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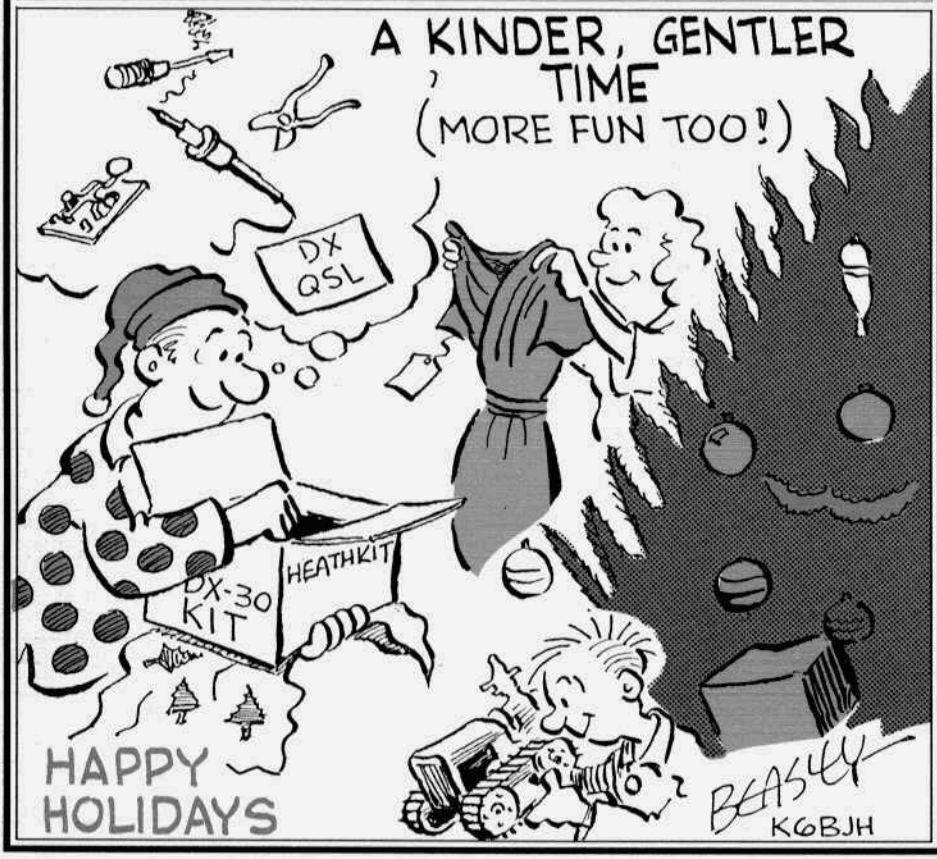
ELECTRIC RADIO

celebrating a bygone era

Number 56 December 1993



ELECTRIC RADIO

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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:

Walt Hutchens, KJ4KV; Bill Kleronomos, KDØHG; Ray Osterwald, NØDMS; John Staples, W6BM; Dave Ishmael, WA6VVL; Jim Hanlon, W8KGI; Chuck Penson, WA7ZZE; Jim Musgrove, K5BZH; Dennis Petrich, KØEOO; Bob Dennison, W2HBE; Dale Gagnon, KW1I; Rob Brownstein, NS6V; Dick Houston, WØPK; Andy Howard, WA4KCY; Skip Green, K7YOO; George Maier, KU1R; Albert Roehm, W2OBJ; Mike O'Brien, NØNLQ, Bob Sitterley, K7POF (photos) and others.

EDITOR'S COMMENTS Barry Wiseman, N6CSW/Ø

With this issue we've increased the size of the magazine by four pages. We hope to add another four pages in the spring. At that time - with the May issue - the price of the magazine will increase. We haven't decided how much yet. To offset the increase, which may be a hardship to some, we're allowing everyone to renew for up to three years at present prices until May 1.

In this issue we have our first article on NFM. Dennis Petrich, KØEOO, has put together an excellent overview article that should be of interest to everyone. As most of you know NFM was experimented with on the hambands in the '50's and then abandoned when SSB came into general use. Although this mode has drawbacks as compared with AM it does enjoy some advantages and should be experimented with further. It is definetely a vintage mode. In fact, Dennis could not find any modern ham equipment with NFM capability. Everyone should be cautioned that modern equipment with FM capability has a deviation of 5 kHz with gives it a bandwidth of 15 kHz and is illegal below 29 MHz. I hope that this article inspires others to get involved with NFM experimentation. I think that there is a great deal to be learned about this mode regarding its use on the hambands. Wouldn't it be great if we could enjoy 160 in the summer as we do in the winter? NFM might make this possible.

On page 2, of this issue, where it appeared for over three years, you'll see another and I'm sure the last "Reflections Down the Feedline" column by the late Fred Huntley, W6RNC. I found this article while rummaging through a box of old papers. It was like finding a gold nugget.

Shirley and I extend our best wishes for the holiday season. We hope everyone has a very merry Christmas and a very Happy New Year.

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Cover: In keeping with the tradition that we've established over the last five years, another fine Christmas cover by cartoonist/artist Robert Beasley, K6BJH.

Reflections Down the Feedline

by Fred Huntley, W6RNC, Silent Key

Manual CW a Dying Art

Radiotelegraphy is an art, a kind of music, a language. Manipulation of a hand or bug key can convey to the discerning listener the identity, the mood, nationality and individuality of the sender, just through his manner of sending.

Good CW is like music that flows with perfect character and space formations that emanate in a constant, uninterrupted stream. There have been many artistic practitioners of the hand and bug key, with an infinite number of individual variations. There was the Lake Erie Swing, the Banana Boat Swing plus various other styles of sending. Not to be excluded is the Sideswiper, which is in a class all by itself.

Various nationalities also had their own peculiar sending accent. Most of the time, as a commercial shipboard operator, I could tell just by the manner of sending whether the operator was French, Italian, Spanish, Scandinavian or English. Of course, Japanese and Mexicans were easy to spot. Various Oriental, African and Arabic operators had a totally different style of their own too.

Not only is it possible to know an operator just by the sound of his sending, it is also possible to detect his mood by the way he was sending at a given time. Call it intuition or whatever--but it is a fact.

Well-sent code by hand, bug or mechanical keyer is music, very definitely. It stirs the soul and inspires beauty. Its leading practitioners might be compared to Beethoven, Strauss or Mozart.

Good CW sending is a many splendored thing--but very sadly, it is diminishing and becoming a rare commodity. I trace the downfall of good CW to the advent of the electronic keyer. The first of these was the W9TO keyer, which was manufactured by Hallicrafters. While it was a good instrument and was capable of good code, it also was very capable of putting out poor code, when used by incompetent operators.

After the TO keyer came a long line of other electronic keyer--all with the same limitations--capable of sounding good or terrible, depending on the skill of the operator. After that came the deluge--electronic keyboards. It was the same as with the keyer--they could be made to sound either good or bad depending on the operator's skill.

However there were some exceptions. In the 1960's, W5FRJ (I believe that was his call) always sent flawless CW with a home-built keyer. The first Curtis keyboard was one of the best sounding KBs ever made. The Skipjack kit KB also was capable of very good CW with a good operator punching the keys. In recent years, various keyboards have come and gone. Almost all still were dependent on the operator's skill to be capable of putting out perfect code.

Most recently we've seen the introduction of the computer as a means of generating CW. They are not immune to sounding awful either. Really, there is no means of sending CW that is completely immune from operator butchering.

The Stradivarius of all keyers was (and still is) the old Boehme mechanical

keyer that was used by commercials and military. It operated on punched paper tape that was typed out on a Wheatstone Perforator keyboard--many made by Teletype Corp. Even mechanical tape keying is subject to operator deficiencies--but, in my opinion, the capabilities of a Boehme keyer to put out beautiful, perfect code has never been equaled by any electronic keyer or keyboard--including computers.

Good keying is not only having perfect character formation and spacing. It also means having a steady uninterrupted flow of text, unencumbered by excessive punctuation, etc. Good sending means having good transmitter keying characteristics--preferably slightly hard on the make and clean on the break. W1AW code signals are excessively soft and a poor example for radio amateurs.

Well--where do we go from here? The radio spectrum these days is covered with all kinds of weird sounding modes like packet, facsimile AMTOR, ASCII, etc. And morse radiotelegraphy signals are disappearing. At least, general coverage receivers (xcvrs) are coming back into style, but there is a diminishing availability of commercial CW signals that amateur operators can listen to. Most amateur operators have gotten their CW background by listening to other amateur operators. The system has been feeding upon itself. Amateur operator CW sending has become progressively worse over the years. No voice has been raised against it. We are overwhelmed with bum fists, bum keyers, bum keyboards.

As I said at the beginning, good CW is music, or at least it ought to be. Why does the amateur radio community tolerate the butchering of the morse code by 75 percent of the operators? Would we tolerate the butchering of musical compositions by Beethoven, Mozart, Artie Shaw or even the Beetles? ER

W6RNC with his vintage gear. The transmitter to the right in the corner was made by Technical Radio of San Francisco in 1945. This is the rig Fred used when he was net control for the Westcoast AM net on 3870.

The Elements of Collins Quality

by Fred Johnson
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Sachse, TX 75048

Operational dependability has always been an appreciated attribute of Collins equipment. There is evidence of that everywhere. The fact that Collins products proved reliable is no accident. Arthur Collins' philosophies determined that end result.

The purpose of what follows is to describe the design methodologies, and the environment, in which the reliable designs originated. Focus will be on the design "process", rather than on details of specific, type-numbered equipments. Time frame of subjects covered is from the late '40's to mid '60's.

The author's perspective is that of the Mechanical Engineering Group Head of the department in which Collins ham equipment was developed. Other equipment developments were ongoing in this group, as well as elsewhere in the Collins engineering organization. But, the principles were the same everywhere.

After a few introductory comments, the subjects to be discussed are under headings of design disciplines and development tools that were in use at the time Collins ham equipments were designed and produced. Taken together with the talents of the design personnel, these and related factors determined how the reliable designs originated.

Today, there are many hawkers of methodologies for statistical certainty and reliability. Taguchi, Deming, Crosby, Juran et. al. While much of what they espouse is valuable to uninitiated engineers, the principles they push are the stuff that was second nature and already long in practice by Collins en-

Fred W. Johnson (not a ham) started with Collins Radio in 1948 as a mechanical engineer. He later became the head of the mechanical engineering group involved in broadcast and HF communications equipment as well as ham equipment. He was with Collins to the end (1971) when Rockwell took over Collins. He continued with Rockwell-Collins until 1983. This photo was taken in the late '70's.

gineers at the time of ham equipment design and manufacture. Collins designs were not only centered statistically, they were in many instances thoroughly "worst-cased". That means that all tolerances on components would not detract from specified performance of the unit or final assembly.

It would be easy to claim more in this area than is warranted, but read on for details that fill in the picture.

The Collins engineer was part of an extensive team having elaborate support systems. This is an organizational scheme that keeps being rediscovered by progressive managements. In addition to technical expertise in several fundamental areas, the product design engineer

had available to him many specialized labs and shops to contribute to the design process. Because the product engineer couldn't reasonably have expertise in every area, support groups were set up with facilities and expert personnel from which the project engineer could draw advice and assistance.

Here are some of the disciplines and facilities that contributed to good, reliable designs. There is no relation of sequence to importance:

Oscillators

A small group of engineer specialists was responsible for design of virtually all MO's, BFO's etc. This group knew what there was to know about thermal expansions, coil linearities, backlash, humidity effects, vibration sensitivities, signal purity, crystal characteristics -- and on and on. They were always "consultants" to other engineers. Often, they did a detail design on a more or less contract basis to the product design engineer. The net effect was that the product engineer didn't have to worry about all the variables that are unique to oscillators. And, the quality of oscillator design benefitted from accumulated knowledge in the oscillator group. This is an early example of what the world later called a "center of excellence".

Component and Materials Group

A group of specialist engineers was tasked with sourcing, testing and qualifying all components to be used in Collins products. We called this group the "Spec Dept". A project engineer used these specialists to get the best parts at lowest cost. Reliability was a never ending concern. Thus, extensive testing preceded approval for use. And, approved components were required before a design could be released for production. It was generally recognized that you can't build a 100% radio without 100% parts. So, the project engineer wasn't allowed to screw up a design with unapproved components. In the end, this adds up to reliability.

A sub-set of the materials function was a Chem and Plastics lab. This group had information and facilities for evaluating dielectrics, making special model parts, chemical treatments, adhesives, and the like. When the project engineer needed help in these areas it was available to him at the PhD level.

Test Equipment

A special engineering group was responsible for all engineering test equipment. This included procurement, calibration, maintenance, distribution and storage when unused. The project engineer was assigned necessary conventional equipment for use in his lab.

When special needs arose, the test equipment folks could design and build. Or sometimes the project group would design and have the test equipment folks do the build. Special wide screen video-display spectrum analyzers showing the spectral distribution of 3rd order and other RF distortion products was a special test equipment designed and produced in-house. These units came into broad usage in the development of SSB equipments -- ham and others. Here again the knowledge of operational variabilities made for reliable designs. Lord Kelvin had it right: If you are unable to quantify what you are interested in, your knowledge is of a meager and insufficient kind. (slightly paraphrased).

Environmental Considerations

In addition to portable temperature chambers available at the project engineer's lab bench, Collins had a large environmental test function capable of hot-cold extremes, shock and vibration, humidity and cycling tests in any combination. This allowed the engineer to evaluate performance at his component, subassembly or complete assembly stage. Here is where worst-casing contributed to end product reliability in the field.

Shock and vibration effects at all levels of construction bear on reliability in

continued next page

several ways. Getting the packaged radio to the end user without damage is a non-trivial issue. The table top radios had to survive dropping from a truck tailgate in their normal packaging. More than once a substantial design change had to be made to meet this requirement. And then there are the modulation effects of vibration on system performance. All of these were tested as part of a development program.

A subset of environmental concerns was the thermal lab. Here a group of specialists designed and accumulated equipment for extensive search into thermal performance of components and assemblies. Variable air flows could be generated, measured and directed "anywhere". Flows from 3 lb/hr to 9000 lb/hr were possible, enabling evaluation of something as small as a half-watt resistor, a transistor, or a complete 5-10 Kw transmitter. Very special thermocoupling techniques were developed in the thermal lab. TC beads as small as .006" to .009" dia. were routinely bonded into tube envelopes, and onto the full range of components. The tight relation of temperature to reliability was always a serious consideration. Thus the special efforts to know exactly an equipment's thermal profile.

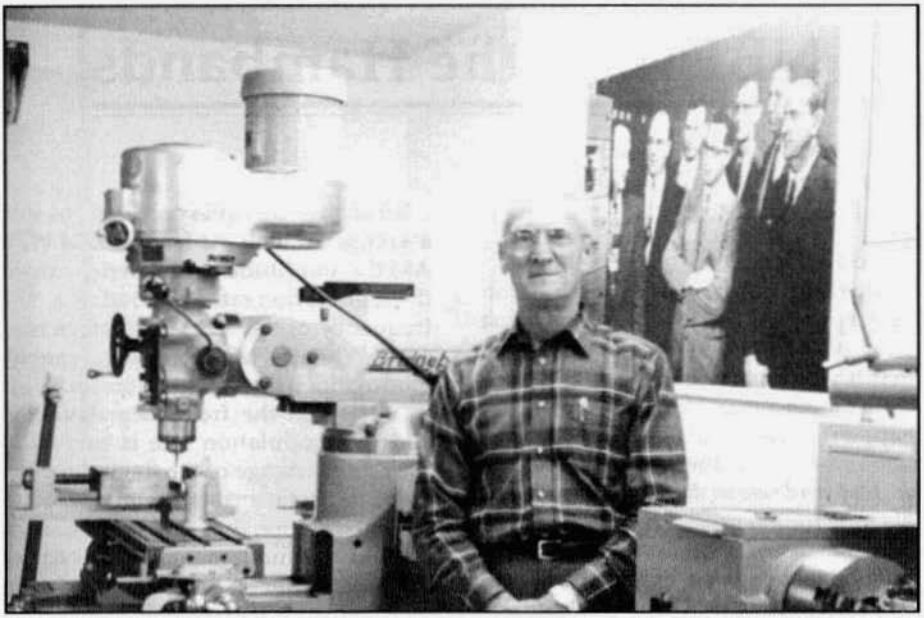
Placing thermocouples on components that are operational brings up the issue of accidentally contacted common mode voltages being injected into the thermocouple bridge inputs. It's not nice to inject this stuff into the thermocouple bridge. So, techniques were worked out to achieve isolation of RF, and a balancing-out of DC voltages that might be on surfaces to which the thermocouples were attached. Bi-filar Pi-wound chokes of copper/constantan wire were one technique for RF isolation.

Another isolation scheme was to feed the thermocouple wire through a tubular plate coil at the ground end. At the hot end the thermocouple was attached to the external anode tube. To null the high voltage DC, the entire thermocouple bridge was elevated to the plate voltage. Of course there were careful safety measures. These schemes were used to get anode temperatures from thermocouples buried in holes drilled into the copper anodes of 4CX250's, 4CX5000's etc. Voltages up to 6000 were handled. It should be obvious this is not a piece of cake. The driving motivation, however, was the quest for reliability, and the knowledge that heat is the enemy of longevity of electronics.

Our specially designed venturi airflow measuring capability in the thermal lab made it easy to quantitatively evaluate a blower's performance. Arthur Collins had arranged for Dr. Alexander Lippisch, who was one of the group of German scientists who came over with Werner Von Braun, to come to Collins for aerodynamic studies. Dr. Lippisch introduced us to flow-visualization techniques, and his inputs alerted us to the subtleties of recovering the velocity head from blowers. This led to the design of the 30S-1, which ended up with a "too small-looking" (but sufficient) blower mounted directly under the final tube socket. Because the blower is small it is relatively quiet, and the equipment is reliable. All this followed a predecessor design that didn't reflect this degree of thermal elegance -- but was equally reliable!

Wood Model Shop

A well equipped shop was maintained with skilled technicians who worked with designers to construct 3D scale models using balsa, birch, basswood, cardboard, etc. Arthur Collins and engineering management used the technique of making mockups to be sure an equipment plan was realistic before it was committed to detail design. EE's strong suits often don't include the ability to visualize things to scale in 3D. So, mockups were de rigeuer. Today, there are emerging techniques to construct models from computer-driven lasers



A Mech. Eng. in front of his 'gear'. The large photo on the wall was a retirement gift. Shown in this '50's photo are some of the men Fred worked with at Collins, From L to R; Ernie Pappenfus, Jack Smith, Warren Bruene, Dave Weber, Fred, Bob Miedke and Lou Coullard.

and layered photoplastics. The need hasn't changed. Remembering that reliability is the absence of surprises, the better a design is modeled, the fewer the surprises.

Metal Model Shop

When a design engineer had management approval of his schematic and a balsa model, the project mechanical engineer and draftsmen would make an accurate design layout. From that layout individual piece parts would be detailed, dimensioned, and toleranced on part drawings. These drawings were sent to the metal model shop with an order for a specified number of units to be built "the hard way". This means no permanent tooling. Completed parts were returned to the engineers who had technicians assemble them and wire the unit. The plan was to have the model as nearly like a production unit as possible. Ideally, all that would be needed at this stage was confirmation tests that design specs had been met -- with margin. If necessary, another round of parts might be required if something didn't come up to par. The equipment specification was the standard to be met. This model was used for the mechanical and thermal tests that lead to reliability.

Design Release

With a few variations, relating to the specifics of a given equipment, all designs went through a preproduction release procedure. Not infrequently a pilot production run would be made. From the moment of production release there were no more revisions to the drawings or specs without a formal revision approval procedure. This kept the design documentation up to date, and prevented the inevitable surprises when an engineer does something he thinks will "improve" the design, but hasn't done all his homework. Reliability, again, is no surprises.

