WW-II German, Japanese, Italian radio equipment or any parts, any condition. Also interested in U.S. Coast Guard, Forest Service, 1930s-1940s aviation and maritime, lifeboat CW transceivers, aircraft radar jammers and special receivers, plus specific models ARR-16, ARQ-, AXR-, MBM, PRC-5, RAX, TRC. Manuals, handbooks, catalogs, most any kinda paper on any of above! (Interests tending toward the small/nifty and/or unusual, I suppose...) FOR SALE: Multi-Elmac; RCA CRMP3 tube CB; case for RBM; 20 TBS xtals; 1930s ship LF xtals; access. kit for Dutch-English 88 set; BC-1031 panadaptor; Mackay 128 VLF rcvr. Thank You! Hugh Miller, KA7LXY, 6400 Maltby Rd., Woodinville, WA 98072-8375.

FOR SALE: SP-600JX-27. **WANTED:** 100 kc crystal calibrator. Tracy Reese, WB6TMY, POB 4694, Santa Rosa, CA 95402. (707) 527-8124

WANTED: Filament xfmr, 2.5 v, 10 amp, 5000 v test; 50 K, 100 watt bleeder. Bob Dennison, W2HBE, 82 Virginia Ave., Westmont, NJ 08108. (609) 854-3301

WANTED: 'Ole-man' wants to build antique phone mono-band cw/phone rig. Looking for 204A or 849 with socket for final amp. Hank Clark, W2IQ, (615) 397-9796

WANTED: S-meter for Gonset Communicator III or G-50. J.M. Roseman, 2716 West 3rd St., Coal Valley, IL 61240.

WANTED: Johnson Ranger II tx or any identical AM tx in working condition; also Japanese WW-II Chi-ichi rx which is similar to HRO-5. Stan Tajima, JA1DNQ, c/o Toshiba, 701 Westchester Ave., White Plains, NY 10604. (914) 949-7750

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WANTED: In excellent operating condition for a BLIND friend of mine, a Collins 51J4 receiver. You can deal with him, address below. Don Southern, RFD#3 Royal Drive, Livermore Falls, ME 04254. (207) 897-2502. Tnx.... K1OKO

WANTED: Espionage equipment. Historian purchases spy radios, code and cipher machines and any equipment, devises or manuals pertaining to the world's intelligence organizations. Keith Melton, Box 5755, Bossier City, LA 71171. (318) 747-9616

FOR SALE: Drake SW-4A rcvr w/spkr - $125; 5" Simpson scope - $40. Pat Keogh, WB9GKZ, (414) 499-1336

FOR SALE: Heath DX-100B, microphone, Dow relay, Hallicrafters SX-100, speaker, complete station - $225 pu only; Knight T-60, Knight vfo, Hallicrafters HT-40 - $25 each. John Maver, W6MQK, 1049 N. Holliston Ave., Pasadena, CA 91104. (818) 798-9345

WANTED: Collins 270G-3 speaker for 75A-4 receiver; (2) 807 tubes; 75A-2 or 75A-3 in good to excellent condition. Don Hilliard, WØPW, Rt 5, Box 219, Neosho, MO 64850. (417) 451-5892

WANTED: WE371B tube data; S-Line cabinet; right-angle drive unit with 1:1 ratio; T-368 manuals. James C. Owens, NWØO, 1363 Tipperary St., Boulder, CO 80303. (303) 673-9019

WANTED: RCA AVT-15 transmitter; AVA-120 trailing wire antenna reel and related hardware; SCR-319 items. Ken Gillis, 27217 Garden Way, Franklin, MI 48025. (313) 390-6873 days.

