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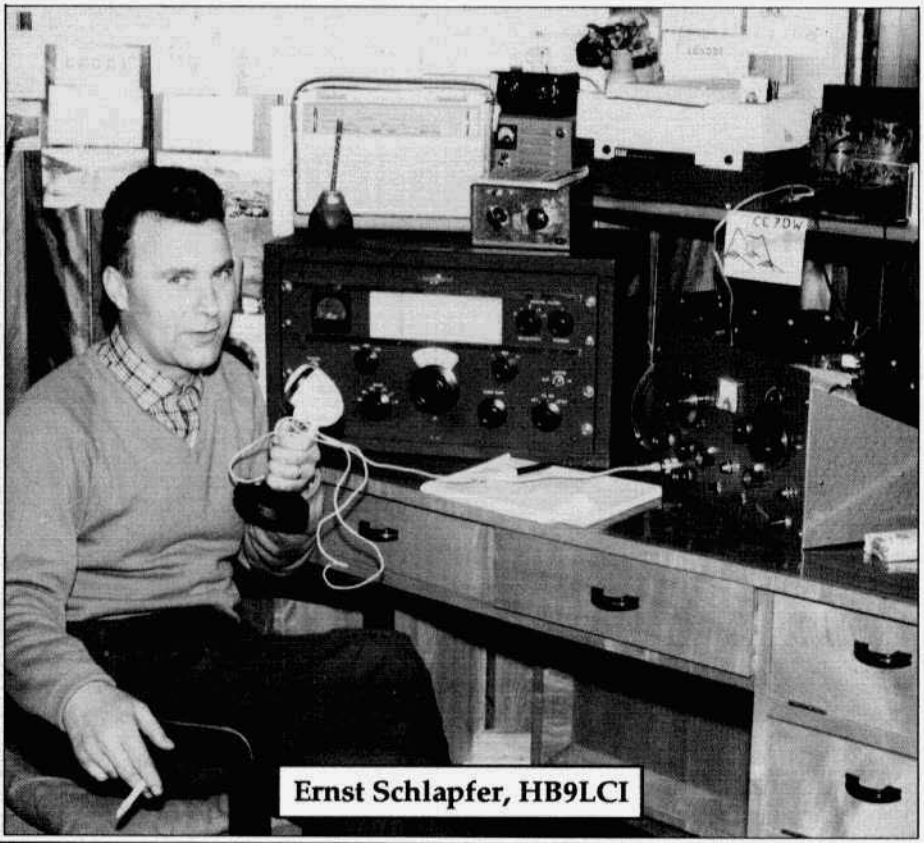
ELECTRIC RADIO

celebrating a bygone era

Number 50 June 1993



Ernst Schlapfer, HB9LCI

ELECTRIC RADIO

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REGULAR CONTRIBUTORS

WALT HUTCHENS,KJ4KV.....ELECTRIC RADIO IN UNIFORM
FRED HUNTLEY,W6RNC.....REFLECTIONS DOWN THE FEED-LINE
BILL KLERONOMOS, KDØHG.....VINTAGE PRODUCT REVIEWS
DALE GAGNON, KW1I..... AM REGULATION UPDATES

Electric Radio is published for amateur radio operators and others who appreciate the older tube type equipment. It is hoped that the magazine will stimulate the collecting of, and interest in, this type of equipment.The magazine will provide information regarding the modification,repair and building of equipment. We will also work to-wards a greater understanding of amplitude modulation and the problems this mode faces.

Electric Radio Solicits Material

We are constantly searching for good material for the magazine. We want articles on almost anything that pertains to the older amateur equipment or AM operation. From time to time we will also have articles and stories relevant to the CW operator and the SWL. Good photo's of ham shacks, home-brew equipment and AM operators (preferably in front of their equipment) are always needed. We also welcome suggestions for stories or information on unusual equipment. For additional information please write us or give us a call.

EDITOR'S COMMENTS Barry Wiseman, N6CSW/Ø

This month in place of my comments I've decided to print a letter I received recently from Michael Wilke, WB4AQL.

"It was with great sadness and a sense of loss that I learned of Fred Huntley's death. I found his column, "Reflections Down the Feedline", to be the most enjoyable segment of "Electric Radio". I planned to write Fred and tell him that, but now-alas it is too late.

"Fred seemed to personify the spirit of amateur radio in a manner which has become increasingly rare. Fred's experience and wisdom, magnified by his unassuming style, was a wellspring to those of us who love radio. He was the type of person who inspired me to join the ranks of amateur radio. Today I don't think an individual whose experience is confined to the purchase and operation of a 2M HT could prompt such efforts.

"Fred was a microcosm of the AM/CW community as it exists today. Let us endeavor to nurture, inspire, and appreciate that community. As a result of some particularly unpleasant RFI experiences, I have not lately been an active AM participant. I work mostly CW, but do a lot of AM listening. I cherish my vintage gear and my friends within the AM community. I consider myself an AM'er!

"Amateur Radio is a wonderful privilege; long may it flourish."

Michael Wilke, WB4AQL

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Cover: This photo was taken in 1967 in Puerto Montt, South America when Ernst was CE7DW. He was one of the few regular operators on 10-meter AM. His Ten-Ten number is 345. The rig was homebrew consisting of 6146's modulated by 807's.

KOBY, K5MZH, SK

From the San Antonio Express News

"As a detective in the intelligence bureau of the San Antonio Police Department in 1974, Bernard G. Koby helped New Orleans homicide investigators expose an insurance plot that put two Texas murderers behind bars.

"Koby, 71, an accomplished painter and ham-radio operator, retired from the Police Department in 1976.

"He died Monday [April 26] in a local hospital when he suffered a heart attack after his fifth heart bypass operation, his family said.

"Born January 14, 1922, in France, Koby was 13 when his family moved to the United States.

"He enlisted in 1940 and flew cargo planes in the Army Air Corps during World War II. After he was shot down near the Philippines, he injured his back and was stranded on a raft until his rescue.

"Koby left the service in 1945 and the next year joined the Police Department, where he worked 30 years.

"He loved his police work," said his wife, Virginia Lee Britz Koby of San Antonio.