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NBFM on the Hambands

by Dennis Petrich, KØEOO
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Introduction

Narrow band frequency modulation first appeared on the hambands just after WW II. It was thought by some that it would succeed AM as the principle phone mode. However that didn't happen; in fact it never really became popular at all and when SSB came into widespread use in the early '50's NBFM disappeared.

This article is designed to be an introduction to the subject of NFM on the HF frequencies.Other articles will appear in future issues that cover actual NFM receiver, transmitter and deviation measurement projects.

What is NBFM?

Narrow Band Frequency Modulation, or NFM for short, falls under the "phone" designation for all of the HF bands. The 1991 ARRL Handbook says, and I quote: **"Below 29.0 MHz, FCC rules limit the bandwidth of frequency- or phase modulation telephony to that of an AM transmission having the same audio characteristics. The full emission designation for such a signal would be 6KOOF3EJN for frequency modulation and 6KOOG3EJN for phase modulation. These designations break into: 6-KHz bandwidth, F for frequency modulation or G for phase modulation, single-channel analog, telephony, sound of commercial quality and no multiplexing."**

For example, above 29.0 MHz +/-5 KHz is the legal deviation for FM (that's 15 KHz bandwidth), while below 29.0 MHz the limit is as stated above. So, for NFM, how does one comply with the AM bandwidth rule as stated above?

To answer this question leads us into a comparison of AM and NFM.With AM the amplitude of the carrier carries the modulation rate and loudness. The frequency of the AM signal stays constant. While in FM, also known as angle-modulation, the modulation loudness is carried in the frequency deviation and the modulation rate is carried in the rate of change of the deviation. The amplitude stays constant in FM. With AM modulation there are no sidebands beyond the fundamental frequency of the modulation as long as you do not overmodulate. In FM this is not true. FM and PM produce many sets of sidebands that occur at integer multiples of the modulating frequency on both sides of the carrier. Mathematical functions developed by F.W. Bessel show the relationship between these sidebands. Refer to most any ARRL Handbook to see what they look like.These Bessel functions mathematically show the relationship of the amplitude variations of the carrier and sideband pairs with modulation index.

With respect to FM below 29.0 MHz, the 1991 ARRL Handbook continues on with : **"Thus, for voice, a modulation index of 0.6 and a 1.8 KHz deviation will ensure that the second pair of sidebands will be 27 dB below the unmodulated carrier level."** This "27 dB below the unmodulated carrier level" is important because that's the part that deals with the bandwidth of the sidebands created by FM and PM modulation. Again, keeping the highest audio frequency transmitted to around 3 KHz will assure a bandwidth that will meet the NFM definition without overdeviating. See figure 1.

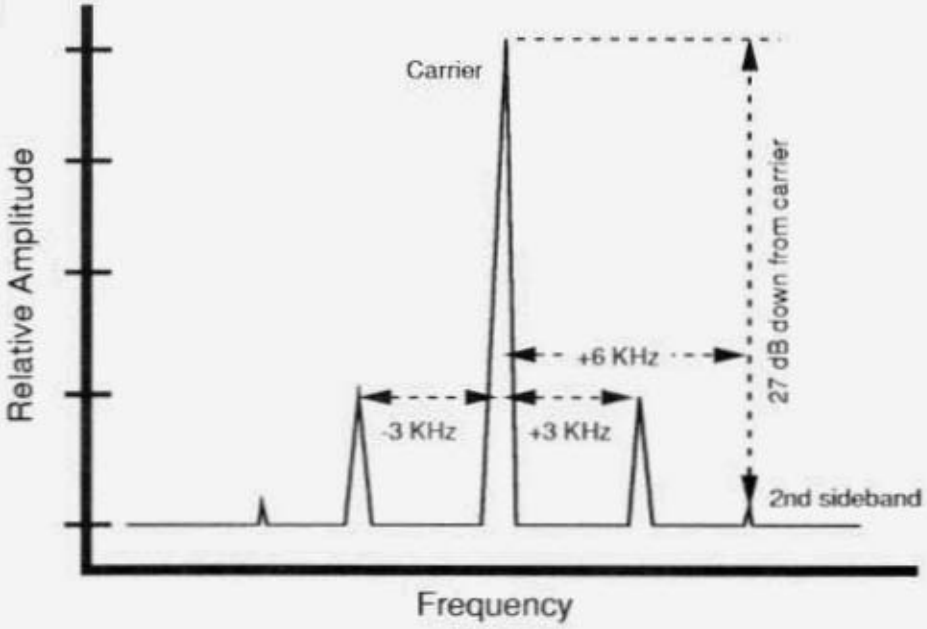

Figure 1

NOTE: An NFM signal has 25% of its amplitude in each sideband whereas an AM signal of the same carrier amplitude has an amplitude of 50% in each sideband. Consequently, depending on the transfer characteristics of the FM discriminator (see figure 2), the NFM signal would not sound as loud as an AM signal of the same power. With a discriminator designed for NFM's lower sideband energy, louder audio response should be possible. Depending on the NFM receive/transmit configuration, some believe NFM enjoys a 6 dB advantage over AM whereas under other circumstances the opposite is possible. More on the relative differences between AM and NFM later.

Also, with AM equipment, modulation is applied to the non-frequency determining elements of the transmitter, whereas with FM the modulation is applied to the VFO, as an example, and because of this, the equipment or operator must take into account that every time you multiply the frequency of the VFO the deviation is also multiplied. An easy way to overcome this issue is to monitor the deviation at the receiver or after the frequency multiplication has been done.

What is the difference between FM and PM?

Put simply: In FM, the change in the carrier frequency (frequency deviation) is proportional to the instantaneous amplitude of the modulating signal (the audio). FM is also capable of conveying DC levels, as it can maintain a specific frequency. In PM, the carrier phase is the characteristic that varies from a reference value. PM cannot convey change in DC levels unless special phase-reference techniques are used. This means that with PM modulation, deviation increases with both the instantaneous amplitude and frequency of the modulating signal.

So, in PM, deviation increases with modulating frequency while in FM it does not. This characteristic is a form of pre-emphasis built into PM and not in

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FM. This effect also causes the two to sound different in a receiver without some form of de-emphasis for the PM mode. My CE100V's PM mode of modulation sounds a bit high pitched because the FM discriminator plug-in in my HRO-50T has no de-emphasis circuit built in. For us to enjoy these two modes it will be necessary to take into account these variations in characteristics in some of the homebrew designs. If we leave PM modulators alone and add pre-emphasis to the FM modulators and de-emphasis to all of the receiver discriminators then both modes should sound equally good.

FM reactance modulation is normally used right at the VFO or crystal oscillator, while PM can be used on the stages after the oscillator. More discussion on these two forms of NFM is forthcoming. Each is quite easy to do, just hard to explain compared to AM. For example, a single tube or transistor stage can modulate a 1.5 KW transmitter using PM or FM. Also, the same discriminator techniques can be used to receive both PM and FM signals.

Advantages of NFM as compared with AM or SSB

To enjoy many of the following advantages of FM the receiver must use a form of FM limiter/discriminator to eliminate the amplitude variations of the received signal.

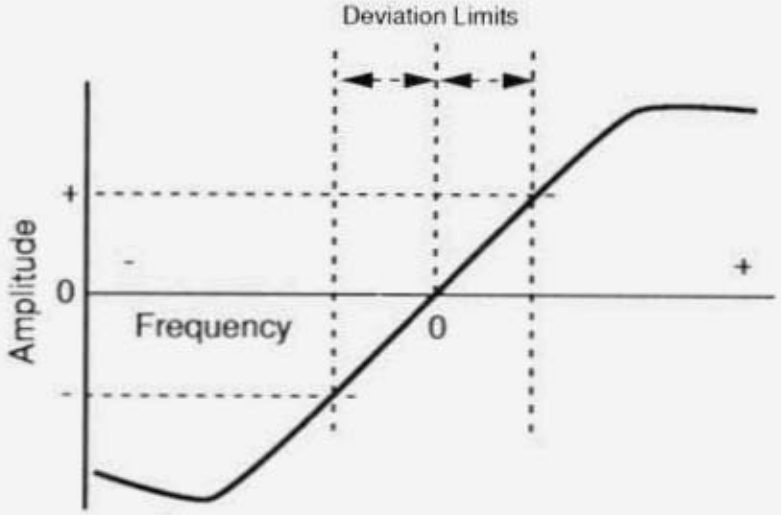
1. NFM has comparable audio fidelity to that of AM. (Better than SSB)
2. Because of the limiter/discriminator detector in the FM receiver QRN due to electrical storms, ignition noise and interfering signals is all but eliminated.
3. The plate modulation power required for 100% AM is eliminated.
4. NFM can be amplified by class C amplifiers. 75% efficiency vs. 55% for linear amplifiers.
5. NFM can legally run 1.5KW output! (Put those "Desks" and KW-1's back to full power.) (What has more punch? A 375-watt carrier or a 1500 watt carrier??)
6. Because there is no amplitude variations transmitted with NFM, there is no TVI, BCI, stereo interference or telephone interference generated!! (NFM should be called the "Prime Time Mode". Some old articles I came across from the '50's mentioned NFM as a mode used to beat BCI/TVI in the early evening.)
7. Because of the amplitude limiting in the receiver the effects of QSB are significantly reduced as compared to AM. (May be replaced by phase distortion.)
8. Due to a phenomenon called capture effect with FM, weak QRM that would cause noticeable interference to AM or SSB signals will not be heard on FM until it becomes stronger than the signal you were listening to.
9. Deviation adjustment of an NFM signal can be done at low power levels without having to turn on the high power amplifiers.

Speech processing is useful with NFM. Some form of limiting or compressor/clipper will increase the talk power with low distortion. Remember though, if clipping is used to make sure that an audio low-pass filter with a cut-off frequency of between 2.5 and 3.0 KHz is used at the output of the clipper.

Disadvantages of NFM as compared with AM or SSB

1. Measuring modulation deviation to comply with FCC rules for below 29.0 MHz.
2. Transmitted bandwidth is 2X that of SSB. (It's the same as AM.)
3. Phase distortion may be noticed when signals travel via the ionosphere.
4. Most ham equipment does not have NFM capability.

The disadvantage list is quite short as compared to the advantage list. But any disadvantage can be a show stopper if you cannot overcome it. It seems to me that the big issues here are effectively



Characteristic of an FM discriminator

Figure 2

measuring your bandwidth or deviation and putting some form of limiter/discriminator into your receiver. Providing FM or PM modulation should be quite simple. In fact many of the vintage transmitters were equipped with NBFM features. More on that later.

Overmodulation

Overmodulation on an AM signal, as we all know, causes splatter and distortion on the transmitted signal and in the receiver. With FM there is no equivalent to AM overmodulation. With FM, as you turn up the audio gain you increase the frequency deviation from the center frequency, which increases those Bessel function sidebands. The only distortion to the transmitted signal will be if you increase the audio gain beyond the linear response of the FM modulator circuitry.

With FM the distortion of over deviating the transmitted signal is determined by the response of the receiver discriminator. So, in effect, 100% modulation for FM is reached when the transmitted and received deviations match each other. For example, if your NFM receiver IF and discriminator was designed for a 6 KHz bandwidth (+/3 KHz), then deviating your transmitted signal beyond a bandwidth of 6 KHz will cause distortion in the receiver. The converse is also true, if your receiver was designed for a bandwidth of 15 KHz, like FM for above 29.0 MHz, then that same 6 KHz transmitted signal will sound undermodulated. See Figure 2.

To my knowledge only vintage equipment is available that has been designed to have deviations that meet the 6 KHz bandwidth requirement for the HF bands. If one tries to use one of the late model transceivers with FM capability be aware that the deviation must be reduced and when this is done that the audio amplitude will sound undermodulated because the discriminators in those transceivers were designed for greater deviations. Also, if you compare that same NFM signal to an AM signal the AM signal will sound louder, even though the loudness difference is only because of the deviation mismatch between the NFM adjustment for the

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transmitter and receiver discriminator which you cannot adjust. Wow, that was a mouth full!!!

Monitoring or measuring your NFM bandwidth

Measuring and correctly adjusting the audio gain/deviation of your transceiver or vintage transmitter is important for proper operation as has been discussed. Several techniques are presented in detail in all of the ARRL Handbooks from about 1950 to the present. All of the techniques are good but the later handbooks apply some newer technology to the problem.

Another technique for measuring deviation was just recently described in the October 1993 issue of QST. It's called the DevMtr and was designed by Lyle Johnson, WA7AXD. I'm currently in contact with the author of this article to see if it can't be modified for 455 KHz IFs. The meter kit costs under $100 and is self-calibrating through the receiver's IF. It measures and displays the transmitter deviation directly! More on that later.

One of the best techniques I know of is to use a spectrum analyzer or Panadapter on your receiver. Many of us already have these installed and in use. With the Panadapter or Scanalyzer you can visually see the carrier and generated sidebands. The deviation of the transmitter can be adjusted to look like that of figure 1. As was mentioned before, this adjustment can be done at low levels. Hallicrafters, Heathkit and others made ham band spectrum analyzers for years, so, put them to good use on NFM. The SP-44, HO-13 and SB-620 are ham adapters often seen in the want ads and would work well in this application.

Getting on the air with NFM

I went over to the local HRO store the other day and looked through over six of the late model transceivers that have FM capability on the HF bands. All of the models reviewed said that their FM was to be used above 29.0 MHz and were spec'd at +/-5 KHz of deviation (that's 15 KHz bandwidth!). In fact, the deviation of several models had been adjusted at the factory and didn't have front panel controls. The good news is that all could be adjusted as long as you use some technique to guarantee a signal no wider than 6 KHz bandwidth (+/-3 KHz).

Another way to the airwaves is with vintage equipment and there is a pretty good list of gear with this time forgotten mode ready to go.

Transmitters

Central Electronics 100V, 10B and 20A; AF-67; HT-18 and HT-19; Some models of the Meissner Signal Shifter; Collins 32V-1 and 32V-2 if you have the 148B-1 plug-in; Peter Brickey, KD6ADR, found an aftermarket product called a "Bee Bee" model 500 NBFM reactance modulator unit for use with existing transmitters. It's a neat little unit that can be used today. If anyone knows of other such units please write to ER.

Receivers

Here's the short list of receivers with NFM capability: Collins 75A-4, 75A-3 with the 148C-1 plug-in; National NC-183, NC-183D, HRO-50, HRO-50-1, HRO-60 with the NFM-83-50 plug-in and the NC-173 with a different plug-in; Hallicrafters SX-71 and SX-73. The NC-300 and NC-303's have accessory sockets that will accept NFM adapters and are selectable from the front panel mode switch position "ACC". The National NFM-83-50 adapter fits electrically but not physically into that spot.

A temporary solution to receiving an NFM signal on one of the vintage receivers with only an AM detector is to use a technique called "slope detection". To use this technique just tune off to one side of the center frequency of the NFM signal. You will notice that the audio loudness will increase as you do this. But, be careful not to draw too many conclusions about the effectiveness of NFM if you use this technique: without a limiter/discriminator many of the benefits of NFM are not realized.

Homebrew

An FM reactance modulator can easily be added to any of the vintage VFO's such as the EFJ-122, Heath VF-1 and those made by Globe, Knight Kit, Hallicrafters and others. The 1950/'51 ARRL Handbooks show tube circuits and the newer handbooks show solid-state versions. Limiter/discriminator circuits appear in old as well as new ARRL Handbooks and can be made into plug-ins for most of the receivers mentioned above.

The idea is to make this NFM stuff easy and fun! I hope that others who share this NFM curiosity will join in and contribute ideas, projects and results of your own experiences either new or old. Again, more on this later.

NFM Nets

An NFM net is starting on 75 meters at 3855 KHz on Thursdays at 8:30 PM. All you need is NFM transmit capability to check in. So, if you're interested in some joint experimenting please don't hesitate to jump in. I know this time and frequency helps only the westcoasters but 40 is too noisy with broadcasters in the evenings and 20 meters is all but dead after about 7 PM. I would be willing to try other alternatives, so, just write or call. Also, if other NFM nets get started I would like to know about them.

Conclusions

In doing the research for this article I became rather impressed with the potential capabilities of NFM on the QRM/QRN filled HF bands. I wonder if it might not be a good time to take out and dust off this forgotten mode and see what it can do for us against the QRM of SSB and the power restrictions on AM. I think some experimentation is called for. As many of us that can need to get on the air with NFM to shake out the problems and see if this mode can really give us good audio quality, no QRN and don't forget NO TVI or TELEPHONE INTERFERENCE!! ER

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1949 Hints & Kinks
1950, 1951 ARRL Handbooks
Collins 75A-2 manual
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QST, Sept. '46, p 73, "A New Approach to FM Reception".
QST, Oct. '60, p 164, "Frequency vs. AM Modulation" by National Radio.
QST, June '60, p 41, "NFM Adaptor for NC-300"
Teenews, March 1952, "Phase modulator With De-emphasis"
NFM-83-50 adapter data sheet for HRO-50/60 and NC-183/183D receivers
Shrader, Electronic Communication, third edition, Mc Graw Hill
"Bee Bee" model 500 NBFM reactance modulator data sheet
1961, RSGB Handbook

Editor's Note:

At this point in time I think there are many unanswered questions regarding 'NFM in the hambands'. It's going to be interesting and a lot of fun experimenting with this mode over the winter. By spring I hope we have come to some clear understanding of this mode's capabilities. Wouldn't it be great it NFM gave us the use of 160 meters in the summer months.

IT SERVED ME SO WELL BEFORE IT DIED, I'D LIKE TO HAVE IT STUFFED AND MOUNTED

LETTERS

Dear ER,

I just had to write you a note and thank you for printing my letter in the September issue! It's nice to know that there are others out there who think that the state of the art is still hollow and are interested in good audio.

The reason for this letter, though, is not for that. It is to thank you for the wonderful idea of the "Electric Radio" T-shirts. Recently I wore one to a hamfest and it attracted great attention, so much so, that I ended up coming home with a radio that I had been searching for for a while. A fellow ham at the swapfest saw the shirt and asked if I collected old radios. After an affirmative answer, which I expressed cautiously as you never really know where someone is coming from, he asked how I would like to acquire the KWS-1 that was sitting in his garage about 35 miles from the fest.

My friend, Sulphur John, WD5EHS, was with me when the gent made the offer. While I was asking the ham about the condition of the rig, John was dancing like a 4 year old on the way to a postponed trip to the bathroom! He was as excited as me but he showed it more! Needless to say, I agreed to the price and now I am the proud owner of one of America's finest. All this is because of wearing the "ER": T-shirt!

The T-shirts are great attention getters and may in fact give one a greater enjoyment of the hobby! I won't promise that the shirts will scare off mad dogs or make beautiful women fall into your arms, but a rig or two might just crawl out of the shadows because of the shirt. I know that in the future any hamfest I attend, my trusty "ER" T-shirt will be there too!

Rick Blank, KI5SL

Dear ER

I hear so many people say that they have a "mint" this or that. As you know, mint means brand new equipment still in its original box and wrapper which has never been opened or used. The term "mint" obviously comes from the coin collecting industry. A mint coin is one that has been put into a protective plastic envelope immediately after it has been stamped at the government mint. By definition, the coin has never been put into circulation or touched by human hands since the time it came off the stamping machine at the mint. There is certainly not much, if any, of that stuff floating around in the way of used ham gear nowadays.

Generally, people upgrade their equipment many notches when they go to sell it. (Puffing the product.) This has to stop. Absolute honesty in the descriptions of quality and cosmetic condition must be stressed as many of us purchase this gear sight unseen. We depend on honest, accurate descriptions of the gear right down to the smallest scratch or modification.