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Bumper sticker - $1 each with a #10 SASE. We service American made amateur radio products circa 1940's, 50's and 60's. Manuals and/or schematics available for most rigs and radio sets back to mid 1920's. Call or write for a quote on your service or tech data requirements. **Classic Radio,** PO Box 3486 Eureka, CA 95502. 24 hour phone (707) 444-3911. K6VHP

FOR SALE: Collins 75A-3, .8 and 3.1 kc filters, mint inside and out - $250; 3TF4A ballast tubes (R-390A), new - $25 each; SX-42 - $85; MT-3000A, 3 Kw 1.8-30 Mhz tuner, built in dummy, balun, dual meter wattmeter - $250; Johnson 500 - $295. **WANTED:** Mint Ranger II; CVM-5. Alan Gray, W3VL, 212 Penn Valley Terrace, Yardley, PA 19067. (215) 295-6331

FOR SALE: Heath DX-40 w/manual - $40; Heath VF-1 vfo, no manual - $25. Both in good condition. Jerry Jetzer, WB9TKO, 3212 N 21st, Sheboygan, WI 53083.

WANTED: Hallicrafters SR-400A Cyclone III (later model from 1971) in excellent condition with manuals. Will consider earlier SR-400s or SR-2000 (if finals ok). Mark Thompson, WB9QZB, 5356 N. Glenwood Ave., Chicago, IL 60064. (312) 275-6867

FOR SALE: Merit transformers (audio); coils and chokes or assorted values and sizes. I also have Clarostat and Mallory controls and filter capacitors of assorted values and sizes. I will sell the whole lot very reasonable. Art Reiss, 169 N. Delaware Ave., Lindenhurst, L.I., NY 11757. (516) 884-8527

WANTED: Intelligence museum wants German, Japanese, Italian, Russian and Chinese communication equipment and any British or U.S. spy radios. LTC William Howard, 219 Harborview Lane, Largo, FL 34640. (813) 585-7756

WANTED: Several Shure microphones, Model 51. Dewey Angerhofer, WØZUS, POB 540, Edgemont, SD 57735. (605) 662-7692

FOR SALE: 75A-4 with all three filters - $400; Heath Marauder - $200; National NC-183D - $200; NC-300 - $150. Cliff Fleury, AI7Y, 64174 Tumalo Rim Dr., Bend, OR 97701. (503) 382-9162

WANTED: Heath DX-35; AR-3 rcvr; National SW-54 and Johnson Thunderbolt amp. Clem Duval, W8VO, 33727 Brownlea, Sterling Hts., MI 48312. (313) 268-2467

WANTED: BC-923; BC-474; BC-966; 10-59/APA-11; APN-12; R-252/ARN 14 military radios. Prefer unmodified. Leroy E. Sparks, W6SYC, 924 W. McFadden Ave., Santa Ana, CA 92707. (714) 540-8123

WANTED: Schematic or unit: Western Radio novice BA80-40, 80M/40M transceiver advertised in old Popular Electronics mag. around 1958. J. Torres, K3YCA, 3628 Kimble Rd., Baltimore, MD 21218.

FOR SALE: NOS Eagle ceramic "Radio Lightning Arrestor", model 261 for long-wire receiving antennas, appear to be '30s vintage - $5 each, no box-$3 each; Eimac 6pf/32Kv fixed vacuum capacitor - $5; unused Hallicrafters IF xfmr, has plastic 'h' logo on top and #50C-142, couple of small dents in can, 4x2x1-1/2 - free, u-ship; NOS Amphenol 2 pin mic connectors, fit EFJ, etc - $2.50. Bill Kleronomos, KDØHG, POB 1456, Lyons, CO 80540. (303) 823-6438

FOR SALE: 70 years accumulation. 1920's radios, tube testers, signal generators, meters, transmitter/receiver parts, Radio Master catalogs, flyers, books, manuals, linear amplifiers, 48 pages - $1. F.H. Yonker, W2IBH, 7 Old Farms Rd., Saddle River, NJ 07458. (201) 825-1895

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FOR SALE: Collins vernier knob/drive for 75A-4/KWS-1 - $45; 70H-3 PTO - $10; R-392 PTO - $20; R-392 parts; HP-608D - $35; Viking II parts; National NFM-83 - $45; Good used tubes $3.50 each: 1625, 815, 832, 2C39A, 350A, 836, 3E29, 3B28, 3B22, 8012; new 807s - $6.50. Shipping extra. George Babits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147