"Police Lt. Jesse Porter said Koby was well respected and well liked around the department.

"Koby's final assignment at the Police Department was in the intelligence bureau, where he investigated narcotics, white-collar crime and terrorist crimes.

"Working with New Orleans Detective John Dillmann, now a best-selling author, Koby helped convict Texans Sam Corey and Jim Giesick of murder of Patricia Ann Giesick, who was struck by a hit and run driver during her honeymoon in New Orleans.

"The story was told in Dillmann's book, "Unholy Matrimony," in which Koby was featured.

Koby, K5MZH, on the right with his lifelong friend, Otis Nonken, K5SWK

"Koby credited his uncle, a painter, with sparking his interest in oil painting, according to an article written about Koby in the late 1970s.

"At least one of Koby's paintings was presented to Ladybird Johnson and hangs at the LBJ Ranch, said Koby's daughter, Sharon Lynn Koby of San Antonio.

"She said her father always was trying to invent things.

"He invented an alarm, like a burglar alarm, but someone else got the patent," she said.

"She remembers, when she was a child, that her father "helped put in the intercom speaker systems at the new Police Department."

"His wife said he built all his own radio equipment. Koby's ham-radio call number was K5MZH.

"Koby also played harmonica and a little bit of piano.

"Also surviving are another daughter, Nancy June Koby Kenning of San Anto-

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A TWO-TUBE SUPERHETERODYNE RECEIVER

by Paul W. Fritsch, W3HHC
4251 Oakleigh Road
Allentown, PA 18104-4419

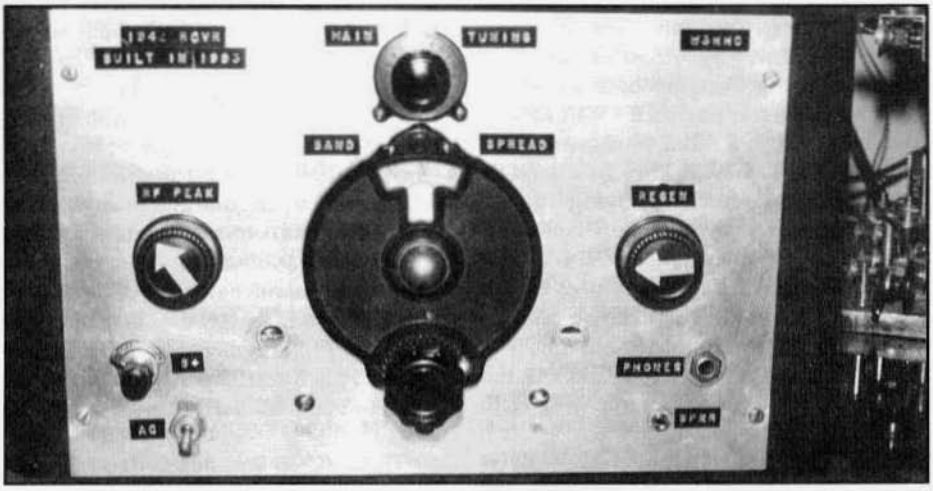
A few weeks ago just before my 75th birthday, I decided to build this two-tube set which I had built 50 years ago. I did it to satisfy myself as being an old-timer, which meant constructing something from scratch. I was amazed the receiver worked, and it wasn't hard to get the touch of a regenerative receiver again.

The article on this receiver is in the 1942 and 1946 ARRL Handbook. I wound only two coils thus far, and with my eagle eye and sharp ears, I found the 40 meter band plus or minus plenty of short wave stations. I used it to work CW and a bit of AM phone. Just SWL'ing I've heard VKS, Europeans, etc.

"Although all the advantages of the superheterodyne-type receiver cannot be secured without going to rather elaborate multi-tube circuits, it is possible to use the superhet principle to overcome most of the disadvantages of the simple regenerative receiver. These are chiefly the necessity for critical adjustment of the regeneration control with tuning antenna "dead spots", lack of stability (both in the detector circuit itself and because of slight changes in frequency when the antenna swings with the wind), and blocking, or the tendency for strong signals to pull the detector into zero beat. These effects can be largely eliminated by making the regenerative detector operate on a fixed low frequency and designing it for maximum stability. The incoming signal is then converted to the fixed detector frequency before being detected."

The previous paragraph was the first one from the handbook article showing the difference between a simple regenerative set and the simplest form of a superheterodyne circuit.

The set uses a 6K8 to convert the incoming signal to the intermediate frequency around 1700 Khz and a 6C8G (I used a 6SL7GT since I had no 6C8G) as a detector and audio amplifier. The description in the handbook gives the bill of material, coil winding data, and other hints on construction. It wasn't as easy as building a foxhole razor blade crystal set but sure was fun. **ER**



This two-tube superheterodyne receiver is described in the 1942 and 1946 ARRL Handbooks.

ELECTRIC RADIO IN UNIFORM

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

"The ARC-39 Transceiver"

When we looked at the famous HF 'command' sets (ATA and ARA, SCR-274N, and ARC-5) we found that these sets had lost their 'command' (control of planes in a formation) job almost when they were introduced but continued to play a role where longer-than-VHF range was needed and to talk to aircraft and ground stations which did not yet have VHF equipment. This month we'll visit the set which took over the non-command work of the command sets when they retired. Though successful, it is (like many children of the famous) almost forgotten now.

Overview

RT-427/ARC-39 is a twelve channel crystal controlled aircraft transceiver built for the U.S. Navy by Aircraft Radio Corporation -- the designer of the original command sets. It covers 2 - 9.10 Mcs in two bands with a rated transmitter output of 10 watts AM voice and a superhetrodyne receiver having a sensitivity of five microvolts. There is no provision for CW operation.

The 20 tubes are all miniatures except for the 6159's (6146's with 26.5 volt filaments) in the final and modulator. The transceiver is 8" x 10" x 22" (H x W x D, the standard 'ATR' package) and weighs 36 pounds.