Our hobby stoops to an all time low if there is no integrity within the halls of our own fraternal organization. I could write volumes of horror stories on the subject of used gear for which I have been stung, as I am sure that most of us in the collecting biz could. This is by no means an indictment of all sellers of used equipment. There are many sellers that are totally up front about their gear, and they have my deepest respect. So what if there is a scratch or a simple modification? It will probably have little effect on the price anyway. Let's face it, no gear 30 or 40 years old is going to be anything near perfect, and if you want the piece bad enough you are not going to question the asking price too vigorously. But, it is important to know what you are getting into up front so that there are no surprises when the gear arrives on your doorstep.

Peter Brown, KH6IRT

Dear ER,

The article by Brian Ryan on Russian military aircraft radios (ER # 53, Sept. '93) was interesting. However, I will take issue with the assertion that the BC-348 clone came from a B-29 bomber's radio set. More likely the clone came as a result of thousands of radios and other equipment sent to Russia during WW II under the lend lease program. During the '50's it was not uncommon to talk to Russian hams who were using BC-348 or similar receivers. Attached is a copy of a 1959 QSO card from UA9DM in Sverdlovsk who was using a BC-312 (Sverdlovsk was later made famous by Gary Powers). Often they simply indicated how many tubes were in the receiver but when they had a BC-312 or BC-348 they said so.

At the time of that QSO I was using a DX-35, SX-99, and 3-element beam and was glad I wasn't trying to work 20 meters with a BC-312!

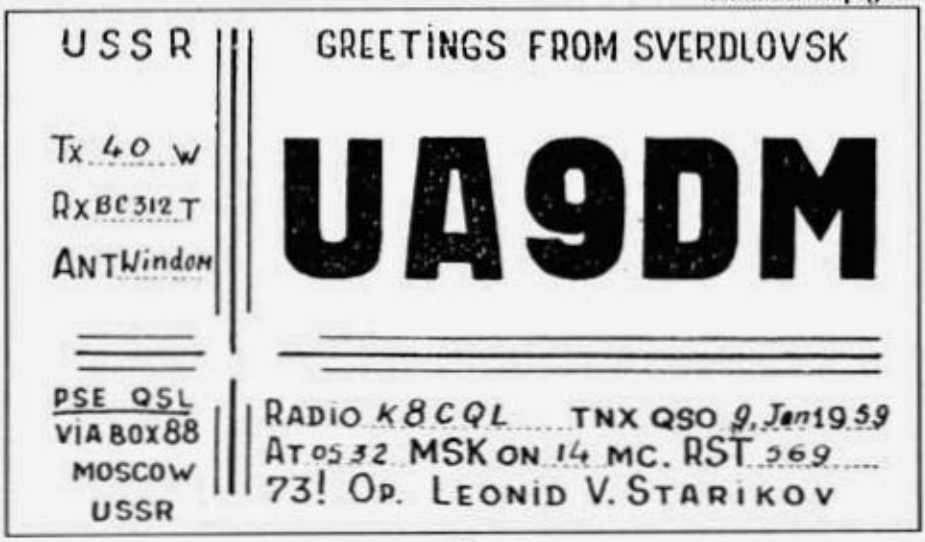
Ken Lakin, KD6B

Dear ER,

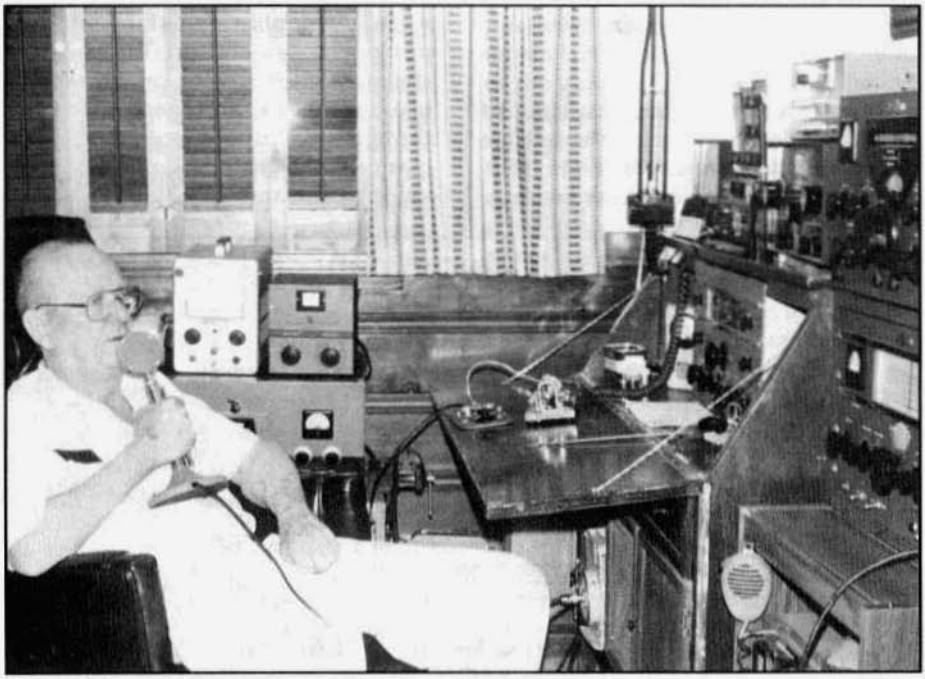
Ray Osterwald's description of "cathode interface" in his article "Thermonic Mysteries" (ER#54, Oct. '93) evoked memories of my encounter with that effect in 1952. I had just joined RCA's Broadcast Systems Division and was assigned to complete product design of the TA-4 Pulse Distribution Amplifier. This project had been started by *ER* contributor Bob Dennison, W2HBE, who went on to devote his design skills to the RCA TA-7, television's first special effects generator.

The pulse DA removed hum and reshaped pulse signals utilized in TV plants. It consisted of a regenerative clipper followed by four high-perveance triode line drivers, each feeding 4-volt negative-going pulses into 75-ohm coax lines. The output tubes were two GE 6BX7 dual triodes, although they were branded "RCA," a common practice among tube manufacturers. The TA-4 was soon ready for production release - or so we thought! At the very last moment, however, I noticed some prototypes were developing overshoots on output pulses which initially had ideal shape. As time went on, this effect became worse and new tubes, although providing excellent performance when installed, gradually developed the anomaly.

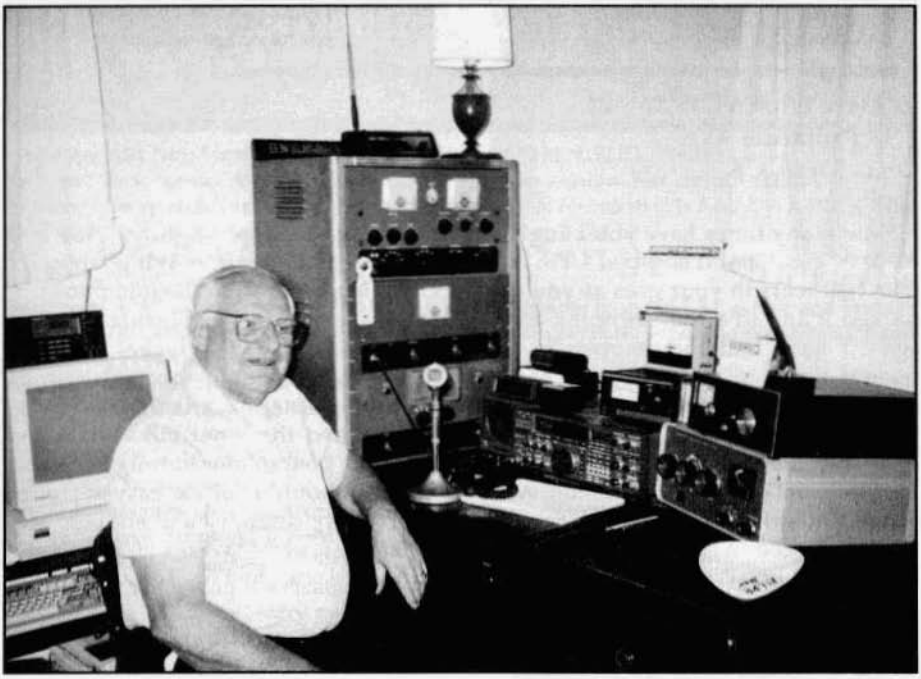
continued on page 36



Edward Mantick, N3GWE, with his GWE-1 (Great Watt Emitter) homebrew transmitter that he completed this summer. The transmitter consists of a single 813 modulated by 811A's.



Zeke Adair, W5LUT, in his shack. He worked for Collins in Dallas for about ten years so he says he has an affinity for Collins Radio stuff. He uses an RCA CR-88 and a 32V-2 on all bands. He says he's happiest on 29 Mcs.



Don Schwardt, W6RIQ, in his Waverley, Ohio hamshack. The transmitter is a Globe King.

Jim Jorgensen, K9RJ, with some of his vintage equipment which includes a Collins KW-1 and Johnson Desk KW. Sitting on the desk is a Ranger, a Valiant and a 75A-4.

Packaging Gear to Survive UPS

by Dave Ishmael, WA6VVL
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Costa Mesa, CA

How many times have you bought a piece of gear, had it shipped UPS, and then had tears in your eyes as you unpacked it and saw the "shipping damage"? I have had this happen to me several times in the last two years - more than enough to make me uncomfortable about buying gear that needs to be shipped via UPS.

In spite of UPS' poor reputation, ALL of the units that arrived via UPS that were damaged in shipment were NOT the fault of UPS. While it is true that the damage occurred during shipping and/or handling, the damage could have been prevented by "proper" packaging.

Like beauty, proper packaging is "in the eye of the beholder" and is only "skin deep" - it's what's inside that counts. In shipping electronic gear via UPS, you have to plan for worst case shipping/handling scenarios. To that end, I will usually use a double-box packaging technique. The following is a thumbnail sketch of my double-box technique:

* Place the unit to be shipped into a plastic bag and tape it shut. This will keep the shipping material from getting into the unit. Make sure that the AC line cord won't scratch the cabinet or front panel - keep it outside the plastic bag if possible.

* Tightly wrap the unit in several layers of foam or large bubble wrap. wrap in all three directions.

* Place the wrapped unit inside the inner box using a four inch clearance all the way around, top and bottom. Using peanuts, center the unit in the inner box. Pack the peanuts tightly. When you close and tape the inner box, the box should bulge slightly. This will minimize the unit moving around/changing location in the inner box.

* Place the inner box inside the outer box using four to five inches clearance all the way around, top and bottom. Using peanuts, pack it the same way you packed the inner box. When you close the box, it should bulge slightly. The box shouldn't be too easy to tape or it probably doesn't have enough peanuts. Use several layers of tape top and bottom to seal the box. Tape the edges.

Additional Notes:

* **DON'T USE PAPER AS A PACKING MATERIAL!** It compresses and will allow the unit to move around inside the box - bad news if there is a heavy power transformer on a thin gauge aluminum chassis.

* Pack the unit as tightly as possible. The box should bulge slightly after taping.

* Keep the unit away from the sides of the box. Expect the outer box to be penetrated and/or dropped.

* Generally speaking, the larger and heavier the unit, the more clearance required inside. If you're not sure, increase the clearance. The clearances I stated above are extremely arbitrary - use what works for you. **ER**

Editor's Note:

Putting the peanuts in plastic grocery bags will prevent a mess when the gear is unpacked and may also be beneficial in preventing migration of the gear around the box.

VINTAGE NETS

Westcoast AM Net: Meets informally, nightly on 3870 at 9:30 PT. Wednesday at 9:00 PM PT they have their formal AM net which includes a swap session. Net control rotates.
Southeast Swap Net: Tuesday nights at 7:30 ET on 3885. Net control is Andy, WA4KCY. This same group also has a Sunday afternoon net on 3885 at 2 PM ET.
Eastern AM Swap Net: Thursday evenings on 3885 at 7:30 ET. This net is for the exchange of AM related equipment only.
Northwest AM Net: Recently started by Pat, K7YIR, this net is on 3875, Mondays and Fridays at 9:30 PT. This same group meets on 6 meters (50.4) Sundays and Wednesdays at 8:00 PT and on 2 meters (144.4) Tuesdays and Thursdays at 8:00 PT.
Twenty Meter AM Net: This net on 14.286 has been in continuous operation for at least the last 20 years. It starts at 5:30 PM PT, 7 days a week and usually goes for about 2 hours. Net control is Les, K6HQI.
Arizona AM Net: Meets Sundays at 3 PM MT on 3860. On 6 meters (50.4) this group meets at 8 PM MT Saturdays.
Colorado Morning Net: An informal group of AM'ers get together on 3875 Monday, Wednesday and Friday mornings at 7AM MT.
DX-60 Net: This net meets on 7290 at 2 PM ET. Net control is Jim, N8LUV. This net is all about entry-level AM rigs like the Heath DX-60.
Military Net: It isn't necessary to check in with military gear but that is what this net is all about. Net control is usually Walt, KJ4KV, but sometimes it rotates to other ops. It starts at 5 AM ET Saturday mornings on 3885.
Grey Hair Net: The oldest (or one of the oldest) 160-meter AM nets. It meets on Tuesday nights on 1945 at 8 PM in the winter and 9 PM ET in the summer.
Vintage CW Net: For CW ops who enjoy using vintage equipment.This is not a traffic net; speed is not important. The net meets on 14.062, Saturdays at 3 PM PT. Net control is Tracy, WB6TMY.
Vintage SSB Net: Net control is Chuck, N5SWO. The group meets on 14.293 at 1 PM CT, Sunday afternoons.
Collins Users Net: The oldest of the 'users nets'. It meets on 14.263 Sunday afternoons at 2 PM CT. The net control revolves. This group also gets together for an informal ragchew on 3805 Tuesday evenings at 7 PM CT.
Drake Users Net: Another relatively new net. This group gets together on 3865 Saturday nights at 8 PM ET. Net controls are Criss, KB8IZX; Don, WZ8O; Rob, KE3EE and Huey, KD3UI.
Heath Users Net: A new net started by Marty, WB2FOU/5. Net control is shared by Fred, AA5LW. It meets on 14.275 at 4 PM CT Sundays. Check in on either AM or SSB.
Swan Users Net: This group meets on 14.250 Sunday afternoons at 4 PM CT. The net control is usually Dean, WA9AZK.

Fifth Annual ER 160 Meter AM Contest

One night only this year, **Sunday December 26**, from 6 PM until 12 midnight ET. One point for each contact (AM stations only), five extra for working an AMI member and recording his number. All scores from logs sent in by January 25 will appear in the February ER. Logs should contain the following information from stations worked: name, call, QTH, signal report, gear (rx and tx), antenna, time and AMI number.

The SW3 and I... and Other Stories

Part 1

by Roger Faulstik, KD4AS
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Jim Hanlon's excellent October ER article on the wondrous SW3 is a great mixture of early 1930's radio history, personal experience and technical information. I decided that in my early years I hadn't really appreciated this very interesting and fun piece of equipment. With the recent acquisition of a pristine SW3 with coils and many sheets of original National documentation, I couldn't resist sitting down at my computer, clearing the cobwebs off over forty years of ham radio and remembering how it was when I first laid my young hands on a SW3.

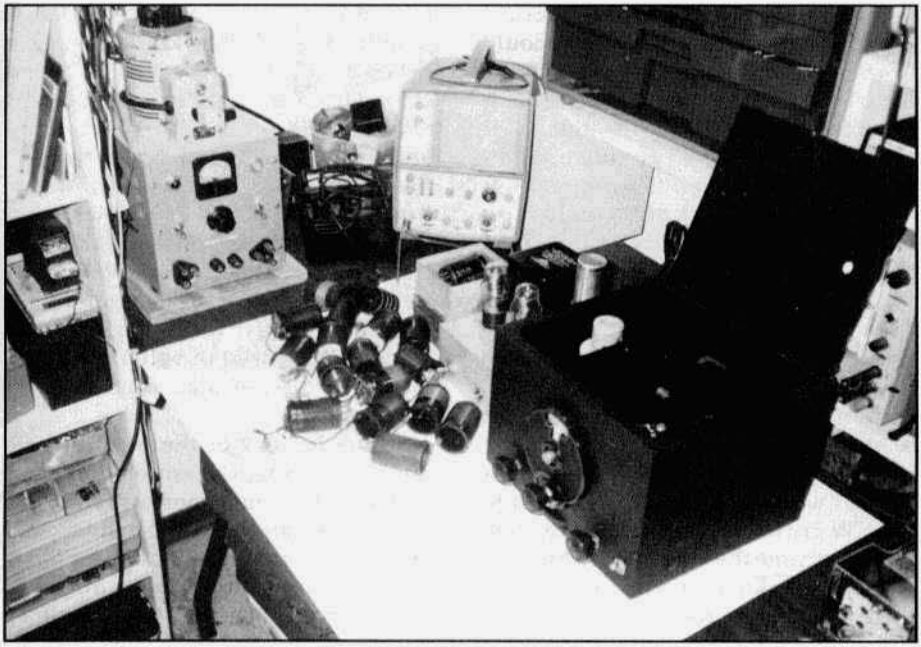
I had never used a SW3 for ham communications. However, I occasionally did listen to the Ham bands, utility stations and sometimes slipped down below 500 kHz to explore the circuitous world of LF. My experience with SW3's is probably quite different from what the average ham my age would have experienced. So, SW3 aficionados let's go back to my ham world, right after WW II.

With the dramatic advances made in component and equipment design during the war, even to a young twelve year old, the SW3 seemed to be a archaic, quirky, funny looking piece of equipment. However, due to its excellent mechanical design, it could be easily converted and provide the basis for building any number of electronic projects. An old 1931 design, broad as a barn "blooper" regenerative receiver was not very interesting to most 1949 amateurs.

My ham world was dominated by military surplus. The surplus market was full of fairly high performance military receivers that were just asking to be converted to neat double conversion designs with cascade front ends that gave outstanding performance. Or if you had the money (I didn't) you could buy an AR-88, HRO-5TA, a Super-Pro or maybe some Hallicrafters junk, that were usually repackaged 1939 designs. I took the less costly route and I built (usually out of ARC-5 parts) several double conversion receivers that easily outperformed most anything on the market, commercial or military surplus. In those days, I would have been considered a real war surplus animal. I knew every scrap yard, surplus dealer and military auction facility within two hundred miles of Chicago. This was about as far my father would drive me.

In the exuberance of youth, I must have destroyed at least five or six SW3's for parts or converted them to some other use. They were available for next to nothing or for free. When I got my hands on a nice clean SW3, I would use the cabinet, variable capacitor and vernier dial and toss out the strange audio coupling network and the weird coils that didn't fit anything except other SW3's. I noticed that when you threw a coil up against a cement wall they kinda shattered like a clay hand grenade.

The low frequency coils were especially nice because of the heft of all that fine wire. (Kind of sounds like I was a young 'Conan the Electronic Barbarian'). . . .could be. . . But you have to remember gentle reader, in the days of the fifties and sixties, old prewar equipment didn't seem to have much interest or value. Remember all that old ham gear stacked three high at the hamfests?



The author's SW3 and coils on his workbench.

I converted SW3's into preselectors, converters, antenna bridges etc. One of my most successful SW3 conversion projects was a completely self contained, 15-watt CW transmitter, with power supply, 6AK5 VFO, 6AG7 PA, band switching from forty to ten meters. Surplus 6AK5's were sometimes notoriously microphonic, were reasonably stable as a ECO, and best of all, they sold new for ten cents at the local electronics junk shop.

I soon discovered that by talking loudly into the oscillator compartment and with the top lid at a certain magic angle, I could actually frequency modulate the rig. My father accidentally walked in when this was going on, and told my mother, "I have accepted that the kid is a little strange, but young Proteus Steinmetz has passed beyond the point of strangeness, he seems to be having a discussion with his receiver." The audio was a little bassy, and when my nose got near the oscillator coil the frequency pulled. But to a young scientist, it was the great thing for night round tables on the old eleven meter band with my electronic buddies. It seemed that some production lots of 6AK5's manufactured and/or packaged by 'Generous Electric' developed a obscure type of problem that was traced to a loose internal structure which acted like a low mass condenser microphone. I was the only kid in town always looking for microphonic 6AK5's.