FOR SALE: NC-300 w/spkr - $155 (will split); new 4D32 - $30; National MB-40 - $12; 3 Khz filter for 75A-3 - $45; S-38 - $35; Parting HRO-60, Viking II and TDQ. Joe Sloss, K7MKS, 4732 119th SE, Bellevue, WA 98006. (206) 747-5349

FOR SALE: Hallicrafters S-120 and S-200 rcvrs, good condition; National NC-100A, modified, good for parts, Heath HX-30 6M SSB transmitter, w/manual, good condition. $30 each. Steve Johnson, WD8DAS, 2321 Calvin Ave., Norfolk, VA 23518. (804) 583-8525

WANTED: vfo dial (skirt dial) for Collins KW-1 or suggestions for duplication. Bob Sitterley, K7POF, 19545 East Cronin Drive, Rowland Heights, CA 91748.

WANTED: Copies of manuals for Johnson Courier, 122 vfo, Paco G-15 grid dip meter and Hallicrafters S-119. I have manuals for the Navigator, Ranger, Adventurer and Challenger. Al Bernard, NI4Q, POB 690098, Orlando, FL 32819. (407) 351-5536

FOR SALE: Racal RA-17CB rcvr - $350; Heathkit DX-60 w/HG-10B vfo, homebrew console - $80 plus shipping; HT-32, HT-33A, not working - $150 for both, PU only; SX-40, works - $40. Rich Lucchesi, WA2RQY, 941 N. Park Ave., N. Massapequa, L.I., NY 11758.

WANTED: Transistor radios from the '50s and early '60s. Cash or trade. James Weil, 15915 Armada Ctr. Rd., Romeo, MI 48065. (313) 784-9860

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WANTED: Collins KW-1, 30K, 32V-3, 75A-3, 270G speaker for 75A-4, KWM-2, late W/E for my collection. Will pick up or pay shipping. Joe Rose, WA2PJP, 60 Sunset Ave., Selden, L.I., NY 11784. (516) 736-0261

FOR SALE: Two self contained high-fidelity audio amplifiers, each has three discreet channels of push-pull 6L6's, built by Haygren Organ Company. Both units are in excellent condition, fully operational, with all tubes - $50 each or B/O (the power supplies alone are worth it!). John Werner, WB8IPG, 183 Tacoma Blvd., Troy, MI 48084-5424. (313) 362-2656 message or 362-2706. No calls after 0400 UCT.

WANTED: Collins 32W-1 exciter; KW-1; KWS-1; 32V-2,-3; 75A-3; 75A-4. Equipment which is new or mint or indetectably blemished (spotless!) will command substantive premium. Write or call. Roy, N5QQM, 1336 Sherwood Forest Blvd., Baton Rouge, LA 70815-5330. (504) 272-2563; FAX (504) 272-4913

Electric Radio - the first year - all twelve issues delivered First Class in a padded envelope - $25. Individual copies $2.50 delivered. #1, #5 and #11 are reproductions.

WANTED: Transmitter tuning units for BC-223: TU-17, TU-18, TU-25; BC-191or BC-375:TU-50 to TU-26B; for Navy GP7; tuning units CAY47150A to CAY47155C; ART-13, BC-348 and R-392. Alan Mark, POB 372, Pembroke, MA 02359.

FOR SALE: 120/800 cy, AC-DC gen., 1.18 KVA plus 14v DC 20 amps - $80; Collins TVI filter, 1KW - $35; 14v - 440v dynamotor - $20; 14v - 1000v dynamotor - $35; 807s, 1625s and 6Y6s - $4 each; variable condensers, 10 to 200 mfd - $2 to $7; power supply for BC-221 freq meter - $20; 100:1 divider - $10; 10:1 attenuator - $10. Jos Battyany, W6CAS, 1501 Sherwood Ave., Sacramento, CA 95822. (916) 731-8261

WANTED: Machine shop work. Knobs, shafts, bushings etc. made to your sample or drawing. Reasonable. Jim Dill, Box 5044, Greeley, CO 80631. (303) 353-8561 even.

ER Parts Unit Directory

At this point the directory has about 75 units in it and it's growing daily. If you need a part for a vintage restoration send $1 and an SASE for the list. If you have a parts unit consider putting it on the list. Your dead unit can help bring others to life.