A full set of front panel controls is provided: receiver and transmitter TUNING, PA LOAD, ANT TAP, ANT FINE, a channel switch, REC ANT, a meter switch, and local receiver volume and SIDETONE screwdriver adjustments. Once the first four controls are set for a channel and locked, a 'retuner' unit similar to the famous Collins Autotune resets them when that channel is selected again. A control box (C-2241) allows remote channel selection and volume adjustment; audio input and output normally were tied to the plane's intercom system but jacks for both are also on the panel.

A bank of 24 sockets below the controls on the front panel holds the receiver and transmitter crystals.

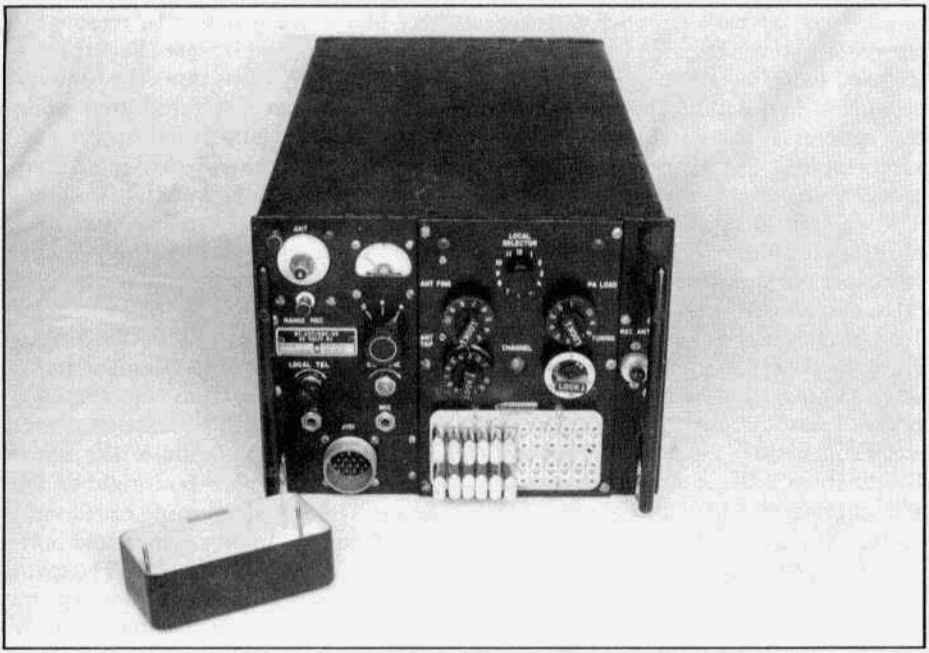
Except for the antenna, all connections are made by a front panel 'AN' type connector. Power is provided by a built-in dynamotor. The set requires 24-28 VDC at a maximum of 9 amps.

History

I don't have any solid history for the ARC-39 so some of this section is supposition and hearsay.

Except for LF receivers used for navigation purposes, the production of 'command' gear ended shortly after WW II. By the mid 1950's, stocks of new command equipment were gone and in any case the single channel somewhat drifty command set design was obsolete. There was, however, still a requirement for a lower powered transceiver for use in places like training aircraft where HF capability was needed but not an expensive 'liaison' (aircraft to base) set like the ARC-2 or ARC-38.

The ARC-39 was developed to fill this role. From the serial numbers I've seen, total production may have been as few as 500. By the time the ARC-39 retired from



The ARC-39 transceiver. The twelve crystals on the left are for the six channels on the low band, 2 - 4.27 Mcs; the twelve empty sockets at the right are for the high band, 4.27 - 9.10 Mcs. The cover in front protects and holds the crystals in place. Barely visible at the upper right of the panel is a sticker saying that this unit was repaired at the Naval Air Rework Facility, North Island (San Diego, CA) in February, 1969.

service (probably about 1970), SSB was taking over and military aircraft of all types were so expensive that a lower-cost radio probably wasn't considered important. Fair Radio Sales had ARC-39's for a number of years but they disappeared from the catalog around 1990.

Audio Processing For Communications AM

In a communications transmitter like the ARC-39 you want to get the message through in the worst possible conditions. Audio processing for AM has two main parts. First, it was found by experiment that nearly all the information which helps recognize words is in the frequencies between about 300 and 3000 cps. Higher and lower frequencies make your voice 'sound like you' but they do little to help another station understand what you're saying.

One might say "Well, even if the extra frequencies don't do much good why not leave them in" but voice peaks are the result of all the frequencies adding up; a wider range of frequencies will mean higher peaks which will require reducing the gain to prevent going over 100% modulation. Thus extra frequencies mean less sideband power for the frequencies which help the other station understand your words.

Second, no matter what the frequency range, ordinary speech has a very high ratio of peak to average power. Adjusting for 100% modulation on peaks means a low average modulation level and low sideband power. By cutting off the peaks the audio gain can be increased without going over 100% modulation. This raises the average sideband power so the signal is louder and easier to understand when

continued next page

ER in Uniform from previous page
there is noise, but of course such clipping distorts the voice signal. As clipping is increased (with the audio gain raised to keep 100% modulation) there is at first little difference except that the signal sounds louder. As you cut more deeply, however, you eventually get to a point where the signal starts to get harder to understand again.

By experimenting it was found that the greatest intelligibility is obtained at about 20 dB of clipping; that is, when the top 90% of the voice wave form is cut off and the remaining signal amplified to produce full modulation. At this clipping level the increase of intelligibility is 4 to 5 dB—the signal will get through as well as an unclipped signal of three times the power.

The usual scheme for a transmitter using speech clipping and filtering is:

1. Use a high-pass filter to remove speech frequencies below about 300 cps. Part of this filtering can be done by selecting a microphone which has little response to the unwanted range and all military mics are designed this way.
2. Clip the resulting signal.
3. Filter the clipper output to remove frequencies above 3000 cps. Not only does this reduce unwanted frequencies in the original speech but it takes care of the harmonics produced by the clipping process.
4. Amplify the clipped and filtered speech enough to fully modulate the transmitter. The stages after the clipper must have low frequency response well below the lowest frequency they will amplify to reduce phase shift which would turn the flat tops of the clipped signal into 'sawteeth', forcing reduced gain and a lower average modulation percentage.