I used to get complaints about the audio and to "please keep my nose away from the oscillator". They got tired of chasing me up and down the band. However, it was their lot to suffer, after all, I was transmitting a composite signal with both AM sidebands and with plenty of FM deviation. If my signal didn't meet with their expectations, they were being unnecessarily critical. I told them to move up to seventy five meters with all the old class A hard nose operators. The signal definitely had a certain style and sound, and it was reported to me that some other amateurs couldn't

continued next page

really figure out what mode I was using. But nobody got upset, you could hear some very strange signals on the old eleven meter band; including bootleg kids, wide band FM, something that sounded like Class D modulation, dielectric heaters and other esoteric signals. . . .Come to think of it, you can still hear very strange signals on that band today. I finally gave in to the constant verbal abuse of my peers and designed a Mark II version and changed the 6AK5 to either a 6AK6 or 6AU6 and added an additional tube for screen modulation. For some reason the local older hams seemed much friendlier.

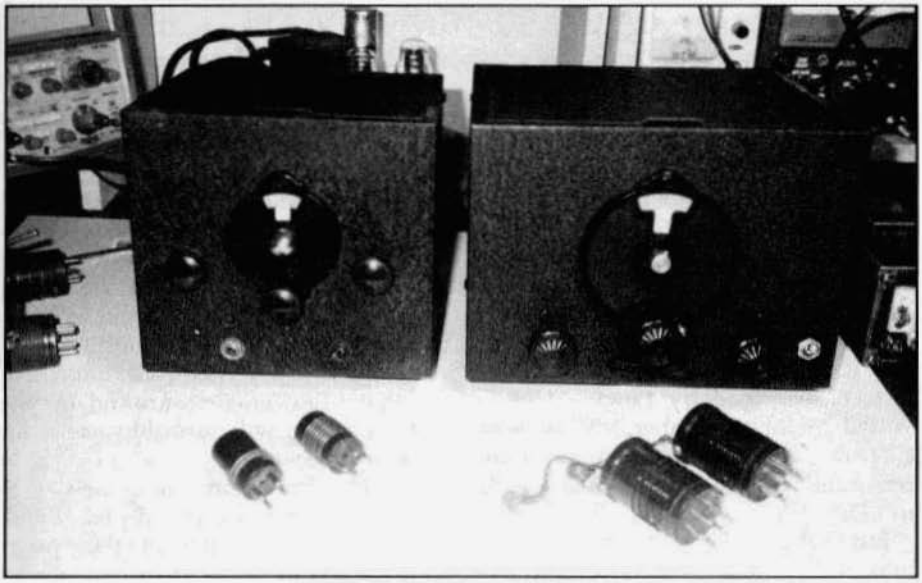
The little transmitter was so successful that when the word got around to the CW crowd six or eight more were built. I became the king of 'SW3 busters; you can thank me in part for the high prices demanded for SW3's and accessories today. I was even asked to write an article for either *CQ* or *S9* magazines, however about this time I discovered the wonderful world of girls and besides, my technical abilities far exceeded any writing talents.

Over the years, I always have had several SW3's sitting in my shack and never thought much about them. Out of the six or so spare National dog house power supplies I've owned, I had two of the 5880 AB power supplies. As I remember, I purchased them from Newark Electric in Chicago. I guess the Poncher brothers got tired of looking at them. They weren't exactly a hot sales item. Since my two-volt National receiver already had a power supply, they just sat in my garage looking for a home. At the time I wasn't sure what piece of National gear they were supposed to go with. Nobody else seemed to know and I never had an SW3 manual, like the SW3's, they had become only a historic curiosity.

Recently at the local Melbourne, Florida Hamfest, I felt that I had stepped back into a 1930 time machine. Being fleet of foot, swift of hand and blessed with the eyes of a hawk, (prerequisites to be a certified 'hamfest animal') I purchased from an estate an almost perfect SW3 with 18 sets of general coverage and band spread coils plus two additional pieces of 1930 National equipment; a model TRM five meter transceiver and a model SRR 80 to 5-M rx that looks just like a little SW3. Modestly forbids me from mentioning the reasonable sum that I paid. However, I have been accused of suffering from a incurable disease diagnosed as 'tight pistons'.

Struggling out of the hamfest with my fifty pounds of treasure, I witnessed an amazing phenomenon. As I was passing by a small group of hamfest animals, they suddenly stopped talking and their noses turned in my direction, and their bright eyes started scoping out each passing ham. They had detected (in parts per million) the rich aroma of vintage National. It is a hard to describe, a delicate mixture of old wrinkle paint, mildew, and the slight bouquet of rusty iron. As they zeroed in, the bottom of one of the larger boxes filled with 1930 goodies split, and a dozen SW3 and SW5 coil sets in their original National boxes (still wrapped in paper) started falling on the ground. The horde started acting like hound dogs in heat. Quick nervous movements, gimlet eyes, intense investigation of me and my treasure. . . . .Bold questions like "what have you got there old man?" (as if they didn't know) Ah. . . . . .say there fella, do you want to sell that old piece of equipment or those old coils? I need some for parts. . . . . Hey buddy where did you get all those big boxes of that old stuff, is there any left?. . . . .I quickly got to my car, looked around for other 'animals' that might be lurking in the grass, and locked the boxes in the trunk.

There haven't been a lot of articles since the 1930's written about the SW3



A view of the rare SSR 5-80-meter receiver with an SW3

series of radios, considering that National manufactured over ten thousand over a period of approximately fifteen years. This has to be a production record for a radio that was specifically designed for radio amateurs. Some of the best of the articles are as follows.

Bill Orr (one of the great ham authors) wrote a classic article, "The National SW3 Receiver: Revisited" *CQ* February 1978. It is one of the most definitive articles ever written on the SW3. It's four pages of elegant writing is a must read for every SW3 aficionado.

John Nagle wrote an excellent article titled "The SW5 A Pioneer Amateur Receiver" *CQ* November 1978. The SW5 is like an SW3 with a push-pull audio stage added for speaker reception. Its coils and circuitry are almost identical to the SW3. This is a very good historical article that documents the very early days of the National Company.

Another interesting article appeared in *QST* September 1931 written by James Millen. "A Combination AC and DC Amateur-Band Receiver" It appears to be based on his pamphlet "Peak Efficiency Design on the Short Waves". It goes into considerable detail about the design philosophy of Jim Millen and the SW3.

Each article seems to have some information or covers a certain facet of their design or history which helps give a better overall picture of what National Company and the great milestone receiver the SW3 were all about.

National never published any information on SW3 factory modifications. This is not too surprising considering that on the standard production SW3's (as far as I know) they never identified them as National products, or put on any type of logo, model, or serial number. I had heard that they did stick on a paper label or sometimes a gold decal with the National logo. However, I guess the angels came down and took them all away before the radios fell into my hands. I can't really remember if I ever saw one. The only label I ever saw on an SW3 was the one put on by Jackson Labs, indicating that the radio received KDKA with good strength. (Gee Wizz, what a swell performance test!)

To be continued next issue.

A Two-Tube 6AG7 80/40M CW Transmitter

by Dave Ishmael, WA6VVL
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Costa Mesa, CA 92626

After building Robert "Doc" Kurth, W5IRP's 1-tube 5763 80/40/30M xmtr (ER #45), it worked so well I wanted to build one for myself. This article describes the construction of my 2-tube 6AG7 80/40M CW transmitter. The design is based on the 1-tube 6AG7 transmitter described by Lewis McCoy, W1ICP, in the November, 1953 issue of *QST*. This design has been copied many times and was the first xmtr that I built in 1959.

From the outside, the 6AG7 xmtr looks very similar to the 5763 xmtr described in ER #45. Even though there are some improvements in the electrical design (notably the power supply), the significant differences are in the mechanical design. The following are some of the highlights of the transmitters's design:

* The 2-1/2" x 8" x 7" enclosure that I used for the first 5763 xmtr from Easy Tech, Inc. for $12.95 is no longer available. That's really too bad because it was about the cheapest inclosure in the "known universe". After looking at alternative enclosures, I decided to use the Ten Tec Constructo Series 2-1/2" x 9" x 9" BU929 enclosure. It's a bit pricey at $37, but it is a very high-quality enclosure. The box construction with an adjustable height chassis plate offers design flexibility not possible with the cheaper enclosure. The BU929's larger size gave me sufficient room to add the 6E5 tuning indicator, use the larger 6AG7, and use a larger power transformer. The front and rear panels have a very durable baked enamel finish that did not flake/crack in spite of drilling, filing, chassis punching. . . .,etc. The modular nature of the BU929 allows you to build the xmtr in stages, much like a kit. The front panel, for example, can be laid out, drilled, punched, labelled, assembled, and wired in one day, the rear panel the next day, and so on. I used an internal 2-1/4" x 9" panel to mount the 6AG7 and power transformer and this panel was cut from the adjustable chassis plate supplied with the enclosure. I was quite impressed with the Ten Tec enclosure and, in spite of the price, will probably use it for other projects.

* The front and rear panels were carefully laid out on a quad-pad. I didn't start the layout until I had all the parts. I made a copy of the quad-pad layouts and taped it to the panels as a center punching guide. I used a sharp scribe as a center punch instead of the automatic type because I can more accurately and consistently locate the holes with the scribe. After center punching, I used a small #60 drill (0.040") as a pilot drill. The next hole size was the 4-40 holes for the meter so I drilled all the holes with this drill also. It took a bit more time to double- and triple-drill the panels but the accuracy is very good using this technique. One word of caution - not all copiers make 1:1 copies! Check the dimensional accuracy of your copies BEFORE center punching the panels!

* All of the larger 5/8", 1-1/8", 1-3/8", and 1-1/2" holes, were done with Greenlee chassis punches. I used a couple of pieces of paper between the chassis punch and the inside/non-painted side. The edges of the punched holes were quite satisfactory cosmetically with minimal "scuffing" of the paint. Holes up to 3/8" were drilled. Holes from 3/8" to 1/2" were enlarged from 3/8" with a T-handled reamer. I don't like to use drills larger than 3/8" in soft aluminum - especially with hand-held electric drills.

The two-tube xmtr was built into a Ten Tec Constructo Series enclosure. Total cost was $75.

* The power supply uses a Stancor PA-8421 xfmr with 125VAC @ 0.05A and 6.3VAC @ 2A secondaries. The Thordarson 26R38 or Triad R-30X xfmr will also work. I used a conventional full-wave voltage doubler circuit with two 47-ufd 350V electrolytics at the output. Two 100K 1W resistors across these caps provide a bit of voltage equalization and bleeder resistance. I used 1N4007 rectifiers with 22-ohm series resistors. The combined secondary rating of the PA-8421 is almost 19 watts. With the 6AG7/6E5 filaments drawing 6.3VAC @ 0.95A or 6W, this leaves a 13W margin for the xmtr's plate and screen requirements - more than adequate. Even without ventilation holes in the enclosure, the xfmr is only warm after several hours of operation. The output voltage was 374 VDC key-up dropping to about 327 VDC at 8W input key-down. The low voltage tap on the voltage doubler provides 186 VDC to the 6E5/6U5 indicator tube key-up, dropping to 163 VDC key-down. The indicator tube dims a bit as the xmtr is keyed, but it's not objectionable.

* The power supply/6AG7 circuit boards were made from GC Electronics pre-sensitized positive acting single-sided board material. They were laid out 1:1 on a quad-pad, taped on clear vinyl sheet protectors, and the artworks used to expose the boards. The boards were cut to size on a shear.

* The tuning/load caps were purchased from Antique Electronic Supply in Tempe, AZ. Their P/N CV-235 @ $3.90 each are just the right size for this xmtr with their 1" length. Even with an enclosure depth of 9", I still needed some relatively small plate tuning and loading caps.

* As in the 5763 xmtr, I used 42T B&W 3016 miniductor stock for the pi-network coil, tapped at 21T for 40M. Since my xmtr was for 80/40M only, I used a slide switch for the bandswitch. I mounted the coil on a 2" x 3" piece of bare 0.062" PCB material and spaced it 1-1/2" from the front panel using 6-32 spacers.

* The 2" 0-50 mA Phaostron meter

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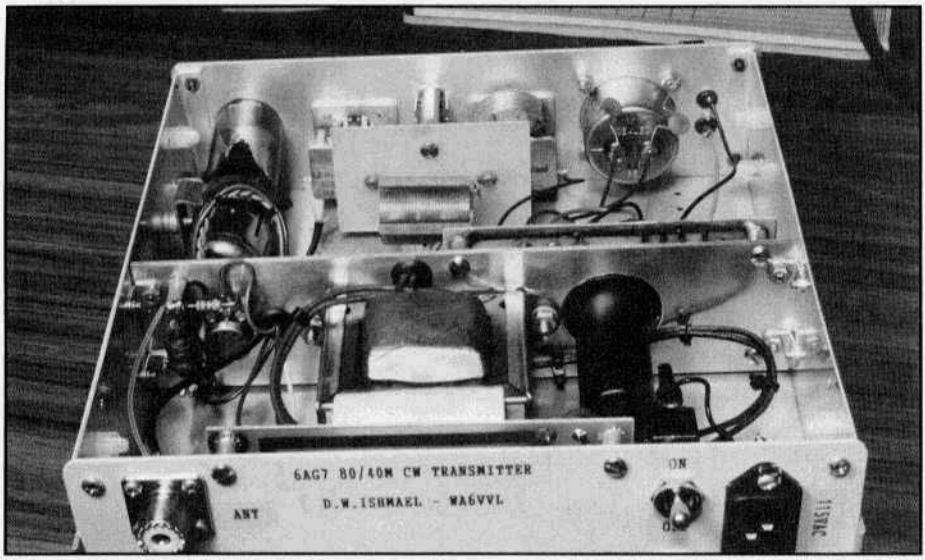


Looking from the rear down into the enclosure.

monitors the 6AG7's plate and screen current.

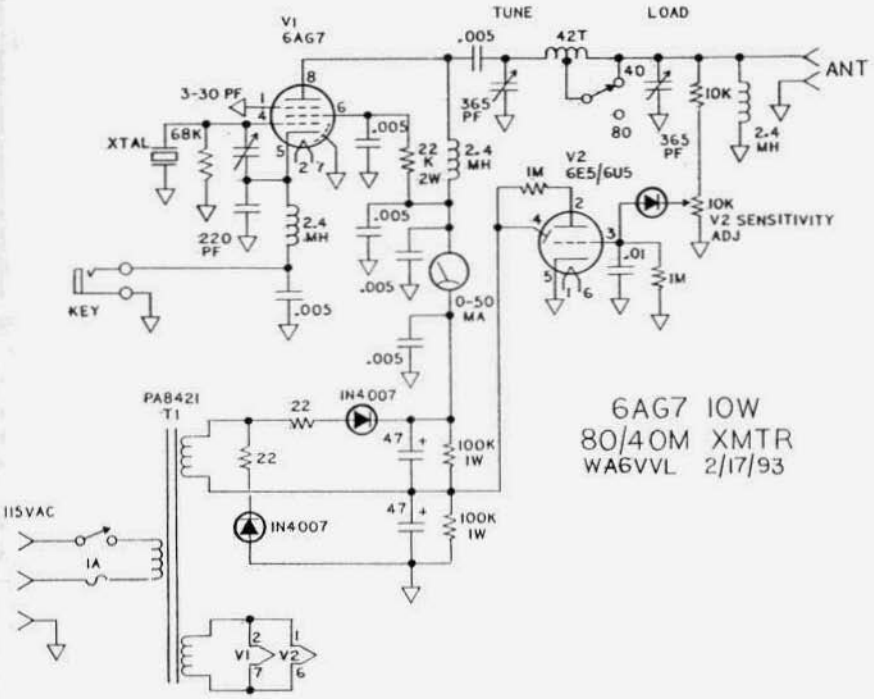
* The 6E5 or 6U5 "magic-eye" indicator tube assures that the xmtr is tuned for maximum output. I used a 10K pot in the RF divider so that either 6E5 or 6U5 tubes could be used. The 6E5 takes about -7.5 VDC to close the eye while the 6U5 takes about -22 VDC. A fixed resistor could be used if only one tube-type is going to be used. I considered a small PCB for the indicator tube socket and components but since I didn't know the tube-to-tube variation in shadow alignment, I finally decided to secure the tube base in a u-clamp so that I could manually align the shadow. If a transformer is used that has a 12.6 VAC secondary (or 5 VAC + 6.3 VAC), a 1629 eye tube can be used. The 1629 has the same specs as the 6E5 but has an octal base and a 12.6 VAC filament.

* The power switch and key jack were mounted on the rear panel. I decided to use a 3-conductor recessed power receptacle for the 115 VAC line instead of the "traditional" line-cord/grommet combo. The exposed connections on the receptacle, power switch, and 3AG fuse holder were covered with heat-shrink tubing.

* The front and rear panel lettering was done using a Brother P-touch. This is the 2nd project I have labelled this way. I have no idea how durable this labelling system is for amateur equipment but it's quicker than dry-transfers and looks much better than the old dymo tape labels.

The total time for construction was approximately 22 hours. The total cost was $75. Even with access to the TRW swapmeet, the cost of the Ten Tec enclosure almost doubled the cost of my xmtr. Even so, I really enjoyed building this xmtr. It went together much "cleaner" using the Ten Tec enclosure and I am looking forward to building other projects with these enclosures.

I had only one problem with this xmtr - 40M crystals were too "chirpy". I decreased the chirp by replacing the 6AG7 but it was still too bad to use on the air. The original circuit used a 22pF/220pF divider in the 6AG7's grid and reducing the value of the 22pF helped. I finally just replaced the 22pF with a 2-25pF PCB mount variable and tuned it for



minimum chirp. End of problem. It appears that the 22pF needs to be closer to 13pF.

This xmtr is a lot of fun to use. It brings back a lot of what I "miss" about amateur radio. The feeling of making my first contact with a homebrew xmtr is just as exhilarating now as it was 30 years ago! With (only) 3 watts of output power, I got my share of 569 and 579 signal reports and a few 599 reports.

Crystal control, however, is NOT what it used to be - you used to tune "several" KHz around your crystal (calling frequency) - but not any more! I finally took Dave Mills, AJ7O's advice and started calling CQ more and my "hit rate" went up. Even so, QRP/xtal control takes a bit of patience - you can't be in a hurry!

A large SASE will get you a full-sized schematic, parts list, and copies of the artwork and PCB layouts.

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4. RCA 6AG7 Power Pentode Tube Data Sheet, Nov. 1, 1952.

5. RCA 6E5 Electron Ray Tube Data Sheet, Dec. 15, 1944.

6. RCA 6U5 Electron Ray Tube Data Sheet, Aug. 9, 1954.

The TX-1 and RX-1: Heathkit's Green Machines

by Chuck Penson WA7ZZE
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St. Paul MN 55102

On the strength of just two products, the AT-1 and DX-100 transmitters, the Heath company had established itself as a major player in the amateur radio marketplace, and one to be taken seriously. Not wanting to lose the momentum it had generated, and emboldened by the huge financial gains made with the DX-100, Heath quickly began planning their next amateur products.

While the AT-1 and the DX-100 were well-designed products, at least from an electrical point of view, they were designed primarily to test the waters. Still, the DX-100 was selling better than Heath could have ever imagined. So rather than replace it with a new rig, Heath decided that a refinement of the 100 offered as a "high end" product would give customers a choice of rigs while giving Heath a greater share of the overall market. This low-end vs high-end strategy proved so exceptionally effective that Heath would go on to use it again and again with future products. Additionally, Heath knew that if it were to compete aggressively it would need a decent receiver in its product line. Heath also reasoned that designing the new products as a matched pair would not only look nice, it would enable the company to use many of the same parts on both units, thus saving money. The "economics of scale" was a concept on which Heath had a firm grasp.