WANTED: B&W HDVL plus in coils, all bands. Also assembly manual for Johnson Rangers; will buy basket case Rangers. Please advise condition and price. Bill Shields, W4OWR, 516 College St., Madisonville, TN 37354.

WANTED: National HRO-60T accessories: HRO-60TS speaker; SOJ-3 Select-O-Ject; Coils AA, AB, AC. I will pay top $ for any or all of the above. Frank DeCoito, Star Rt #2, Box 242, La Honda, CA 94020. (415) 948-2045

FOR SALE: SX-99 - $60; NC-173 - $75; 19 inch rack enclosures - $20 to $35; 1 KW SWR meters - $35; 813s - $20; 805s - $20; 3B28s - $5. Levy, W6QJT, 13330 Blanco Road, #907, San Antonio, TX 78216.

WANTED: National HRO-60 with speaker and coils; schematic for Navy medium frequency receiver type CCT46076. Will trade my Pilot Wasp coils for Pilot Super Wasp coils. Niel Wiegand, WA5VLZ, 911 North Bend Dr., Austin, TX 78758. (512) 837-2492

FOR SALE: BC-610 and BC-640 transmitters; also homebrew xmtr w/T55 final, excellent workmanship. Frank Bridges, R#1, Box 28A, Brevard, NC 28712. (704) 885-2470

FOR SALE: Central Electronics 100V - $250; Collins 75A-4 w/3 filters - $300; National 183R - $125. Will trade. WANTED: Valiant II or Johnson 500. Tom Arnold, N4VHG, 2007 E. Powhatan Ave., Tampa, FL 33610. (813) 237-0317

WANTED: Marine receiver AR-8506-B, 85 Kcs - 25 Mcs, Radio Marine Corp. of America. Ted Bracco, WØNZW, Quincy College, Quincy, IL 62301. (217) 228-5213

WANTED: UG-970/U adapter connector for R-390 antenna input. J. Lucas, NI2A, 160 South Fourth St., Lindenhurst, NY 11757. (516) 589-1051 evenings

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WANTED: Military radios: ARR1, ATB, TBY power supplies, R395/PRD1 loop, rod antennas and TBW PS/mod. Charles DiCecca, 501 Mystic Valley Pkwy., Medford, MA 02155. (617) 396-9354

FOR SALE: SX-17; SX-24; R-390; RBA; Echophone Commercial & EC-2; Polydyne AM TRF; HT-6; HT-9; HT-18; HT-19; HT-30; HT-40; Harvey Wells TBS 50C w/vfo; Instructograph; new boxed 807s. Most VGC w/manuals. Perry Ballinger, W8AU, 2468 Bellevue SW; Massillon, OH 44648. (216) 832-8612

WANTED: Manual or schematic and function switch for Heathkit Seneca VHF-1; 6146Ws and National NC-303. Vance Gildersleeve, K5CF, 206 Michelle Dr., Poteau, OK 74953. (918) 647-9044

FOR SALE: Heathkit Mohawk rcvr and Apache xmtr - $250; B&W 5100 - $130; Viking Adventurer - $30; VFI vfo - $25; homebrew modulator w/6L6s - $25. Gary Gompf, W7FG, 3300 Wayside Dr., Bartlesville, OK 74006. (918) 333-7893

WANTED: NC44, NC44A or NC44B; calibrated dial and plastic dial cover in excellent condition for RCA AR88LF or CR91A. Jim Ellerington, VE5BQ, Box 658, Rosthern, Sask., Canada S0K 3RO. (306) 232-5674

FOR SALE: Antique radios, parts, tubes, books, 150 panel meters, knobs, amateur, test equipment, transmitter crystals, etc. 13 lists. SASE + $2 cash (no checks). Richard & Rose's Radio Mart, POB 691443, Tulsa, OK 74169.