A well designed communications voice transmitter including speech clipping and filtering does not 'sound bad'. In fact, 10 dB or so of clipping is almost undetectable although the transmitter will get through like one of about twice the power. At 20 dB, your voice will not sound exactly like you but it will be reasonably clear and not unpleasant. Perhaps the reason so many hams think the contrary is that most ham AM transmitters using speech clipping and filtering were designed to be as inexpensive as possible. That meant using the minimum number of parts and the least expensive ones that would do the job; in some cases it also meant cut-rate engineering.

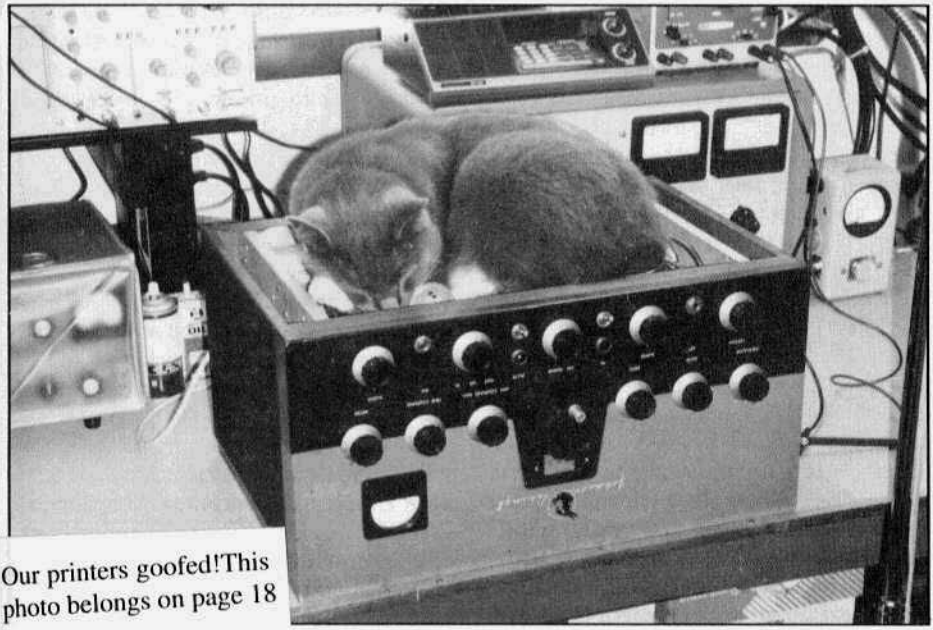
Design

The overall design of the ARC-39 says 'committee'; this is not a beautiful transceiver. A flat chassis holds a receiver IF/audio assembly, an RF/preselector unit and the PA/driver module. The transmitter audio section is built right on the chassis. The antenna loading coil sits in a pit and the dynamotor is mounted horizontally under the chassis rear. The space right behind the panel is taken up by controls and the very compact retuner mechanism.

The receiver circuit is almost a command receiver updated: you could design most of it in your sleep. There's a 6BA6 RF amp, a 6BE6 mixer, two 6BA6 IF stages and a 5814 (military 12AU7) with the sections diode connected, serving as a detector and series noise limiter. Half of a second 5814 is used as a cathode follower on the AVC line; this gives higher effective AVC voltage gain since the DC current drawn by the AVC circuit doesn't have to come from the diode detector. The other half of this tube serves as the first audio stage. A 5686 (roughly a 9-pin 6AQ5) is the audio power amp.

A 12AT7 is used as the receiver local oscillator; one half is connected in a modified Pierce circuit and the other as a cathode follower. The IF is 750 kcs with the oscillator above the channel frequency.

The transmitter uses a 6BA6 crystal oscillator, a 5686 driver, and a 6159 (6146 with 26 volt filament) final amplifier. Another 5686 is used as a screen clamp to protect the final in case of loss of drive -- if for example you select a channel for which no crystal is installed.



Our printers goofed!This photo belongs on page 18

Left top view of the ARC-39. Rear to front of set at top of photo: IF/audio assembly, modulator, loading coil with variometer and tap switch, antenna relay. Bottom: Modulation transformer, RF/mixer assembly (note 'command' set coils and cover), final amplifier/driver assembly. The top of the retuner is next to the front panel above the driver assembly.

The final is plate and screen modulated. The design of the transmitter audio section follows the AM speech processing scheme described above. A 5814 serves as a mic amp (only half of the tube is used) driving a diode connected 5814 in a series clipper circuit. The frequency response of the mic amp drops off below about 2000 cps to help get rid of the lower voice frequencies. The gain of the mic amp is adjustable to allow setting the amount of clipping between none and about 15 dB. The clipper is followed by a low-pass LC filter network which cuts off sharply above 4000 cps. A pot following the filter allows setting the modulation level.

The first half of a 12AT7 drives the second half as a phase splitter to feed a pair of 6159's operating class AB1. The response of these circuits extends down to around 100 cps to reduce sawtooth effects.

The final tank is parallel tuned. On the higher band a second coil is connected in parallel with the low band tank coil; this somewhat unusual arrangement allows use of link coupling to the antenna without either a change of ratio or complex switching.

Antenna coupling is adjusted by rotating the link inside the tank coil. A large tapped series loading coil with a variometer for fine adjustment allows loading even very short antennas.

Hummm. . . Aircraft Radio Corporation. . . link rotating inside the tank coil - - yep, the PA tank looks exactly like a command transmitter tank coil. I did not count the turns but it is at least a near clone of the coil in the 2.1 to 3 Mcs ARC-5 transmitter. The sharp eye will spot a number of other command set parts in this rig, among them the receiver RF coils and shields, the REC ANT knob and the fixed vacuum capacitor.

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The three receiver front end tuning capacitors are ganged with the driver and PA plate caps; all five are operated by the TUNING knob and retuner mechanism.

The retuner mechanism uses the same basic ideas as the Collins scheme but with important differences. There are fewer parts (the pawls and springs of the Collins design are gone) and the parts are smaller, allowing the drives for all four shafts plus the crystal and bandswitches to be combined in a single compact subassembly. This means a cast and precision machined chassis isn't needed and there is no line shaft, chain drive, etc. as used by the Collins design.