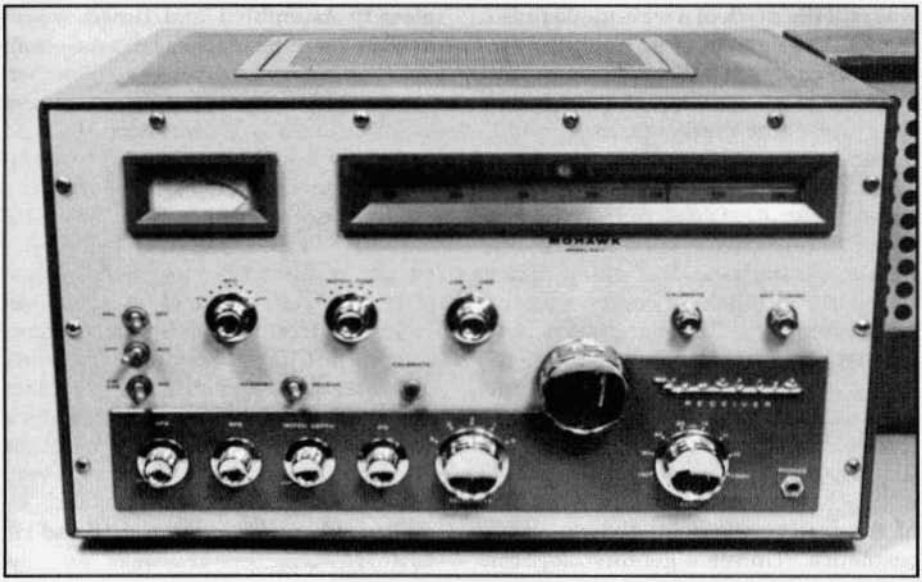
A Ready Market

Heath turned its attention first to developing a receiver, since the receiver would be far more complex to design than the transmitter and would take much longer to get to a prototype stage.

It's easy to see why Heath would have wanted to get into the receiver market. While there were lots of companies cranking out transmitters, there was very little competition with respect to receivers. Prior to 1958—the year Heath released the receiver—the vast majority of commercially available receivers were general coverage units with a band spread added for the ham bands. High quality ham-band-only receivers were pretty scarce, and the few that were on the market were pretty expensive. In designing the RX-1, Heath looked carefully at 5 or 6 of the better receivers of the day to get a feel for what features a decent communications receiver might include—and how much it might cost.

The Hallicrafters SX-101 was a completely average receiver that ran about $400. The Hammerlund HQ-110 was a thoroughly unremarkable radio for $230 (the somewhat more remarkable HQ-170 didn't arrive until 1958). National had a couple of very professional receivers, priced accordingly: the HRO-60 cost just under $500 and the NC-300 went for about $350. Then of course there was the Collins 75A-4 which, at $650 was affordable only by the military and a few of the more affluent hams. (Remember, in 1957 $50 was almost a month's rent.) These receivers, Heath figured, would be the ones to compete with.

A quick analysis found that most of the better receivers on the market had a few things in common. Virtually all were dual conversion superhet designs and most had slide rule dials which were regarded as a sign of quality. Additionally most had adjustable selectivity, some kind of notch filter, a crystal calibrator, and a tunable front



The RX-1 Mohawk receiver.

end. So with a laundry list of features and specifications in hand, Heath turned, as it had for its previous amateur products, to chief engineer Roger Mace. The challenge was to combine all the features of the best receivers in a stylish cabinet and sell it for say, under $300.

The RX-1 More Than Just a Pretty Face

The physical design of the new receiver, dubbed the RX-1 "Mohawk," was realized by Heath's in-house industrial designer, hired after Heath decided to get serious about cosmetics. The RX-1 would be about the same physical size as the DX-100 but would be finished in a glossy two-tone green paint, fitted with attractive escutcheons, and garnished with shiny die-cast aluminum knobs. We will never know with certainty why Heath settled on green, but we do know there was great interest in an attempt to distinguish Heath products from the ubiquitous gray and wrinkle black boxes of their competitors. While there may have been some industrial psychology involved, it is more likely that given the alternatives of red, blue, and yellow, green may simply have been viewed as the only real choice. In any case it wasn't long before the color green was synonymous with Heathkits. Indeed, the color scheme proved so popular Heath would go on to use it in virtually every amateur product it made until the early '80s.

Electrically, the RX-1 is a pretty straightforward design. It is a dual conversion superheterodyne unit with IFs at 1680 kHz and 50 kHz. It uses 15 tubes including a 6BZ6 RF amplifier, 6BA6s in the IF stages, a 6CS6 product detector, an OA2 voltage regulator, and a 5V4 rectifier. Heath engineers went to the trouble of using ceramic tube sockets and switch wafers throughout, and spent a lot of time looking for "quiet" tubes and high Q coils.

Like the DX-100, the RX-1 is built on a heavy gauge steel chassis, with an 1/8 inch thick aluminum front panel, and is enclosed by a one-piece formed copper-clad steel cabinet (the same cabinet used on the DX-100B). "Big and heavy"

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The TX1 and RX1 from previous page
was still the mark of a well-made radio: the RX-1 weighs in at 52 pounds. The receiver covers 160 through 10 (including 11) meters and features a dial position and band markings for 6 and 2 meters for use with option converters. The Mohawk's slide rule dial provides smooth, accurate tuning, requiring about 14 turns of the knob to make one pass across the band, and was designed to feel like a Collins—a point not lost on *QST* reviewers. The band switching mechanism uses a much-too-fragile rotating plastic drum on which the band markings have been screened. RX-1s found today often have cracks in the dial drum; while a cracked drum will not necessarily affect the performance of the receiver, it does mar the unit's cosmetics. (Unless a genuine part can be salvaged, perfectionists can replace the drum only with great effort and expense.) The RX-1's operating modes include selectable upper and lower sideband, AM, and CW. Also included is a built-in 100 kHz crystal calibrator and automatic noise limiter.

Receiver or Swiss Watch?

Building a device as complex as a communications receiver is a daunting task under the best of circumstances. The assembly of the RX-1's dial drive mechanism, for example, was enough to intimidate a watch maker, and the point-to-point wiring required a much smaller iron and a much steadier hand than many ops were accustomed to. Heath developed a number of strategies to help the builder cope with the intricacies of the work, including improved instructions, graphics, and diagrams in the manual; the use of color-coded wiring harnesses; and that simple but ingenious tool, the plastic nut starter. But it was the preassembled and tuned front-end sub-chassis that really made the RX-1 possible in kit form. Heath quickly recognized the complexities of aligning such a unit and wisely decided that providing the front-end already assembled and tuned would avoid a lot of headaches later on—both for themselves and for the consumer. Without a preassembled and tuned front end, the alignment of the receiver would have been a painful and time consuming task, beyond the capabilities of many ops and/or their test equipment. Heath knew that if they wanted to sell receivers they would have to make the construction both practical and possible. Heath contracted with Sherwood Electronics in Chicago to build the front-end assembly. Whether Roger Mace designed the unit himself or farmed it out to Sherwood is not known, but the entire front-end module was, at the very least, assembled and aligned by Sherwood and included the RF and HF oscillators, the mixer stages, and the band switch unit. All the kit builder had to do was attach it to the main chassis with a few screws and plug in a couple of cables. With the IF frequencies established, the tune-up procedure could be done using nothing more that the RX-1's built-in crystal calibrator and S-meter.

Functionally the RX-1 turned out exceedingly well. With a sensitivity of around 1 uV it was as good as or better than just about anything else on the market, and from a user's perspective the RX-1 was a joy. With five switchable selectivity settings (from as wide as 5 kHz to as narrow as 500 Hz) and a 50 dB tunable passive notch filter, the RX-1 was a pleasure to operate. For those who wanted to sit down in front of lots of dials and switches, Heath brought out just about every possible function to a front panel control. Since a lot of thought went into making the RX-1 a stable radio, it is curious that Heath never specified the stability of the unit. Experientially, however, the RX-1 was found to be as good as receivers costing much more.

Cosmetically the RX-1 surpassed expectations. It was shiny and stylish and

The TX-1 Apache transmitter.

had a very professional look. Much of this was made possible by the new electrostatic paint system Heath had installed at their new plant in St. Joseph. Heath had moved across the river to St. Joseph almost immediately after being acquired by Daystrom and after it became apparent that the old building in Benton Harbor was just too small to accommodate Heath's plans to expand.

The final price of the unit also contributed to the RX-1's popularity. At just $274.95 the Mohawk was a full $75 less expensive than anything else in its class.

Could I Give You a Hand With That?

By late 1957 the RX-1 had already been designed and prototyed and was coming along nicely. But Mace knew that he was going to need a little help with the project if he was going to get both the receiver and the transmitter out the door on time. Enter Al Robertson—a young man in the right place at the right time.

A Michigan native, Al Robertson graduated from Michigan Tech in 1955 holding a degree in Electrical Engineering with a Communications Option. In those days the big corporations were hiring E.E.s as fast as they could, so Al had no trouble landing a job with General Electric in Utica, New York, working in the area of military avionics. After only a few of months with General Electric, ROTC called him up for a couple of years of active duty and stationed him at Wright Paterson Air Force Base in Dayton, Ohio. When his stint with the Air Force was over, Al decided that working for a government contractor wasn't much fun, that the military didn't thrill him all that much either—and come to think of it, that Michigan wasn't such a bad place after all. So with resume in hand Al headed back to his home state. While interviewing with an electronics company near Benton Harbor, Al stopped by to visit an old Michigan Tech friend who'd taken a job in

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TX1 and RX1 from previous page

Heath's audio division. Al had picked up his ham license in the service and thought that a career in ham radio might be interesting. He must have walked in the door just about the same time Roger Mace was saying "You know, I sure could use some help, here." Al was hired on the spot.

The TX-1: Springs and Gear and Pulleys, Oh My!

Heath's new transmitter was designated the TX-1 "Apache." The Indian names were Mace's idea. He had a special affection for Native American themes as his wife was a Native American. The practice of using Indian names continued until Mace's failing health forced him to leave Heath in 1960. The "Mohican" solid-state general coverage receiver, designed during Mace's tenure but not released until 1961, was the last product to be so named.

Robertson's first assignment was to build the TX-1 into a box that matched the RX-1 receiver. This sounded simple enough—but there was a hitch. Since the RX-1 had been designed from scratch, its front panel controls were placed pretty much wherever they needed to be. But the TX-1 had to match, and that meant its front panel control positions had to be in places corresponding to those on the RX-1—whether those were the best locations or not. The implication of all this is that connecting the TX-1's front panel knobs to their associated controls on the chassis often required some complicated linkages. One of the most elaborate of these linkages was in the VFO band switching mechanism. The VFO oscillator ran at one of three frequency ranges (1750-2000 kHz, 7000-7175 kHz, or 7000-7425 kHz) depending on what band was selected. Since these three ranges served all five bands, the VFO didn't need to change frequency ranges every time the band switch was turned. Al had to invent a mechanically interrupted switch assembly to choose the correct range with each turn of the band switch. Robertson admits he was no mechanical engineer but since he knew he hadn't been around long enough to argue—he had to come up with something. He describes his solution as "a real Mickey Mouse lash up", and adds that he was never very proud of it. But he is also quick to note that it ended up working quite well and proved extremely durable.

The dial drive assembly was another of Heath's famous (or infamous) Rube Goldberg mechanisms and had been designed for the RX-1 before Al arrived. Not wanting to reinvent any wheels, Robertson chose to use the exact same unit in the TX-1. It was a collection of springs, gears, pulleys, and string that gave pause to even seasoned home brewers. Several entire pages of the assembly manual were devoted to its construction, and it likely took a couple of evenings to complete. Exactly who was responsible for its design is not known, but in the end it too proved to be a very good design, being both durable and mechanically stable.

The actual electronics of the TX-1 were very much easier to design and build. More than just a DX-100 in a new box, the TX-1 was a refinement of the 100 and included several distinct improvements and additions. Particular attention was given to the VFO. While Heath used the old favorite 6AU6 Clapp oscillator, Robertson designed it as a subassembly to enhance frequency stability. Since the rig was being designed with a sideband option in mind, great pains were taken to ensure that the unit would be as stable as possible. Painstaking trial and error experiments were conducted to find just the right value and type of components. Great care was taken in the physical placement of parts. Heavily doped ceramic coil forms were used, and a great deal of thought and experimenting went into temperature compensation. To further reduce the

effects of heat on the VFO, the oscillator tube was mounted outside the VFO enclosure, and the tube's filament was kept lighted even when the transmitter's main power was switched off.

To allow for sideband operation the TX-1 made provisions for direct connection to the SB-10 single sideband adapter, which was also under development. The SB-10 was supposed to be ready for the DX-100 and was to be called the DX-10, but the fellow in charge couldn't get it working—even though it was a direct copy of an adapter made by B&W. Eventually that fellow lost his job over the project and the SB-10 was turned over to Robertson, who also had problems with it, but finally got it going. A pair of SO-239s on the TX-1's rear panel permitted a front panel control to put the SB-10 in the RF path between the driver and the final amplifier. Heath wanted to use the SB-10 to hedge its bets on the popularity of SSB. At the time there was a lot of discussion (sometimes heated) about the future of SSB. Many ops swore (occasionally on the air) they would never use it. The strategy of providing an optional adapter ensured that Heath would not lose out whatever the final verdict on sideband turned out to be.

Another improvement in the TX-1 was in the battle against TVI. Most hams using modern equipment and living in communities with cable TV have lost sight of the fact that in the early days of ham radio, TVI was a major problem. Robertson gave a great deal of time and attention to giving the TX-1 better TVI protection, adding more shielding, more partitioning of the chassis, and even AC line filtering.

The TX-1 uses 19 tubes including a pair of fan-cooled 6146s in the final cage. The rig covers 80 through 10 (including 11) meters and runs 150 watts AM and 180 watts CW. The final amplifier runs class C for AM and CW but is switched to AB1 when the mode switch is turned to SSB. The modulator, a pair of 6CA7s (often supplied as EL34s) is operated in push-pull class AB2. Heath was using the 6CA7 in most of its hi-fi gear and was being supplied by Mullard, a British company, hence the EL34 designation. The modulator ran about 100 watts and a rear panel 500-ohm tap was provided for external use. It is interesting to note that operation on 11 meters requires a crystal and that the 160 meter band is missing altogether. The latter point is especially curious since the matching RX-1 includes the band. The Apache was designed with a Pi-network output circuit, and featured what Heath referred to as "time sequence keying" for "chirpless CW." This sounds a lot more complicated than it really is. The circuit is mostly a simple RC shaping device. The spotting switch is another example of something that appears to be more than it really is. It is just a push button in parallel with the key. When you spot the rig you are doing so at full power unless you first switch off the high voltage. The high voltage, by the way, is provided by a pair of 5R4s in a full-wave configuration and runs around 750 volts. The low voltage (around 350 volts) is provided by a single 5V4. The use of big, potted, conservatively rated transformers and chokes represents a considerable fraction of the TX-1's 95 pounds; they were supplied by Chicago Standard. Heath specified potted transformers for use in all its hi-fi gear because they looked so nice on open chassis amplifiers. Even though unpotted transformers would have worked admirably in a transmitter, Heath thought the potted versions would add to an overall "professionalism"—even if they were hidden under the hood.

The TX-1 provides for extensive audio tailoring. In addition to filters which limit the frequency response to the 300-3000 Hz range, the Apache also includes a front panel adjustable low level speech

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TX1 and RX1 from previous page
clipper as well as a main modulation level control. Since the latter control is adjusted by reaching through the key jack with a screw driver, many latter day users who got a TX-1 without a manual may not know of the existence of the control. This, combined with component failure and/or drift due to age, along with good old operator error, may account for reports of rough sounding audio. Hence the nickname "scratchy Apache"— not really heard until recent years—is probably undeserved.

The TX-1 and RX-1 hit the market together in June 1958 and were met with rave reviews. Now Heath began to throttle up its advertising campaign, buying 5-page spreads in popular hobby magazines.

A Flood of Green Machines

While the AT-1 and DX-100 marked Heath's official entry into amateur radio, they served primarily as a kind of "proving ground"—a couple of low risk products to see if a market existed for kit form ham equipment, and to determine the difficulties involved in bringing such products to market. The release of the TX-1 and RX-1 was different. These products were the result of a newfound conviction to pursue the amateur radio market based on the unbridled success of their first two products. Now, for the first time, amateur products were not an experiment. Heath committed serious design, engineering, and marketing muscle to the Apache/Mohawk project and began planning a long range strategy for its emerging product line. This shift in attitude marked the beginning of a truly phenomenal era for Heath. It was as though Heath had hit resonance. New products practically flooded out the doors. To complement the Apache and Mohawk, Heath developed two linear amplifiers, the ill fated KL-1 "Chippewa," and the very successful HA-10 "Warrior." Work was started on an SSB transmitter (the HX-10 "Marauder") and an extensive line of VHF products. It was also during this time that Heath designed its legendary "DX" family of small novice class transmitters, mobile HF gear, a line of accessory products, and more. No one, not even those who worked for Heath, could have imagined what was in store for the company. Indeed, Heath was on a roll that would last more than 20 years.

In November of '58, just five months after Heath unveiled the TX-1 and RX-1, engineers at Heath opened the latest issue of *QST* and saw something that gave them pause. It was a new receiver. Sleek, gray, and small, it had just seven knobs and weighed only 20 pounds. With an almost military appearance this new receiver was both rugged and highly functional. While many of the industry's leading manufacturers failed to grasp the meaning of what they saw in this ad (a failure that would cost them dearly), the instant Al Robertson saw it he understood as clearly as a 40 over 9 signal that the days of the big heavy radio were over. Heath had seen the future, and it looked like a Collins 75S-1. Showing the ad to his coworker, Joe Shafer, who had been hired just after Al, Joe remarked confidently "we could do that." And do it they would. But that is another story. ER

Editor's Note: Chuck has written a book on the Heathkit Company. It should be available sometime in the next year.

The Elements of Collins Quality from page 7

Manufacturing

The fabrication and assembly of all ham products was done in-house. In that timeframe the company had all the machines and processes to do what was needed. In general, the design ME's knew all the production machines available, so they designed parts to use only known reliable processes. Sometimes a new process would be required. It was then incumbent on the designers to get together with manufacturing and have the necessary capability available when the unit hit production. A fashionable name for all this today would be "concurrent" engineering. At Collins, in the ham equipment era, all that was second nature.

Manufacturing had their own test department for evaluation of produced units. It was common for design engineers to have close ties with production and production test as the engineer's unit progressed in manufacturing. When equipments were burned-in, the engineers learned those lessons that can only be learned in "rate production". This is where the realities of statistics are found. Because this is valuable learning, engineers would be given assignments to work with manufacturing on what was known as "collateral" engineering. On a rotational basis this was good education, but not always fun. But it makes for reliable products! However, that's the start of a whole other story.

There are many other specifics and details which could be illustrated to support how Collins equipment earned its reputation for dependability. But, it should be clear by now that Collins design engineering was broadly based, and all design engineers were backed by sufficient resources to be sure every design was thoroughly understood as it went to production. Where in a few cases something slipped through a crack in this system, Arthur Collins set the absolute standard of response to anything that was not right. This philosophy permeated the organization to the point that Arthur really didn't have to watch everything with an eagle eye. His inputs were less than the legend -- parsimonious is a term he occasionally used to express this kind of thought -- but his inputs were amplified by everyone's desire to do the best that could be done. One example of how Arthur instilled a sense of direction is illustrated by what he explained to someone worried about a tight schedule. He said: "Look, I want you to do it right as fast as you can, not fast as right as you can!"

Those of us who worked in this environment found it stimulating -- particularly in retrospect. Having your chief engineer put his foot on your desk, and, after 15 seconds of reading your engineering notebook upside down, say: "I don't think your data is worth a damn", can be momentarily unnerving -- especially when he is right. On the other hand, it's a tremendous learning experience which makes everything that follows a little better. We all learned at a rapid rate. It's hard to overestimate the long term value of working in the Collins environment at that time. It was a culture!