WANTED: 3-wide ARC-5 transmitter rack and shockmount, 3-wide ARC-5 or SCR-274 receiver rack and shockmount, T-15/ARC-5 transmitter, TN-6/ARC-5 loading coil and MT-159/ARC-5 mount, any other ARC-5 or SCR-274 accessories,PP-2792/ARN-30 power supply. David Ross, 2502 Amethyst Drive, Santa Clara, 95051. (408) 984-1929

WANTED: Wierd tubes (duds ok) for display. Marcus Frisch, WA9IXP, Box 28803 Greenfield, WI 53220-0803.

Please remember to count the words in your ad. If you are over 30 words please send 10 cents for each addictional word.

FOR SALE: Transmitting/receiving tubes, new and used. Exa: OD3, 3B28, 4X150, 4X500, 4-65A, 4-125A, 6A3, 12A6, 45, 807, 809, 810, 811A, 812, 815, 829, 832, 836, 872, 1619, 1625, 5894, 6130, 6146, 9003 plus others. LSASE for list. I also collect old and unique tubes of any type. Maybe you have something to trade? John H. Walker Jr., 16112 W. 125th St., Olathe, KS 66062. (913) 782-6455

WANTED: Sam's transistor service manuals TSM-1 thru TSM-50. All numbers needed. James Weil, 15915 Armada Ctr. Rd., Romeo, MI 48065. (313) 784-9860

WANTED: Collins SC-101 Station Control; 312A-1 Control/Speaker units; 310A -series speaker/phone patches. Written offer or leads appreciated. Roy, N5QQM, 1336 Sherwood Forest Blvd., Baton Rouge, LA 70815-5330. (504) 272-2563; FAX (504) 272-4913

WANTED: Buy and sell all types of electron tubes. Harold Bramstedt, C&N Electronics, 6104 Egg Lake Road, Hugo, MN 55038. (800) 421-9397, (612) 429-9397

FOR SALE: Newly published instruction books, authorized by Rockwell International, are now available for the Rockwell/Collins S-Line. These instruction books are brand new and have been printed from the latest editions - complete in every detail, including the front and rear color covers. A money-back guarantee of the purchase price ensures your complete satisfaction. Instruction books for the following models are currently available. KWM-2/2A ($35); 75S-3B/C ($30); 32S-3A ($30); 75S-3/3A ($25); 32S-3 ($25); 312B-4/5 ($20); 516F-2 ($15). For U.S. orders, include 7% of the purchase price for shipping and handling. (Canada and Mexico add 12%; all other international countries add 25%) Ohio residents add 6% sales tax. VISTA Technology Incorporated, 3041 Rising Springs, Bellbrook, OH 45305. (513) 426-6700

WANTED: Brown case "Oceanic" type radios. Also want SR-500 and Electro-Voice 419 mike stand, mike or both. Edward Deptula, KA3OTT, POB 751, Havertown, PA 19083.

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FOR SALE: Bigelow Electronics has been in the electronic mail order business since 1954. Vintage parts and equipment available. Request free "Vintage Flyer". Bigelow Electronics, Box 125, Bluffton, OH 45817.

FOR SALE: 450 military/commercial radio/radar manuals, 1938-1965. Many WW-II, Collins manuals plus military electronic handbooks. Send 25 cent stamp for list. Rainy Day Books, POB 775, Fitzwilliam, NH 03447. (603) 585-3448

FOR SALE: Tubes, new in box. Please send $1 for list of 300+ tubes. Refundable. Wilson Hauck. BTB. Inc. E.R., 6820 Stout Rd., Memphis, TN 38119

FOR SALE: Do you need tubes, parts, schematics? Send SASE. Nick Marshal, 2207 Peachland Ave., Sebastopol, CA 95472.

WANTED: WW-II military electronics; test equipment, radios, radar, odd-ball items, counter measures, APS-13; also manuals, books, articles pertaining to same. William Van Lennop, POB 211, Pepperill, MA 01463. (508) 433-6031

WANTED: Navy RAX CG-46115 rcvr and manual for Navy RAX-RAL rcvrs. Steve Davis, KD2NX, 2372 84th St., Brooklyn, NY 11214. (718) 265-2390

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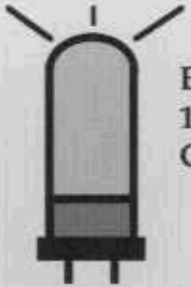

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