The design changes allow a much quicker drive: channel selection takes one or two seconds instead of a few seconds as on the 1944 ARC-2 or perhaps 15 seconds on the ART-13, the original Autotune set. An additional improvement is a window showing the number of the channel actually selected, which lets you be sure the mechanism is working properly.

The panel meter shows PA grid or cathode current or rectified antenna current. A silicon diode samples the transmitter RF output for sidetone – a very desirable feature since it lets the operator hear the signal he's actually transmitting. A vacuum relay connects or disconnects the antenna from the transmitter; additional non-vacuum contacts connect or short the receiver input. The rest of the transmit/receive switching is done by a sealed relay. An extra binding post on the panel allows connection of an LF navigation ('Range') receiver in parallel through a low-pass filter with the ARC-39's receiver.

There's a bit of cleverness in the high voltage supply. The dynamotor has two output windings. One supplies a negative voltage of about 90 volts on receive; the negative end of a second winding delivering 360 volts is connected to this giving -90 volts bias (for the AVC amplifier) and +360-90 = +270 volts for the receiver plates. With the higher load on transmit the two windings furnish -75 volts and +325 volts respectively; the -75 volts is connected to the PA cathode so this stage operates at 400 volts plate to cathode. The cathodes of the other stages return to ground so they operate at 325 volts.

On The Air With The ARC-39

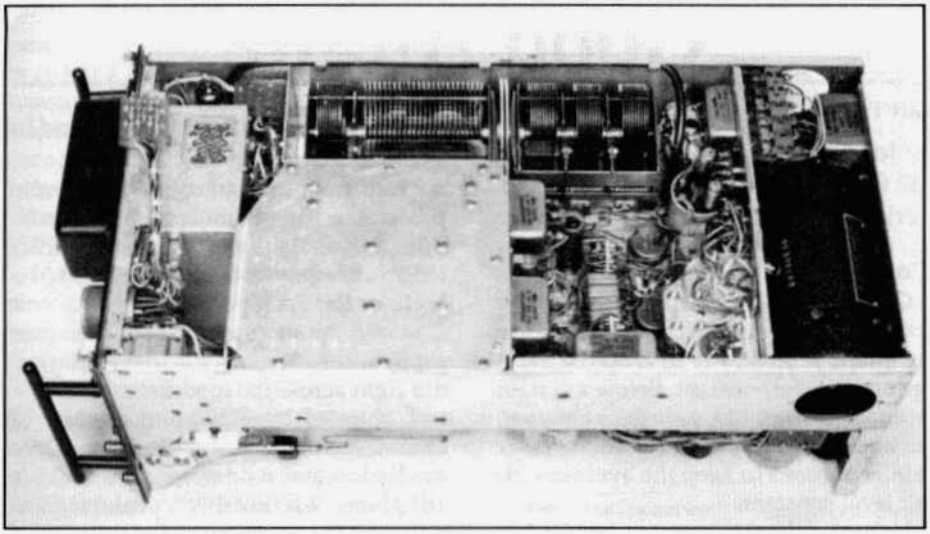
My ARC-39 came from Fair Radio about 1985 and may have been the rig on which I made my first contact as a reactivated ham – refusing to do anything the easy way is probably one mark of the true military fanatic! It required only the usual minor work – cleaning, checking of tubes, and lubing of the dynamotor before going on the air.

Like the original command sets, the ARC-39 really doesn't want to load a 50 ohm antenna; the output power rating is given at 10 ohms as would be typical of an aircraft antenna. The answer is a step-up transformer: twenty turns of no. 26 wire wound on a plastic 35mm film can with a tap at ten turns connected to the set will do. A series capacitor will probably be needed if your antenna is near resonance; 500 mmf works well. At 3885 kcs my set delivers about 14 watts.

The one essential 'mod' if you want to operate the set from the front panel controls is to replace the screwdriver adjust receiver gain control with one having a shaft long enough to take a knob. Disconnecting the low pass filter parts will let you hook up an auxiliary receiver to the RANGE REC antenna connection.

Following the postwar pattern, the dynamotor is a small hard working unit which is screwed to the chassis without shock mounts. It will have a relatively short life and delivers an especially large dose of that authentic 'vacuum cleaner sound'. If the ARC-39 becomes one of your favorites an external HV supply might be a good idea.

The HC-6/U crystals are available from all the modern makers; since two are needed for each frequency you're looking at about $20 per channel but 90% of 80/40 meter AM activity occurs on three or four frequencies so a full set isn't needed.



Left bottom view of the ARC-39. Rear to front of set at top of photo: Dynamotor connections, receiver tuning capacitor (may look familiar!) transmitter tuning cap, bottom end of retuner assembly. Bottom: Dynamotor, modulator circuits, bottom of loading coil pit, panel connector wiring and bypasses. Note connector pulled from retuner for photo: the pins are the same small banana pins used in the 'command' sets.

The series-parallel filament circuit means that if some tubes are missing or open the life of the others in parallel with it may be a few minutes or less; check the filaments before applying power. On any autotune set you should change the channel immediately when you apply power. If the set doesn't channel, shut down and find the problem. Something may be jammed and the first real warning can be a bad smell and smoke from the motor.

The ARC-39 is crystal controlled and it definitely isn't a high powered set. With no BFO there's no way to copy SSB. Once you get beyond these things, however, it makes a fine rig for the vintage military enthusiast. The selectivity is good for a set of this period and the amplified AVC and excellent noise limiter make it a real pleasure in net operation. This is about the easiest HF rig there is to get working and to use; operating it will give you a feel for military radio at its best.

Conclusions

Looking at the ARC-39 design overall, you can't help thinking that the Aircraft Radio engineers studied every military set then in production and copied from most of them. That's good -- the requirement didn't call for advances in the state of the art and how many sets have we reviewed which were obsolete before they were in production or which did wrong something that every other set of the period did right?

The ARC-39 is simple to tune up and operate; among mechanically retuned transceivers it probably has the fastest channel change time.