The Collins ham equipment design group is now long gone as an entity. But many of the original gang are still around. In the past, some of them have described in these pages the details of projects they were involved in. To add to this I am considering preparing a few additional thoughts on how the development of specific ham equipments looked from the mechanical engineering viewpoint.

Let me close with a direct quote from another of that gang, a man who was my boss at the time. I had been very concerned about something that was barely meeting specs -- no margin, as I recall. When sharing my concern, he said "Cheer up ---, maybe a truck will

run over you on the way home tonight and you won't have to worry about this anymore".

I hope that today there are among the new generations of designers some digital design guys that are as productive and are having as much enjoyment in accomplishment as we did in that time period. **ER**

Editors' Note: On not being a ham Fred has this comment," My interests are in RF, microwave, audio, music, silicon process, design automation, etc. Although I got to 13 WPM in the Signal Corps I just never bothered to get a ticket. That made me somewhat of an outsider in the Ham Dept....but they were gracious".

Letters from page 15

Because 6BX7s were basically a GE product, the RCA Tube Department exhibited no inclination to assist us, but GE sent a knowledgeable field engineer to observe the effect and measure tube operating conditions. He returned in a few days to explain that the overshoots were caused by cathode interface, and suggested a temporary cure by briefly operating the tubes at elevated heater voltage to purge impurities from the interface region. This eliminated the culprit but, as he acknowledged, the cure was only temporary, for the metal/oxide interface formed again in a few hours of operation. A short time later, samples of new tubes were furnished by GE (perhaps the -A version of the 6BX7) and these permanently solved the overshoot problem.

And finally, although I mentioned that Ray's article fanned my memory of these events, I actually began recalling the problem for the first time in over forty years during a discussion at an October hamfest with Ludwell Sibley, Editor of Antique Wireless Association's *OLD TIMER's BULLETIN*. Imagine my astonishment when I encountered the very same topic when *ER* arrived just a few days later!

Robert G. Thomas, W3QZO

AMI International Election of Officers for 1994

Nominations for AMI offices were concluded in November. Only one nomination was received for each office with the exception of the Great Lakes Regional Director which is currently open. Nominees for each office are thereby declared to be the new holders of these offices for the 1994 term.

President Dale Gagnon, KW1I
Treasurer Warren Ziegler, NY2H

Directors
Northeast Steve Ickes, WB3HUZ
Southeast Andy Howard, WA4KCY
Great Lakes Open
North Central Skip Green, K7YOO
South Central John Firey, WB5HRI
Rocky Mtn. Bill Kleronomos, KDØHG
Northwest Pat Person, K7YIR
Southwest Bill Neeley, K7INK
An Interim Director for the Great Lakes Region will be appointed.

Lack of competition for AMI offices is not necessarily a bad sign this early in the organizational history. AMI has demonstrated a commitment to democratic principles in the selection of its leadership. This will ultimately ensure AMI's responsiveness to its members and its long term viability. **Dale, KW1I**

CLASSIFIEDS

Advertising Information

Subscribers receive 1 free - 25 word- ad per month. **Extra words are .15.** Here's how to count the words in your ad: the heading - For Sale, Wanted, etc count as **1 word**. Your name, call, address and telephone number count as **6 words**. Hyphenated words count as **2 words**. **Please count the words in your ad and if you're over 25 words send payment for the extra words.**

Non-subscribers: $3 minimum for each ad (up to 20 words). Each additional word is .20. **Please call or write for display rates.**

VINTAGE EQUIPMENT ONLY

ER
P.O. Box 57
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DEADLINE FOR THE JAN. ISSUE: JAN. 3

FOR SALE: Repair and restoration on all vintage equipment; 35 years experience. Barney Wooters,W5KSO, 8303 E. Mansfield Ave., Denver, CO 80237. (303) 770-5314

FOR SALE: Hallicrafters S-85 rcvr, exc. condx, w/Heath QF-1 Q-multiplier & orig. manuals for both - $85. B. Lee Cornwell, KD3KD, HCR #1, Box 95, Mt. Pocono, PA 18344. (717) 839-2710

WANTED: Ceramic wafer from DX-40 or DX-60 band switch; copy of DX-60A manual or circuit diagram. Harry Davey, VE7AIJ, 847 Glencoe Dr., Port Moody, B.C. V3H 1G7, Canada. (604) 936-5428

FOR SALE: AN/GRC-109 spy radio set, new, packaged, w/accessories, 2 pwr supplies, tools, spare parts, manual, etc., ready to go, mint condx - $350. Mike Murphy, 11621 Valle Vista Rd., Lakeside, CA 92040-1041. (619) 561-2726 or 444-7717

FOR SALE: New list of 1000's of tubes! Includes new, used, antique, collectible, Majestic and Western Electric types. Send SASE to Jim Cross, 2817 Parklawn Dr., Dayton, OH 45440-1538. (513) 298-5827

FOR SALE: Collins S-Line aluminum knob inlays: small (exciter/PA tuning) - $1; 30L-1 - $2; spinner/plain (main tuning) - $3. Charlie, K3ICH, 13192 Pinnacle Lane, Leesburg, VA 22075. (703) 822-5643

WANTED: Pwr xfmr for the National NC-100A or 101XA rcvr. James T. Schliestett, W4IMQ, POB 93, Cedartown, GA 30125. Phone/FAX (404) 748-5968

FOR SALE: ART-13 parts & other interesting stuff. SASE for "The Bone Yard List." elKay electronics, 231 Shenandoah Trail, Warner Robins, GA 31088-6289.

FOR SALE or TRADE: Gates BC-250GY in good condx. David Murphy, K5FOY, POB 602, Mountain Home, AR 72653. (501) 425-4475 (w), 425-4362 (h)

FOR SALE: Navy type CJB-26003A "flame-proof" keys, new in orig. boxes - $47 CONUS shpg included. Trade for working IC-22A, TCS, or ?. WA7HDL, (208) 756-4147

WANTED: Maas Carillon organ amplifier model 500.Victor Gregowski, 3635 Orvall Dr., Fort Gratiot, MI 48059. (313) 385-9479

FOR SALE: Used technical books - radio, electronics, math, military, magazines, etc. $1 for large list. (stamps ok). Softwave, Dept. ER, 1515 Sashabaw, Ortonville, MI 48462

FOR SALE: DX-60B xmtr and HR-10B rcvr, w/orig. manuals - $75. WANTED: Collins 32V-3/75A-4 in exc. condx. Will consider trading 51S1 R/E. Bill, N2WXJ, (914) 356-6553

FOR SALE: Collins KWM-1, w/516F1; amateur spark xmtr circa 1915. Joel Levine, WB2BMH, 67 Derby Ave., Greenlawn, NY 11740. (516) 757-7641

TRADE: My exc. Knight Ocean Hopper, coils, manual for your exc. Hallicrafters SX-100. Must be near mint. Trade photos. James B. Geer, WB5LXZ, 604 King Dr., Bedford, TX 76022-7124

WANTED: Heath pwr sply model HP-23. Also want junker Heath SSB xcvr model HW-100. Will consider a fair price on a complete wrkg set. Harry MacMullan, 2662 Bancroft Dr., Aston, PA 19014.

FOR SALE: Factory wrapped radar xmtr T-85/APT 5 less mounting. Tubes. One Leecher wire ass'y. Operating handbook instructions. Anyone interested? Pete Ohlson, W5LVM, 8928 Hackney Ln., Dallas, TX 75238. (214) 348-1823

FOR SALE: Collins 32V-1 and 32V-2. **WANTED:** Viking Navigator and 'E' coil for HRO-50T1. KØAL, (319) 377-4367

WANTED: Modulator, Eico 730 or similar 50-W AM modulator. George, WA6HCX, 27 LaFlecha Ln., Santa Barbara, CA 93105. (805) 682-3094

WANTED: Orig. pwr xfmr for NC-183. John Schneider, K4HLM, 320 Woodchuck Ct., Roswell, GA 30076. (404) 491-8981

FOR SALE: Hallicrafters SX-101 MK II - $65; Tempo I xcvr - $200. Pat, WB9GKZ, (414) 434-9016

WANTED: E.H. Scott rcvrs RBO, RCH, SLR-B, SLR-H and manuals for all Scott WW II rcvrs. Also want Nems-Clarke 1301, 1501, 1907, rcvrs and manuals especially for the 1301. Thanks! Tom Smith, N5AMA, 13034 Elmington Dr., Cypress, TX 77429-2062. (713) 376-3436 (h)

Classic Amateur and ALL Lafayette Radio Manuals.
Will match or beat any published price. List available. Satisfaction guaranteed. Pete Markavage, WA2CWA, 27 Walling St., Sayreville, NJ 08872. (908) 238-8964

WANTED: SC-101; SC-301; KW-1; 30K-1 thru 5; 302C1; 75A thru 75A-4 rcvrs and spkrs, any condx. Purchase entire estates, pick up 48 states and top $ paid. Rick, (800) 462-2972

FOR SALE: Rare stuff. Harris RF505; McKay-Dymek DR33; McKay Dymek DR44; DeForest audion amp.; ARC 69 (1917 aircraft rcvr); WW II Japanese 1 tube xcvr, w/generator and cables; Eldico xmtr, rcvr, pwr sply and console (these are Collins clones); Eddystone 770; Collins 50E7; Collins 51J4 (green face); Collins 32RS7. All highest and best offer. Jack H. Osborne, K6LVD, 5636 Del Monte Ct., Santa Rosa, CA 95409. (707) 539-3949

WANTED: Schematic connection diagram for a Thordarson mod. xfmr model T11M77. Bill Allen, W7US, 11720 E. Twin Hills, Tucson, AZ 85748. (602) 721-8202

FOR SALE: HP 5254L, 5253B, 52i2A, OS8C/U scope & case; L&N XL 630 recorder, L&N 4385, 4399, 4399C tech books. **WANTED:** Schematic for Precision Radiation Instruments Inc. model 117. Send SASE for list. Buddy Herring, 1310 Andover Rd., Charlotte, NC 28211. (704) 366-6600

WANTED: Collins 30S-1 amp. in good/exc. condx. Also, Westinghouse MW-2 pwr sply. Gary, WA4ODY, POB 73306, Washington, DC 20056-3306. (202) 483-3932

FOR SALE: Gonset G-50 6-meter Communicator, VG condx - $75; AX-9909 tubes - $70 ea.; AX4-125A tubes - $75 ea.; Johnson Valiant - $325; Viking II - $225; Matchbox, exc. - $145; Drake P-75 phone patch - $85; RCA AR-88A, exc., less than 200 manufactured - $595; Yeasu twins, FL-101, FR-101S, beautiful, still have plastic on front panels - $525. **WANTED:** Johnson 500; Gonset G-76. Steve, WB4IJN, (803) 873-7847 X 200 (d), 821-6931 eves

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WANTED: Mint, unmodified Heath Seneca and Lafayette HE-30 to complete vintage VHF station. Harold W. Deppe, POB 31656, Tucson, AZ 85751.

FOR SALE: R-390A service: Module repair and alignment to complete remanufacture, new front panels, knob sets, VFO calibration,expert service, reasonable, any condition accepted. Rick Mish, (419) 726-2249

FOR SALE: Electronics suite from U.S. aircraft carrier. MF-UHF rcvrs, xmtrs, radars, PPI displays, RTTY cnvters, terminals. Much more.Bob Mantell, W6VQT, 3135 N. Ellington Dr., Los Angeles, CA 90068. (213) 851-2786

FOR SALE: Crystal chest CH-219 with 89 or 106 DC-35 crystals for Radio Set SCR-543-D (BC-669-D) and later. Chest needs some painting, felt liner is good - $75 plus UPS. Also some DC-34 and extra DC-35 crystals @ $3 or offer for lot. Have most connectors for set. Parting out PE-110-D, BC-669-B. LSASE or call. Robert W. Downs, WA5CAB, 2027 Mapleton, Houston, TX 77043. (713) 467-5614

WANTED: WW II Japanese military radio equipment & literatures; Toy Crystal radio kit. Takashi doi:1-21-4 Minamidai Seyaku Yokohama, Japan.

FOR SALE: R-390A; Hammarlund SP-600JX17; Hallicrafters SX-62A MK II; Johnson Viking II, w/Heath VF-1. All unmodified, w/ manuals. No shpg. Dan Radcliffe, KF9BP, W222 N8201, Plainview Pkwy, Sussex, WI 53089. (414) 255-9165

WANTED: R-390A rcvr, mint condx, no mods, preferably w/case. State price and shpg. L. Heaton, K7BIN, 1915 W. 15th Ln., Apache Junction, AZ 85220. (602) 982-1856

FOR SALE: Valiant - $200; SX-100 - $100; amplified D-104 - $50; Johnson directional coupler only - $30. Ron Steinberg, K9IKZ, (708) 773-3503, FAX (708) 773-0822

FOR SALE: RME 45 - $125; HQ-110 - $115; DX-40 - $85; RME-VHF 152 - $50; HT-37 - $150; Multi-Elmac A54H, w/AC sply - $75; ART-13 - $150. Cliff Fleury, 64174 Tumalo Rim Dr., Bend, OR 97701. (503) 382-1697

WANTED: I will pay $10 for NIB 2A3 tubes, $5 ea. for 6L6G and 6J5/G tubes. Jeff Kyle, KF6WX, (916) 678-6154

WANTED: QST March 1927 issue. Charles J. Stinger, W8GFA, 404 Ross Ave., Hamilton, OH 45013. (513) 867-0079

ELECTRON TUBES FREE 1993 Catalog, over 2,000 types in stock. **Electron Tube Enterprises,** Box 311, Essex, VT 05451. (802) 879-0611, FAX (802) 879-7764

FOR SALE: Radio tubes; repair and restoration of all vintage amateur and commercial radios, 25 years experience. Herbert Stark, 321 N. Thompson St., Hemet, CA 92543. (714) 658-3444

FOR SALE: SX-111 - $100; BC-348 - BO. **WANTED:** Complete DX-35 manual or copy; Also FT-243 xtals for ham bands. Al, AI4U, 6251 Fox Hunt Trail, Orlando, FL 32808. (407) 222-0007 (d), 298-3493 eves

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WANTED: Collins literature, manuals, catalogs. SM2, SM3, MM2 mic's, TD1, 647T dipole ant, 35C low pass filter, 55G1. Rick Coyne, KD6CPE, POB 2000-200, Mission Viejo, CA 92692. (714) 855-4689

FOR SALE: National HRO-60T, A-D coils - $350; National small 8" spkr - $50; National HRO-5TA1, A-C coils - $150; National NC-240C & spkr - $125; National NC-125 - $75; Hallicrafters SX-32 & spkr - $250; Zenith Transoceanic, 6A40 chassis - $75; Philco 42-150 - $75. All plus shpg. Discount for PU. **WANTED:** HRO-60 'E' coil or trade HRO-50 'E' coil for one. Bottom plate and pwr xfmr for HRO-60. Will consider junker HRO-60. Also want coil boxes. Will trade for RCA 44DX. Dan, (617) 964-3037

FOR SALE: Ultra Skyrider, VGC - $250; Heath gear - DX-100 - $100, DX-40 - $50, IM-18 VTVM - $12, CO-1 - $10, GW-31 CB walkie-talkie - $10/pr; S-38B - $23; PMR-8 - $20; Lafayette pwr/SWR meter - $10; B&W 5-position coax switch - $10; Silver "Vomax" VTVM - $15; Ameco 6-M converter - $8; 2B - $95; WRL Duo-Bander - $45; Galaxie V MK 2, w/HB pwr sply - $85; WANTED: Babcock and Palco mobile AM xmtr circa mid '50's. Pse call after Dec. 21. Joe Sloss, K7MKS, 4732 119 SE, Bellevue, WA 98006. (206) 747-5349

FOR SALE or TRADE: KWT-6, 1000-W SSB, 400-W AM, operational, w/manuals & TO's; parting out KWT-6. **WANTED:** Pair of 4-125's in good servicable condx (Eimac). Michael McDermott, WØBVA, 305 N. Keith St., Scammon, KS 66773. (316) 479-2756

WANTED: Very early Hallicrafters and Hallicrafters/Silver Marshall equipment including Skyriders with entire front panel dull aluminum color, S-30 radio compass, S-33 Skytrainer, S-35 panadaptor, wood console speakers - R-8 & R-12, HT-2, HT-3, BC-939 antenna tuner, parts, advertising signs, paper memorabilia of Hallicrafters. Also want RCA model AVR-11 airport tower receiver. Chuck Dachis, WD5EOG, "The Hallicrafters Collector", 4500 Russell Dr., Austin, TX 78745. (512) 443-5027

WANTED: Bud, Cardwell, Hammarlund, Johnson, National xmtg variable caps, single or split stator, .100 or greater plate spacing, 100 pF or greater capacity per section. Martin Piepenburg, W9OLD, RR 1, Box 56B, Monterey, IN 46960. (219) 542-2591

WANTED: Buy and sell all types of electron tubes. Harold Bramstedt, C&N Electronics, 6104 Egg Lake Rd., Hugo, MN 55038. (800) 421-9397, FAX (612) 429-0292

FOR SALE: Drake C-Line - R-4C, T-4XC, AC-4, MS-4 and PS-4. All in good condx. PS-4 was repaired and aligned by Drake in July '93 - $600; HQ-170 (ham band only) rcvr in VG condx, w/ matching spkr (small) in good condx, and manual - $150. Charlie Alexander, (614) 351-8835 eves or lve message on tape.

WANTED: SX-62A or B, w/spkr. WA2BTB, POB 110, East Rockaway, NY 11518-0110. (516) 887-0057

WANTED: Hallicrafters S-53A rcvr, wkg or not. Jerry, N5KYE, 14857 Redbud Ln., Piedmont, OK 73078. (405) 373-2228

FOR SALE: Crystal radio kits, complete with face panel, base board, variable capacitor, prewound coil and many parts for old style radio. Remit $22.50. Carl & Grace Ent., 5636 Romeyn, Detroit, MI 48209.

WANTED: BC-348 in new or extra clean condx. I'll ship. Tom Marcotte, N5OFF, 111 Destiny Dr., Lafayette, LA 70506. (318) 989-3430

Western Heritage Museum Omaha, Nebraska
"a magnificent home for your equipment"

Leo Meyerson, WØGFQ, (founder of WRL) needs donations of gear and related materials for the amateur radio exhibit at Western Heritage Museum in Omaha, Nebr.

This permanent display is the only one of its kind in the country and is something that all hams can be proud of. We expect 50,000 visitors annually.

Your tax deductible donation will be permanently noted on a plaque that will be prominently displayed.

For more information contact Leo at (402) 392-1708, May-Nov.; 619) 321-1138, Nov.-May.

FOR SALE: Painting Collins S-Lines and now St. James texture. Also call for your Collins kHz dial needs. Butch, KØBS, (507) 288-0044

WANTED: List, indexes or directories of WW II Navy tech. manuals or equipment. Willing to help to identify WW II Navy 5-digit type numbers. Send SASE. Ray, W6RIC, (805) 985-6048

FOR SALE: Tektronix Parts instruments. I am starting a parts instrument list with 29 of my own instruments. Send $1 & an SASE for my list. If you have Tektronix parts instruments of your own, send me your list and I will include it with mine, no charge to you. Stan griffiths, 18955 SW Blanton, Aloha, OR 97007. (503) 649-0837

FOR SALE: R-390A/URR, all Collins, S/N 4399, rebuilt by Rick Mish in August '93, w/ all covers, meters and knobs, spkr and manual - $600. Charlie Alexander, (614) 351-8835 eves or Ive message on tape.