In general only the very simplest military transceivers (small portables) should use separate crystals for transmitter and receiver. There are simply too many possible mistakes when two nearly identical parts must be installed in the right places and of course an extra crystal for each channel makes the set cost more. It is no big deal to feed the receiver oscillator output through a mixer (with the IF frequency) to get the channel frequency. But

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Good Audio

Part Two

by John Staples, W6BM
732 Cragmont
Berkeley, CA 94708

Compressors and Peak Limiters

Compressors are like AGC circuits: they act quickly on bursts of audio and release the attenuation slowly to keep the average audio level constant. Below a certain input level threshold, gain does not vary, but above the threshold, the compressor gain is reduced to keep the average output level constant.

Note that I said "average level". The speech waveform is complex, and although the compressor affects the average power level, peaks may still sneak through. The compressor gain reduction attack time is a few milliseconds, so low-frequency signals are not distorted. (The compressor gain change must be slower than the longest period of the signal.) The longer release time prevents the gain from rushing up between words and phrases, and reduces the room echo.

Some audio transients are bound to get through and overmodulate the transmitter. Often audio compressors are cascaded, with the attack/decay times of the front-end ones slower, followed by compressors with faster attack/decay times. Compressors operating with short time constants are sometimes called peak limiters.

At W6BM, a Gates Compander with a very long release time is followed by an Altec 436C with a 1.3 second decay time, followed by a CBS Volumax 400 peak limiter with a short attack/decay time to clean up the remaining fast transients.

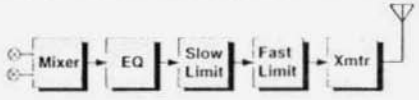

Fig. 4

Alternative Transmitter Audio Feedpoints

The output level of commercial audio processing equipment is usually 10 to 30 dBm, (dB above 1 milliwatt, or about 2.5 to 25 volts rms into 600 ohms). This is too high for the microphone input, as it will overload the stage before the audio gain control. An alternative is to feed the audio right across the modulator gain control, shunted by a 600 ohm resistor to correctly terminate the audio source. Once the limiter and modulator gain controls are properly set for 100% peak modulation, only the gain controls upstream of the limiters should be adjusted.

Distortion

Distortion significantly affects the audibility, or the ease of understanding the words. Clipping, overmodulation, saturated audio transformers and poorly biased modulator stages are the chief causes of distortion. All of these are curable.

The famous "Valiant Sound" is due primarily to saturation of the audio driver transformer by d.c. flowing through the primary, magnetizing the transformer core to near saturation. A modification has been published (Staples, ER #24) which cures the deficiencies of the original circuit.

The idle modulator current should be adjusted to the transmitter specification. If the tubes are weak, they may go into distortion before 100% modulation is reached.

Inverse feedback around the high-level stages following the gain control may help reduce distortion in the output stage.

Take care to eliminate r.f. from the audio circuits: they may rectify the signal and produce feedback. R.F. pickup in low-impedance circuits may be eliminated by placing a 0.005 microfarad capacitor from each side of the balanced line to ground at each piece of equipment.

Class AB2 modulators draw grid current during part of the cycle. The driver must have a low source impedance so the waveform is not distorted during grid current flow. The bias supply decoupling capacitor from the center tap of the driver transformer to ground must be in good condition to lower the impedance of the audio drive to the modulator tubes.

Other causes of distortion are insufficient grid drive, preventing full upward modulation, or weak (emission limited) final amplifier tubes, also preventing full upward modulation.

Monitoring

I am constantly amazed at how few stations have monitoring facilities. Monitors generally fall into three categories: level meters, oscilloscope displays and aural monitors (headphones).

Average level meters, such as VU indicators are the least effective. Mechanical meter movements respond slowly, missing the audio peaks that cause splatter.

Commercial AM modulation monitors, such as the popular General Radio 1931 (A,B) are making their appearance at ham flea markets. These monitors display peak modulation level and carrier shift. The peak level is indicated by a lamp, which can be set to flash at a preselected negative peak modulation level, up to 100%.

The carrier shift meter is useful in establishing the proper operating conditions of the final amplifier. The carrier shift meter indicates the average carrier voltage, which should stay constant during modulation. (The peak voltage for 100% sine-wave modulation doubles, and the average power output increases by 50%, but the carrier voltage, averaged over one period of the modulation waveform, remains constant). Downward carrier shift may indicate overmodulation or poor high-voltage regulation, and upward carrier shift may indicate parasitics. Tuning single-sideband transmitters may be facilitated by using a simple carrier shift metering circuit (Staples, ER#36).

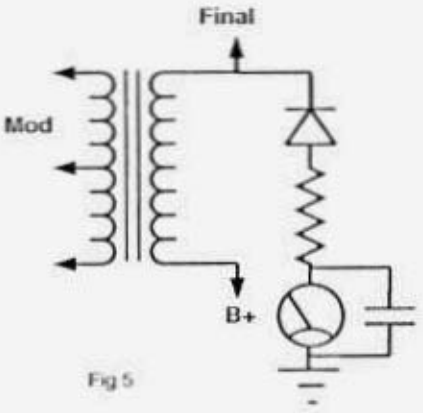

Fig 5

An effective negative-peak overmodulation monitor may be constructed by connecting the cathode of a high-voltage diode to the modulated B+ line to the final and the anode to ground through a meter. Upon negative swings of the modulated B+, the diode will conduct current and deflect the meter.

Oscilloscope-based modulation monitoring provides better information, with a trapezoidal-pattern display easier to interpret than an envelope display (Staples, ER#11). An envelope display is certainly effective, and will help set the phase of the audio to maximize the positive modulation peaks. If the negative peaks appear more prominent than the positive, try switching the audio phase as described above. Overmodulation appears as "beads" along the baseline. My own transmitter has a trapezoidal monitor built right into the final amplifier (Staples, ER#15).

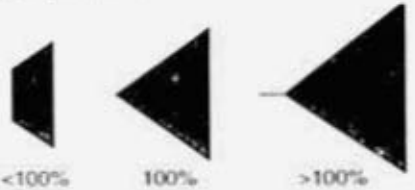

Fig 6

continued next page

Good Audio from previous page

Aural monitoring is perhaps the easiest, requiring a pair of headphones, a diode, a few feet of antenna and a few other small parts (Staples,ER#36). The modulation level can't be accurately monitored, but hum, noise and distortion can be heard. It is useful to be able to reverse the phase of the phones. If the headphone phase is improper, the whole bass register will be lost by destructive interference between the headphone audio and the bone conduction audio from the larynx to the ears.

High-Level Modulation Circuits

The modulator power output capability must be at least one-half the d.c. power input to the final r.f. amplifier. The d.c. power input to the modulator stage is almost equal to the input power to the final for 100% sine-wave modulation, as the plate efficiency of a class-B modulator output stage is usually around 60%. Full 100% sine-wave modulation stresses the modulator and high-voltage power supply.

Triode final amplifiers and pentodes with proper co-modulation of the screen grid voltage have a fairly linear voltage-current characteristic, so the final amplifier plate current approximately follows the instantaneous plate voltage. One modulator tube may work harder than the other due to the varying load impedance of the final amplifier. This may cause distortion due to asymmetrical loading on the positive and negative modulation peaks. Negative peak loading circuits, consisting of a resistor and a diode connected across the modulation transformer to absorb some of the power on the "easy" half of the cycle may reduce this possible source of distortion. A fixed resistor may be included in the plate lead of one of the modulator tubes to equalize the load (Kleronomos, ER#7).

The ultramodulation configuration allows more audio to be placed on the carrier by rectifying part of the audio and adding it to the final B+ voltage, which keeps the modulated B+ from swinging down through zero (Kleronomos, ER#3). This circuit increases the signal level, but at the expense of significant carrier shift and distortion. Since the 1.5 KW legal power limit now refers to peak envelope power, it makes no sense to employ this circuit. Any scheme that causes the average carrier level to fluctuate at a syllable rate, such as controlled-carrier schemes, should be avoided, as they play havoc with the AGC action of many receivers.

With the price of 810's increasing, alternative tubes may be used. Triode-connected 813's work well in transmitters of this power level, operating at almost zero bias. All three grids are connected together, and fixed bias may be derived from a zener diode in the cathode circuit. One advantage of zero-bias operation is that the driver is loaded over the entire audio cycle, not just at the peaks. Swamping resistors may be placed across the secondary of the driver transformer to stabilize the driver load if enough drive power is available.

A technique used in broadcast transmitter isolates the d.c. current flow from the secondary of the modulation trans-

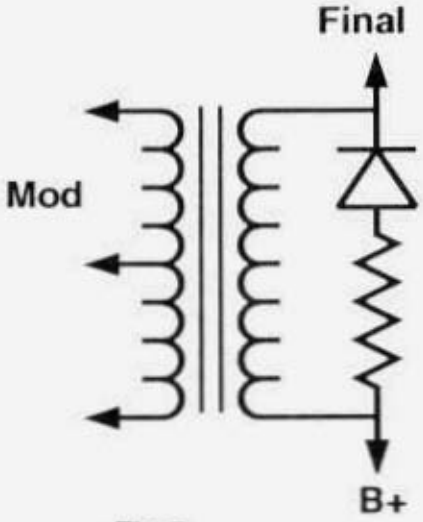

Fig 7

former by feeding plate voltage to the final amplifier through an audio choke which is coupled to the modulation transformer secondary through a d.c. blocking capacitor. This prevents magnetization of the transformer core, raising its inductance, and providing better low-frequency response at reduced distortion.

Almost all high-level modulated broadcast transmitters use push-pull audio amplifier stages throughout and employ negative audio feedback from the plates of the modulator tubes to the grids of the first stage to reduce distortion and stabilize the gain. Negative feedback can be used to advantage in ham transmitters, usually over the last two or three stages preceding the modulation transformer. This will require some experimentation to achieve stability, particularly during transients introduced by overmodulation. Circuit modifications incorporating negative feedback have been published for the Johnson Valiant (Staples, ER#34).

Protecting the Modulation Transformer

During overmodulation, the final plate voltage swings below zero, cutting off the final amplifier plate current. This effectively disconnects the load from the modulator resulting in an open circuit condition on the modulation transformer secondary. What happens next depends in part on the source impedance of the modulator itself.

If the modulator output stage uses triodes, which have a relatively low output impedance, (at least one is always conducting on audio peaks), enough damping may be present to prevent the voltage on the secondary of the modulation transformer from soaring. Pentode or beam power modulator tubes, on the other hand, operating without inverse feedback, provide no such damping and the voltage across the secondary may go high enough during negative overmodulation peaks to cause breakdown. A spark gap across the secondary of the modulation transformer adjusted to break down at a bit more than twice the d.c. supply voltage will protect the transformer (Dennison, ER#25).

Additional protection for the transformer is obtained by isolating the case from ground and allowing it to float up to high voltage potential, reducing the voltage stress between the windings and the iron core. Perhaps half of the modulation transformers in the KW-1 and the Johnson Desk Kilowatt transmitters have already failed (they use the same transformer). Make sure that the transformer is made inaccessible for safety.

Low-Level Modulation Circuits and Single-Sideband Transmitters

Some AM transmitters including many older broadcast transmitters generate the AM signal at low level and amplify it with linear amplifiers. The amplifiers must be capable of providing a peak power output of four times the unmodulated carrier power. The efficiency of class-B linears at the unmodulated carrier level is typically about 33%. To produce the legal limit of 1.5 KW peak envelope power, or 375 watts of unmodulated carrier at 33% efficiency, the unmodulated carrier input power would be 1136 watts, and 761 watts is dissipated as heat on the plates of the output tubes. A 1 KW carrier broadcast transmitter with a linear in the final dissipates 2 KW on the plates. Linears designed for sideband use do not react well to this kind of abuse.