WANTED: Manuals for Hallicrafters model HC-1 capacitance-resistance tester and Hewlett Packard model 200J audio oscillator. Chas Hill, Rt 3, Box 400, Buhl, ID 83316. (208) 543-6081

WANTED: Johnson Valiant II; National NC-400; ITT MacKay Marine 3010-B; Hallicrafters SX-101 Mark III (160-M band). Jim Benedict, 7113 N. 9 Mile, Lake City, MI 49651.

WANTED: Schematic diagram for Boulevard kit rcvr circa 1953 & schematic for Gonset Comm. III. Jerry, WA2ZOA, 14 Hillcrest Ave., Ossining, NY 10562 (914) 941-3703

FOR SALE: We rebuild twist-loc, wet style, rectangular, can capacitors. Mail your can to us, typical in shop time is 10 days. We custom build tubular & can capacitors & rebuild your capacitor. Inquire. Frontier Electronics/Everett Hoard, NØNVQ, Lehr, ND 58460. (701) 378-2341

FOR SALE: Five Collins 75A-4s for sale, S/N 1767 to 3547, reduction tuning, exc. PTOs. Three collector quality, no mods, two average to above average with AGC mod from ER. Price $500 to $1000. Consider 51J4 or Johnson 500 trade. PTO can be inop in clean 51J4. Lon, K5JV, (713) 358-4207

WANTED: Manuals or copies for Jackson model 648-1 tube tester and TS-1771 A/U dummy load/wattmeter. Jim Alexander, KØHIP, 1511 N. Jackson, Russellville, AR 72801. (501) 968-7270

FOR SALE: SX-110, ex. condx - $70 plus shpg. WANTED: S-76; SX-101A. Les Mathews, KD4RAT, 8908 Tar Hill Ln., Orlando, FL 32836.

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

FOR SALE: HQ-170, w/spkr - $175; RME 4350, exc. - $125; Collins 51S1, no cabinet - $550; RME 6900, matching spkr - $200. NØAEF, (319) 752-8475 after 5 PM CST.

WANTED: McIntosh and Thordarson amplifiers; poor to junk Collins 75A-2, 3 and 51J series rcvrs; poor to junk Hallicrafters louvered spkr. Serious sellers only! Marcus Frisch, WA9DXP, Box 28803, Greenfield, WI 53228-0803. (414) 545-5237 (24 hrs) collect.

WANTED: Collins 32V-3, F455B60 filter for 75A-3, 312A-1 spkr; Hallicrafters S41 and S-meter for RCA AR88. Joe, KB9R, (715) 834-4582

FOR SALE: ITT MacKay 3010C rcvr, exc. condx - $600; very clean Drake 2B, w/calibrator and 2BQ - $200; nice CE-20A, w/spare unit for parts - $75; very clean Meissner Signal Shifter - $75.**WANTED:** 8122 tubes. Ron, AD6V, (209) 255-1177.

FOR SALE: Parting out Collins 51J-4. No case, top cover or filters. Call for needs. Kurt, (602) 443-0896

WANTED: Collins 302C-1 watt meter and KW-1. Butch, KØBS, (507) 288-0044

FOR SALE: Racal RA-17C HF rcvr, good condx - $400; R-1051B rcvr, good condx - $275. Gary Gleicher, Box 427, Little Neck, NY 11363. (718) 423-1911 eves

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WANTED: MN-2000 tuner and C-4 station console. Dan, WB4GRA, 1522 S. Sowell Ct., Visalia, CA 93277. (209) 734-0997

WANTED: Heath SB-100, 101 or 102 and SB-600 spkr, w/HP23 pwr sply and orig. manual, cosmetic condx more important than wkg condx; manuals for HP 183B scope and 1841A/1830A/1801A plug-ins, please state serial number range of HP manuals. Reasonable prices please. Bob Smith, KC4WJO, 14779 Kogan Dr., Woodbridge, VA 22193-3314

WANTED: Manual and 110 VAC input xmtr pwr sply for TBX-4; shock mount base, military part # CWQ-10124-A for RBL-4 rcvr. Brad Sagendorf, 2 Windsor Rd., Huntington, CT 06484. (203) 926-1671

WANTED

Collins promotional literature, catalogs and manuals for the period 1933-1983. Jim Stitzinger, WA3CEX, 23800 Via Irana, Valencia, CA 91355. (805) 259-2011. FAX (805) 259-3830

FOR SALE: Collins 75A-4 filters: 6 pole ceramic for high quality AM. 3 bandwidths available: 4, 6, or 9 Khz - $83.50 ea.; single pole CW crystal filters - $88 ea. 10% discount for two filters. Money back guarantee. Calif. residents please add sales tax. Vector Control Systems, 1655 No. Mountain, Ste. 104-45, Upland, CA 91786. (714) 985-6250

FOR SALE: Westinghouse H204 - $50; Philco 50-922 - $50; Marshall 638 - $125; Philco PT44 - $75; Philco 39-7 - $50; Emerson port 523 - $35; Federal RP 101 - $40; RCA 6BX63 - $40; Truetone D2919 - $25; Bulova 350 - $30; Bulova clock radio 190 - $20; Truetone D1002 - $100; NRI kit built - $40; RCA 2X62 - $40; Dunlop 500 - $50; Mitchell 1250 - $35; Philco 46-250 - $40; Zenith H723 - $30; Philco 53-560 - $25; Zenith 6D030E - $40; Silvertone 2421 - $50; GE408 - $40; Zenith 4K035 - $45; Lafayette HE51 - $50; RCA 4X641 - $35; Strom. Carl 1101H - $65; RCA 95T5 - $75; GE123 - $60; Motorola 63L1 - $45. Polaroids $1 plus SASE. Bud Santoro, 3715 Bower Rd., Roanoke, VA 24018. (703) 774-9153

FOR SALE: Vintage parts. Send stamp and request "Vintage Flyer". USA only. Copies of some obsolete Readrite/Triplett equipment manuals. Bigelow Electronics, P.O. Box 125, Bluffton, OH 45817.

THAT'S NOT THE REAL SANTA CLAUS, AND THAT'S YOUR VIKING RANGER HE'S GOT IN THAT BAG!

FOR SALE: Transmitting/Receiving tubes, new and used. LSASE for list. I collect old and unique tubes of any type. **WANTED:** Taylor and Heintz-Kaufman types and large tubes from the old Eimac line; 152T through 2000T for display. John H. Walker Jr., 16112 W. 125th St., Olathe, KS 66062. (913) 782-6455

FOR SALE: Rockwell-Collins 18051 tuner, new - $295; Collins parts; ARRL Handbooks; vintage gear. Call or write. Ron Follmar, 1409 W. Willis, Alvin, TX 77511. (713) 331-1074

WANTED: Johnson gear, all models, any condition. Also parts and literature. Please state condition and shipped price. Wen Turner, AD7Z, Box 451EK, Cal-Nev-Ari, NV 89039.

FOR SALE: RT-556/APX IFF xcvr - $30; AN-104 antenna - $15; R-19/ARC rcvr - $20; equipment; parts; manuals; books; magazines; list - $1. Joe Orgnero, VE6RST, Box 32, Site 7, SS1, Calgary, AB T2M 4N3, Canada. (403) 239-0489

WANTED: Spkr and escutcheon for Collins 75A-4. David A. Clark, K5PHF, 9225 Lait Dr., El Paso, TX 79925. (915) 591-4184

FOR SALE: RME 4350; R-390A; R55; MRU35; NC-98; NC-183D; Transoceanic 6040; AF-67; PMR-7; Starroamer; SBE-33; SBE-34; Collins MR201. Dave Wilson, AB6DV, 9361 Valleyview St., Alta Loma, CA 91701. (909) 945-5431

FOR SALE: Collins meatball lapel pin - $5.95 + $.75 S & H. George Pugsley, W6ZZ, 1362 Via Rancho Prky, Escondido, CA 92029.

WANTED: A 1950's-vintage mobile ham rcvr for daily commuting. Preference for Gonset G66, Peirson KE93, Multi-Elmac PMR12A. Eddy Swynar, VE3CUI, 3773 Concession Road 3, R.R. #8, Newcastle, Ont. L1B 1L9, Canada

ELECTRIC RADIO PARTS UNIT DIRECTORY

If you need a part for a vintage restoration send $2 and an SASE (.52 postage) for a 6 page list of parts units. If you have a parts unit, consider putting it on the list. Your dead unit can help bring others to life!

Repair & refurbishment of older tube-type amateur equipment. Fully FCC licensed; 35 years experience. Chuck Banta, N6FX, Claremont, Calif. (LA area) (909) 593-1861

FOR SALE or TRADE: Collins 30L-1, WE; R-388, w/cabinet; 51S1 WE. **WANTED:** SX-115. K8FD, 116 Fairway Dr., Belmond, IA 50421. (515) 444-4396

WANTED: Collins 51J4 top dust cover; mech. filters F500B-14 and F500B-31; old General Radio company catalogs; Experimenter magazines; apparatus. John Tiedeck, WA2SDE, 212 Grandview Rd., Media, PA 19063. (215) 566-8049

WANTED: Condenser, carbon and other early broadcast microphones; cash or trade. James Steele, Box 620, Kingsland, GA 31548. (912) 729-2242

FOR SALE or TRADE: Stancor ST-202-A, 100-W xmtr. **WANTED:** Eldico TR-75 w/schematic. Ted Bracco, WØNZW, Quincy University, 1800 College Ave., Quincy, IL 62301. (217) 228-5213

FOR SALE: Heath KL-1 Chipewa amplifier and pwr sply, uses 4-400 finals, w/orig. manuals - $395. John Peterman, AB9G, 3024 N. 86th St., Milwaukee, WI 53222. (414) 444-1444

FOR SALE: EFJ KW Matchbox, w/SWR and manual - $195; Collins, WE 312B4 - $125; Collins WE 312B-5, w/orig. manual - $325; EV 664 desk mics and 419 stands - $125 each; Collins DL-1 dummy load - $95; National NC-300, w/manual - $150; National NC-303 for parts - $50. John Peterman, AB9G, 3024 N. 86th St., Milwaukee, WI 53222. (414) 444-1444

WANTED: Hammarlund clock w/cover & S-Meter; 450TLs; 833's. **FOR SALE:** Johnson Directional Coupler w/meter - $50; Signal Sentry - $45; Viking II & Ranger I parts; Elmac PMR-6A - $30; Globe Scout 680 - $35; Hallicrafters HT-9, PU - $150; S-38B - $40; Heath DX-100B - $125; National 183D rack mount - $200; Drake L4-B - $625. W7FG, (918) 333-7893

FOR TRADE: Nice 51J4 for nice NC-400. Please call Sam, N4VIB, (706) 695-5658

WANTED: All types of military electronics, especially RDF and radar items, manuals too. Also need URD2 antenna. William Van Lennep, POB 211 Pepperell, MA 01463. (508) 433-6031

FOR SALE: Collins 32S1 - $300; 75S3 - $300; F500F14 mech. filter - $50; non-Collins 455-10Z , 2.4 kHz (455 I.F.) mech. filter - $30; Ameco PCL-P tunable nuvistor preamp (a must for 6-M AM gear) - $65; tube type FT-401B, FV-401 VFO, SP-401 spkr, 125 watts AM, 300+ CW/SSB - $395; NC-300 (National) - $250. Jim, (616) 229-4318

FOR SALE: Manuals/copies for Eico 720, 730; HQ-100C;Heath VF1; Elmac AF-68; Johnson catalog 956. Write for info. Paul Vaughn, 2317 Williamson Rd., Williamson, GA 30292-9613

WANTED: 2AC calibrator, 2NT xmtr, TR4 xcvr w/AC4 and MS4. Bob, WA6KER, (909) 682-5084

WANTED: Tubes for Tube exchange bank. Receiving tubes, all American, new-in-box. Help us make this zero tube cost system work. SASE for info. Tube Exchange Bank, POB 806, Lake City, MI 49651.

FOR SALE: National HRO-50T1, w/ABCD coils and manual - $300; HRO-7 w/ABCD coils, spkr and manual - $250. Joel Thurtell, K8PSV, 11803 Priscilla, Plymouth, MI 48170. (313) 453-8303

FOR SALE: Orig. operating and service instructions for Hallicrafters SX-101A - $10; Narda directional coupler, .95 - 2 GHz, -10dB coupling - $45. Harry Blesy, N9CQX, 2409 Northgate, No. Riverside, IL 60546. (708) 442-8855

WANTED: Single lever Bencher with oval (not triangular) paddles, in exc. to mint condx. State base finish and price. Tom French, W1HMQ, 120 Great Rd., Maynard, MA 01754. (508) 897-2226

WANTED: E.F. Johnson Courier amplifier and Viking 500 xmtr. Bert, N8NN, 2150 Silentree Dr., Vienna, VA 22182. (703) 448-8016

FOR SALE: Drake R4B (160-10M rcvr), T4X xmtr, AC-4 pwr sply and MS4 matching spkr - all $300. Gary Stigall, WA7RGQ, 3619 Pershing Ave., San Diego, CA 92104. (619) 294-7895.

WANTED: Visitors and tubes by museum. Old and odd amateur or commercial tubes, foreign and domestic purchased, traded or donations welcome. All correspondence answered. K6DIA, Ye Olde Transmitting Tube Museum, POB 97, Crescent City, CA 95531. (707) 464-6470

FOR SALE: RIT for KWM-2 and S-Line. No modifications for KWM-2. $59.95 tested/42.95 for kit. SASE for details and order info. John Webb, W1ETC, Box 747, Amherst, NH 03031.

FOR SALE: Repair & restoration of all classic & vintage radio equipment, reasonable rates, prompt turn around, 25 yrs experience. Mike McKean, N3HJQ, 726 McClellan St., Philadelphia, PA 19148. (215) 336-6111

FOR SALE: Book "Fixing Up Nice Old Radios" by Ed Romney - $9 ppd. Ken Greenberg, 4858 Lee, Skokie, IL 60077. (708) 679-8641

FOR SALE: R-390/R-220 Twinax cables, w/ connectors, 40' - $25, 52' - $31, 59' - $35, 72' - $41, 75' - $43. Plus shpg. Bob Bakinowski, 1524 Saint Tropaz, Tucson, AZ 85713. (602) 624-8029

WANTED: Manual/schematic for Johnson Navigator xmtr. Bob Zimmer, NV1X, 205 Brigham Hill Rd., Milton, VT 05468. (802) 879-7235

WANTED: Manual for CV-483/URA-17 RTTY PSK converter; MT-836 mount for R-392 rcvr. Geoff Fors, WB6NVH, POB 342, Monterey, CA 93942-0342. Phone (408) 373-7636, FAX 373-2345

TRADE: My (4) 4-400s & 1 3CX3000A1 pulls for your NC-240D or RME 9. A. Bruno, 24 Butternut Dr., New City, NY 10956. (914) 354-8899

FOR SALE: National FBX w/pwr sply, exc. - $500; Collins S-Line spkr - $30; Heath SB-200 linear - $200; NOS 810s - $40 pair; 1953 ARRL Handbook - $15. Mark Hovda, NØJWI, POB 10091, Cedar Rapids, IA 52410. (319) 364-4048, 7 - 9 PM CST

Please remember to count the words in your ad. If you are over 25 words, please send 15 cents for each extra word.

WANTED: Collecting early Heathkit gear, accessories and literature. Any condx or parts units. Thanks. Byron Tatum, WA5THJ, 1920 Maxwell, Alvin, TX 77511. (713) 331-2854

FOR SALE: Subscribe to "The Amateur Market Place". A Canadian newsletter, listing new/wanted Amateur/Computer equipment. 10 issues per year $16.50 US. Benefit from $ exchange. P.O. Box 8180, Ottawa, Canada K1G 3H7

WANTED: Coils for HRO-6; HRO spkr; TCS xtals; 75A2/3 mech. filter; Heath HP-23 pwr sply; rack mount HRO junker; ARB; GRC-9/RT-77 & acc.; info - "20J" rx (regen., w/3 3S4 tubes) spy? military? Greg Greenwood, WB6FZH, Box 1325, Weaverville, CA 96093. Msg. # (707) 523-9122

WANTED: Drake TR-6; Hallicrafters SX-115. Steve Barnes, K6PFW, 848 N. Silverwood, Upland, CA 91786. (909) 985-1062

FOR SALE: Johnson Messenger 223, no mic, as is - $20 + $7.50 shpg; Johnson Viking Messenger, w/mic, missing 1 knob, as is - $20 + $7.50 shpg; Heathkit Electronic Design Experimenter, no papers, unchecked, model ET-3100 - $40 + $5 shpg; Heath cathode ray tube checker model CC-1, untested, no paper - $20 + $5 shpg; Approved Elect. Inst. TV strength meter model A-460, untested - $15 + $7.50 shpg; Hallicrafters freq. standard type HT-7, untested, manual is available - $25 + $7.50 shpg. James Fred, R1, Box 41, Cutler, IN 46920. (317) 268-2214

WANTED: Manual, electronic VFO and companion rcvr (plus manual on companion rcvr) for the Ameco two and six meter xmtr model TX-62. Companion rcvr can be equivilant. David Childers, NL7YU, POB 191213, Kodiak, AK 99619. (907) 487-2496, packet NL7YU @ WL7AML . AK . USA . NA

FOR SALE: IBM 12-V regulator, 15 amp - $25; plate and fil. xfmrs, mil spec, new - $30; small parts for builders; oil caps, many sizes, mil spec, new. W6CAS, (916) 731-8261

FOR SALE: Restoration of vintage radios; 25 years experience. Phil Goodman, K4FXB, 4112 Commodore Dr., Atlanta, GA 30341. (404) 457-4195

WANTED: All items found in WW II Martin B-26 radio compartment, BC-461 antenna reel control box, clock, lamps, oxygen hardware, chair, boxes, etc. Greg Greenwood, WB6FZH, Box 1325, Weaverville, CA 96093. Msg. # (707) 523-9122

FOR SALE: NIB tubes, most JAN Eimac: 829A - $5; 832A - $8; 4D21/4-125A - $65; 8165/4-165A - $45; 7289/3CX100A - $25; 8056 - $15; 7587 - $18; 7586 - $22; 5876 - $10; 5894 - $22; 6688/EF180F - $5; Eimac 4CX250B - $50; 3B28/866 solid state - $8; 83 (solid state) - $5. Jim, (616) 229-4318

WANTED: Manuals for the 2-M xcvrs Gonset Comm IV and Knight TR-108. Jerry Kethcart, 16620 Robinhood Dr., Orland Park, IL 60462. (708) 532-9245

FOR SALE: HT-37; Heath 2, 6-M converters; Tecraft xmtr w/2,6 and 1-1/4-M converters; Gonset preamp; 5 Millen wavemeters in box; Silver wavemeter; Radio Eng. Lab. wavemeter; Collins 700C-5. Carter Elliott, 1460 Pinedale Rd., Charlottesville, VA 22901. (804) 979-7383

WANTED: Schematic and/or manual for Precision Apparatus model E-200-C signal/marking generator (copies OK); RCA Receiving Tube Manual (preferably late '60's - '70's vintage) Chet Smith, WB2LUQ, RD #1 Box 30, Verona, NY 13478. (315) 336-1739

WANTED: Pre WW II radio magazines, books, photos of stations, QSL cards, broadcast and ham collections bought. C. MacNeill Book Dealer, WA8ZNX, 3165 12 Mile, Berkley, MI 48072. (313) 543-1177 days

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FOR SALE: Military tech manual listings, largest stock in the world, over 50K - $5 refundable with first order. SASE for inquiries. Lee Frank, POB 60011, Harrisburg, PA 17106-0011.

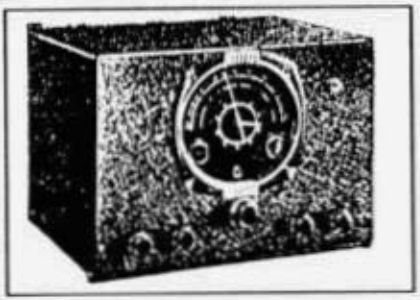
FOR SALE: I have a limited number of the rubber Lord shock mounts which suspend the 30S-1 blower. These aren't genuine Collins parts, but physically fit perfectly. The rubber is a bit stiffer, and should last forever (give or take). Set of 3 - $20. Postage included in USA. Peter R. Brown, KH6IRT, 5332 Puahia Pl., Honolulu, HI 96821. (808) 373-2792

FOR SALE: HQ-110 - $100; S-38 - $60; Heath Two'er - $35; AT-1; Swan 420 VFO - $75; mint Spanmaster - $100. Don Winfield, K5DUT, 6080 Anahuac Ave., Fort Worth, TX 76114. (817) 732-3976

FOR SALE or TRADE: AN/USM-116A Naval VTVM - $62; TS-297/U multimeter - $35; Mercury 101 tube tester $8; JAN-CWL-860 tube - $12; CB $20; walkie-talkie set - $15. Chris Cross, POB 94, McConnell, IL 61050.

WANTED: T-368 xmtr in any condx. TRADE: 1953 Sico tube tester, VG condx, w/orig. manual for Hammarlund rcvr. Vince Bernotas, N2WXF, 864-B Nevada Oval, Plattsburgh, NY 12901-3902. (518) 562-8911

FOR SALE: Hallicrafters SX-100 - $225; SX-28 (fair) - $145. Lane, KM3C, (505) 526-0910



WANTED: Any condition, Hallicrafters Sky Master and EP-132 as shown. Also want SX-46, S-48 and S-49. Chuck Dachis, 'The Hallicrafter Collector', 4500 Russell Dr., Austin, Texas 78745. (512) 443-5027

FOR SALE: Collins KWS-1, exc. - $1500; collector quality RE S-Line - $2500; Collins mfg R-390A PTO, 1988 gov't overhaul, NIB - $175. Lon, K5JV, (713) 358-4207

WANTED: Information on a Collins 500 kc IF mech. filter plug-in adapter type 353E-1 with 6 kc filter (F 500 B 60 type 5V2). This filter unit is triangular shaped and has a standard 7 pin tube plug on it. Horizontally mounted are two tubes, a 6AU6 and a 6BA6. Can anyone please tell me for what receiver this unit was designed? Peter H. Brown, KH6IRT, 5332 Puahia Pl., Honolulu, HI 96821. (808) 373-2792 call collect

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FOR SALE: National HRO-50T1, A/B/C/D coils, calibrator, manual - $225; 872A rectifiers, (7) new/boxed - $15 ea., $85 for all. Richard Prester, 131 Ridge Rd., West Milford, NJ 07480. (201) 728-2454

THIS IS CALLED "CAPACITIVE COUPLING" -- I THINK YOU OLD-TIMERS CALLED IT A "GIMMICK."

FOR SALE: Collins KWS-1, VG, w/manual - $1500; collector quality S-Line, R/E, 32S-3, 75S-3B, 516F2, 312B4, all filters, manuals, cables - $2500; Hallicrafters R-42, VG - $100. **WANTED:** Collins 32V-3 (VG-exc.). Paul Katz, W5NTQ, Houston, TX (713) 776-0440, 7-8 AM or 8-10 PM CST

WANTED: Hallicrafters DD1 Skyrider Diversity, only in VG condx. Jose Cangas, EA4JL. Contact in the States Kurt Keller, (203) 431-6850

FOR SALE: Hallicrafters SX-71 rcvr in fair condx, complete and works - $70. Fred Clinger, WA8KJJ, (419) 468-6117 after 6 PM

WANTED: Manual or copy for Galaxy R530 rcvr; WRL SS-3 Q-multiplier and Brown Brothers straight key. Gary Wagner, K3OMI, 11124 Oak Hollow Rd., Knoxville, TN 37932. (615) 690-4217 (d)

FOR SALE: Tube tester AN-1185 (Card-O-Matic) with tube data card set, calibration/test card set, operational manual, spare cards and punch, good condx - $125; Systron-Donner 512 MHz freq. counter, lab quality, high stability time base - $99, only 2 left. You ship. Texas Connectors, POB 940375, Plano, TX 75094-0375. (214) 423-9625

FOR SALE: Heath SB-220, heavily modified (documented), works perfect, tunes 80-10-M including WARC - $750; Yeasu FV-101B remote VFO for FT-101 series - $165. Lane, KM3C, (505) 526-0910

WANTED: Galaxy gear - bandswitch or parts unit GT-550, spkrs, pwr splys, accessories, xcvrs, wkg or parts units. Byron Tatum, WA5THJ, 1920 Maxwell, Alvin, TX 77511. (713) 331-2854

FOR SALE: WRL Globe King 400 - $350 PU only; Knight T-50 - $40; Swan TV-2 transverter, mint - $100; Swan SW-240 xcvr, w/rare Swan TCU (extra VFO, P/S, spkr) - $200; National NCX-3, w/spkr, sply - $125; Galaxy GT-550, RV-550 VFO, sply - $150; Hammarlund HQ-170 - $125; Hallicrafters SX-99, R-46 spkr - $150; Drake R-4, MS-4 - $90; Heath HW-101, HP-23B, exc. - $160; Johnson Signal Sentry - $15; Globe Matcher Jr. - $12; Swan 350B - $100; Utica 650 6-M xcvr, w/V650 VFO - $50; RCA audio sig. gen. WA-44A - $30. Plus shpg on all. Richard Lucchesi, WA2RQY, 941 N. Park Ave., N. Massapequa, NY 11758. (516) 798-1230

FOR SALE: HF/KWM-380 digital keypads that are electrically and functionally identical to the original model AC 3805A keypad. These are newly manufactured units, packaged in a colormatched and weighted low profile enclosure. A small quantity will be built and I'm taking orders for these units. Price is $99.95, plus $5 S/H with a 30 day moneyback guarantee. Specs available with a SASE. Jerry Brouwer, AB8U, 3041 Rising Springs Ct., Bellbrook, OH 45305.

WANTED: National FB-7 rcvr and any National parts, coils, variable caps, tube sockets, etc. Could trade an SW-3, w/doghouse pwr sply. Richard Bauer, K5RB, 563 Hambrick Rd., Dallas, TX 75218. (214) 348-3378

WANTED: Manual or tech info for U.S. Navy RAL-7 rcvr. Mack, (501) 921-5874

FOR SALE: Dial calibration is easy with our Tri-Mark crystal calibrator. Uses 9-V battery or rectified filament voltage. Three outputs provide rock steady signals from broadcast to UHF. Great pocket signal source. Kit $17.95; assembled $24.95. $4 S&H. Visa/MC. We have a large selection of HV capacitors for tube circuits. $1 brings catalog and coupon. USA/Canada only. Two Fox Electrix Co. POB 235, Tivoli, NY 12583. (914) 757-5800

WANTED: Hallicrafters SX-76, HT-30, HT-31, SX-88, FPM-200, R-46; RME 4350, DB-23; National NC-183D, HRO-60, NC-400; WRL Champ 300A; Johnson Ranger, Adventurer; Heath AK-5; Yeasu FTDX-400/560. Bighorn Museum of Amateur Radio, POB 229, Byers, CO 80103.

FOR SALE: All DX-100 xfmrs, loading and input coils, meter, other misc parts - $15 U-ship. John Rozanski, 10614 Caminito Manso, San Diego, CA 92126. (619) 566-9716

WANTED: HRO-7, w/pwr sply, matching spkr and coils; power xfmr for HT-32. Clark, WØBT, 2546 SE Peck Rd., Topeka, KS 66605. (913) 235-2721

WANTED: Heathkit EK-2, basket case. Need the parts. Richard Gentry, POB 9274, Phoenix, AZ 85068.

FOR SALE: 32S3, 516F2 WE, 75S3B RE - $750; Drake R4A, AC4, MS4, T4X - $325; TR4, AC3, MS4 - $300. U pay shpg. Gary Elliott, NO5H, 808 Clarice St., Delhi, LA 71232. (318) 878-8032

FOR SALE: Collins 75S2, 32S2, 516F2, xtra SW xtals, xtra tubes, lots of data sheets, WE - $875. Lane, KM3G, (505) 526-0910

FOR SALE: Limited quantity of new blue with white stitching handles for Tektronix 545A etc. scopes, complete with new chrome mounting hardware - $7.50; also replacement rolls of special silver bearing solder (3 feet) for Tek scopes - $.50 each. Add $5 S&H. Stan Griffiths, W7NI, 18955 S.W. Blanton, Aloha, OR 97007. (503) 649-0837

WANTED: WRL-70 xmtr; HB xmtrs for display, must be museum quality; thousands of QSL cards to paper walls of Amateur display. Call Leo, (402) 392-1708, Western Heritage Museum, Omaha.

WANTED: SX-101 w/160; Radio Shack DX-400; Uniden CR 2021; TMC GPR-90/92; RCA model CRM R6A; Heath SB-610 monitor scope; 3 RPI CRTs. Rick, K8MLV/Ø, 1802 W. 17th St., Pueblo, CO 81003. (719) 543-2459

WANTED: The following for the National HRO-50: Select-O-Ject SOJ-3; spkr; NBFM adaptor type NFM-83-50 and coil sets E, F, G, H, J, AA, AB, AC (any or all). Peter R. Brown, KH6IRT, 5332 Puahia Pl., Honolulu, HI 96821. (808) 373-2792

FOR SALE: First US Army Air Force airborne ground radar set, SCR-518A dated 1942, was classified "Secret". Brand new in six orig. boxes including underwing antennas and aircraft shockmounts. Only about 2000 were made. $895. Sam Hevener, W8KBF, "The Signal Corps", 3583 Everett Rd., Richfield, OH 44286-9723. (216) 659-3244

HEATHKIT FANS: Don't mourn their passing; enjoy learning more about their past in historic pictures and personal insights from many company oldtimers in 124 page book - $9.95 pp. Heath Nostalgia, 4320 196th S.W., Suite B-111, Lynnwood, WA 98036-6754

WANTED: Hammarlund SP-600, prefer JX-17 or JX-21 in exc. condx. I will pay the price for a quality piece. Terry Neal, 1127 Salvador St., Costa Mesa, CA 92626. (714) 546-9602

FOR SALE: Hunter Bandit amp w/4-572B's; Waters phone patch for Collins gear; mint Heath SB-102, w/pwr sply. Joe Perratto, K2QPR, 1341 SW Evergreen Ln., Palm City, FL 34990. (407) 220-7362

WANTED: Ranger II; Valiant; SX-115 in nice working condx. Consider Globe Champion or 51J4. Need 2 AM setups. San, K5YY, POB 763, Springdale, AR 72765. (501) 756-5010

FOR SALE: Ham Trader Gray Sheets, buy, sell, trade, classic radios. Free ads, 12 issues - $12. Dave Knepper, Box 34, Sidman, PA 15955. (814) 487-7468

WANTED: SX-115 or HRO-60. K8FD, 116 Fairway Dr., Belmond, IA 50421. (515) 444-4396

WANTED: Any Collins 30FX series xmtr. Have Johnson 500, SX-115, etc. for part trade. Gary, WA9MZU, 1751 Michon Dr., San Jose, CA 95124. (408) 266-2218

FOR SALE: Repair! All makes and models, homebrew, maximum labor per unit - $96. Dan Rupe, W7HBF, Telo Technology, 1302 S. Uplands, Camano, WA 98292. (206) 387-3558

FOR SALE: Eimac SK-500 socket, w/chimney & cap (4-1000) - $30; Collins CP-1 - $110. Gary Gleicher, Box 427, Little Neck, NY 11363. (718) 423-1911

WANTED: WW II PPN-2 radio bag & ant also Model 19 MK II control boxes and cables. Steve Bartkowski, 4923 W. 28 St., Cicero, IL 60650-3627

WANTED: Polycomm 6 or 62B xcvrs; need Poly Booster info; looking to buy or swap amateur related manuals. Pete Markavage, WA2CWA, 27 Walling St., Sayreville, NJ 08872. (908) 238-8964

FOR SALE: RG-8X (mini 8) jumpers, soldered PL-259's w/strain reliefs - 3' - $2.50, 12' - $3.65, 20' - $4.45, 50' - $7.75. Cheaper than you can make them yourself! Special good until 1/31/94. Add 10% shpg (minimum $2.50). Over 40 types of cables and over 260 types of connectors in stock. Send $.52 in stamps (free with order) for catalog of great prices and selection. Texas Connectors, POB 940375, Plano, TX 75094-0375. (214) 423-9625

FOR SALE: Cornell-Dubilier vibrators 6VL6H - $3. **WANTED:** Hammarlund HQ-110 manual; TCS units; Johnson 122 VFO. Dave, W1DWZ, (508) 378-3619

WANTED: Manual (copy OK) and spkr for Hammarlund HQ-129X. Tom Mackie, WB2ILA, 807A Bristol Ferry Rd., Portsmouth, RI 02871. (401) 683-9504

WANTED: WE tube types 101D/F, 102D/F/G, 104D, 205D/E/F, 262A/B, 252A, 274A/B, 275, 300A/B, 348A, 350B, 212E. Ed Billeci, (503) 281-4734

FOR SALE: BC-611 parts and National manuals. LSASE for list or call. Robert W. Downs, WA5CAB, 2027 Mapleton, Houston, TX 77043. (713) 467-5614

WANTED: Ampex 300 or 350 series tape deck, half track "portable" preferred; tube audio equip. - Heath, Macintosh, Dynaco, etc. Mike Nowlen, WB4UKB, POB 1941, Herndon, VA 22070. (703) 481-9614

WANTED: SB-620 rcvr multicoupler; 51S1 rejection tune knob; PRC-74 modules. Joseph Pinner, 201 Ruthwood Dr., Lafayette, LA 70503. (318) 981-7766

FOR SALE: Johnson Ranger I, good condx, works - $150. Rhyne Killian, KA1CX, 4 Walter Circle, Westford, MA 01886. (508) 392-9943

FOR SALE: Military keys, telegraph, parts, radio, quack, meters, etc. Lge list - $1 + 2 stamp SASE. J.H. Jacobs, 60 Seaview Terrace, Northport, NY 11768.

FOR SALE: Heath HW-16, w/HG-10B VFO, wks - $110; HR-10B rcvr - $50; HW-18, clean - $40; Hallicrafters S-41G, wrks - $60; S-94 - $15; (2) RBM-5 rcvrs - $40 each. OBO plus shpg. John Devon, (818) 441-5523

FOR SALE: Hallicrafters HT-37 xmtr - $90; T.O. keyer - $35; National NC-300 rcvr - $95; XCU calibrator - $15; Heath SB-303 rcvr, AM/CW filters, SB-650 display - $150; SB-650 display - $35; HP-23 sply - $35; HD-10 keyer - $25; HD-15 phone patch - $20; HM-2140 dual wattmeter - $40; HM-2141 VHF dual wattmeter - $40; Two'er - $25; Six'er - $25; HR-1680 rcvr - $65; Clegg Interceptor B rcvr, w/Allbander converter - $95; Interceptor rcvr, w/ Allbander converter - $75; Venus 6-meter SSB xcvr, w/PS - $125; new S/S speech booster - $35; Zeus xmtr - $65; Ameco TX-62 xmtr - $25; 621 VFO - $20; Drake MS-4 spkr - $20; AC-4 sply - $75. George Hawrysko, K2AWA, POB 568 Boro Hall, Jamaica, NY 11424. (516) 364-5104

WANTED: Will pay $25 for 2 Hallicrafters pointer/bar knobs from SX-23, SX-32, HT-6, etc. Also W.E. candlestick phone with damaged or without mike/horn (model 20 or equal - no dial). Robert Enemark, W1EC, POB 1607, Duxbury, MA 02331. (617) 934-5043

WANTED: Editor's and Engineers Handbooks, especially mid - late '50's; Sprague TO-6 cap analyzer. Barrie Smith, KF7VA, 125 Ben Hogan Dr., Missoula, MT 59803. (406) 549-1921 (n), 728-7637 (d)

FOR SALE: Exchange or donate hard to get xmtr parts, tubes, tech info or anything pertaining to radio. SASE. Cmd. Glenn W. Ritchey, USN Ret., W7SAB, 219 Naval Ave., Bremerton, WA 98310. (206) 373-9631

WANTED: Call sign license plates from all states for W.A.S. display. Will reinburse the postage if you wish. Bighorn Museum of Amateur Radio, POB 229, Byers, CO 80103.

WANTED: Two 4CX-1000 tube chimneys for a Collins 204-H autotune linear amplifier. Peter H. Brown, KH6IRT, 5332 Puahia Pl., Honolulu, HI 96821. (808) 373-2792 call collect

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FOR SALE: Collins KWM-2, WE, Samsonite case, PM-2 strap-on PS, 302C3 wattmeter, MP-1 mobile PS, spare tubes - $975. Lane, KM3G, (505) 526-0910

FOR SALE: HT-37, exc. - $150; HW-12, HW-32, AC & DC splies, mic, all - $160. John, WD9JIM, 69 -19th St., Clintonville, WI 54929. (715) 823-2381

WANTED: National SW-4 regen. rcvr, looks like SW-5 but only 1 coil per band - Super cash or trade. Robert Enemark, W1EC, POB 1607, Duxbury, MA 02331. (617) 934-5043

WANTED: WW II radar equip., units and complete systems. Also collecting early electron microscopes made by RCA, wireless equip. and pre-1900 motors and generators. Allan H. Weiner, 14 Prospect Dr., Yonkers, NY 10705. (914) 423-6638

WANTED: Manuals or diagrams for YO-301 monitor scope and for USM-32 (= Allen Dumont Lab 301A) scope. Hans Zimmerman, HB9AQS, POB 209, CH-3780, Gstaad, Switzerland

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FOR SALE: (2) Collins mech. filters, F455Z 5B 6545 on IF boards with xtals - $50; (1) Collins mech. filter F500Y500A6W2 - $35. P.A. Orobko, VE7FY, 12347 Davison St., Maple Ridge, BC V2X 5N5 Canada. (604) 463-4904

FOR SALE: WW II 50 page illustrated catalog of military communications sets - $2 US, $5 foreign. Sam Hevener, W8KBF, "The Signal Corps" 3583 Everett Rd., Richfield, OH 44286-9723. (216) 659-3244

WANTED: Collins 32V-3/2, 75A-3/2; Collins mech. filters and spkr; McElroy bug. TRADE: Amperite RBM mic. Brian Roberts, K9VKY, 3068 Evergreen Rd., Pittsburgh, PA 15237. (412) 931-4646

WANTED: WW II & Korean mititary sets, xmtrs, rcvrs & test equipment. Send list of equipment along with price. Richard Mollberg, K6PWF, 2340 Almond Ave., Concord, CA 94520. (510) 283-6786 eves

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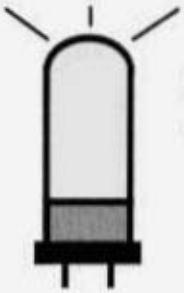
FOR SALE: Pre-War Hallicrafters 10" spkr, big 'h' on front, chrome strips on side, matches SX-16, SX-17, SX-28, etc., cone perfect, cabinet re-finished and re-grilled - $70 or equal trade for 75A-4 spkr. **WANTED:** RME DB-23 preselector and clock for HQ-170A. Gus Stellwag, 117 Edgewood Dr., Orangeburg, NY 10962. (914) 359-0769

WANTED: Collins black escutcheon w/ designation 75S3-C for rcvr. Call collect if you have one. Al, (604) 767-6447

WANTED: Altec 438C compressor amp, high-quality 50 ohm to grid xfmrs; WE 618 mic xfmr; Westrex mic or line amp modules; Ortofon plug-in SPU cartridges; GR 1201-C unit sply. TRADE: Sherwood processor for TR-7. Joe, N4WQC, Box 180562, Austin, TX 78718. (512) 339-6229 phone/FAX



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