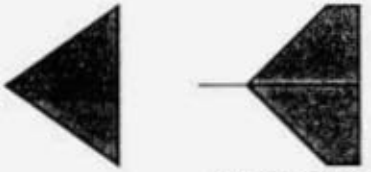

Fig 8

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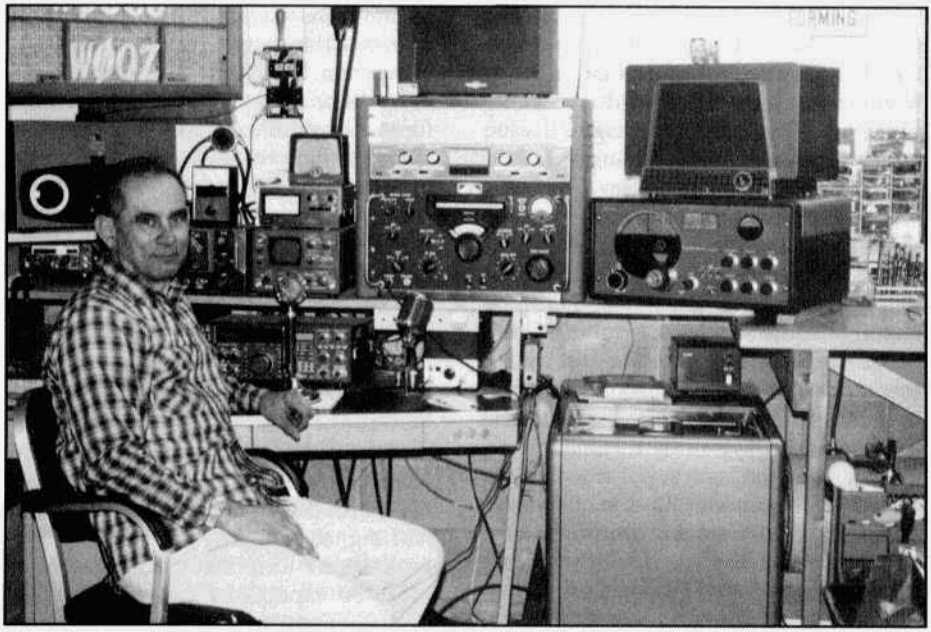
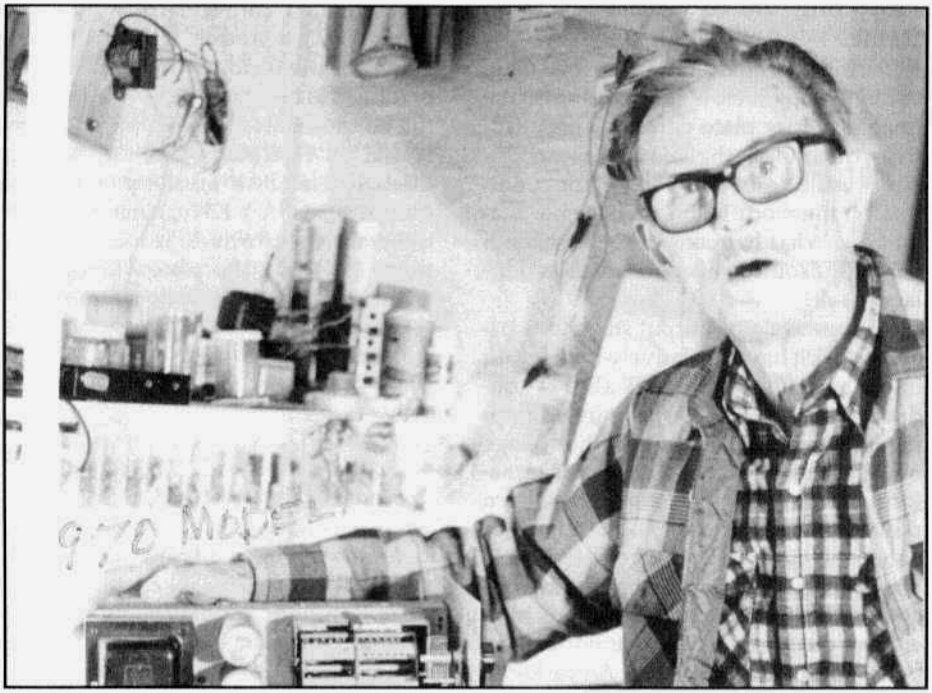
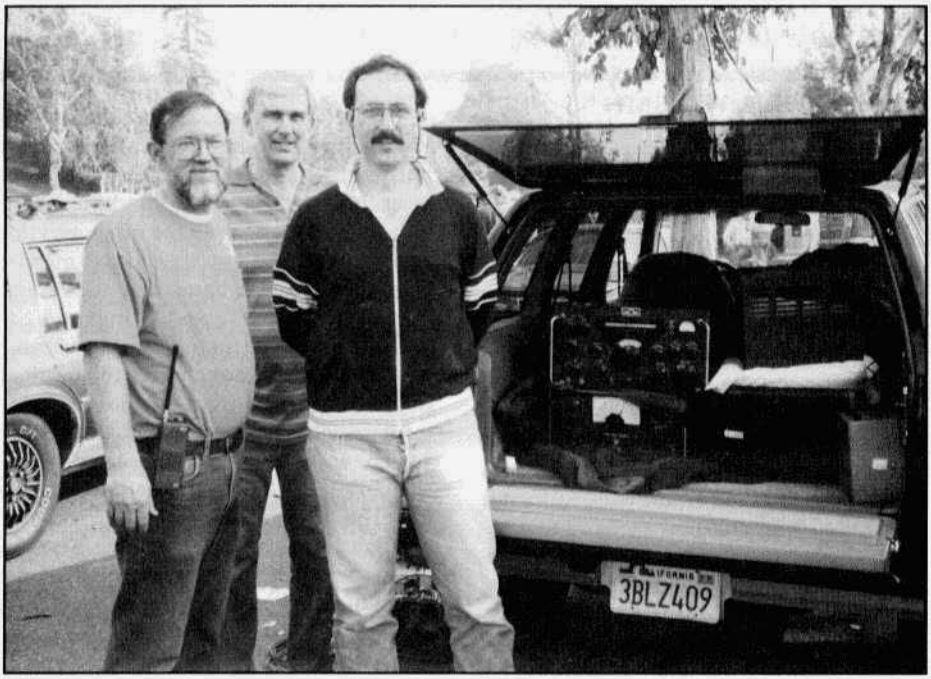


Herm Renner, WØSCU, with some very nice vintage equipment. He operates 160, 80 and VHF.



Frank Susnik, WØARZ, in his workshop. He's 80 years old and was first licensed in 1933. During WW II he served in the Signal Corps. doing radio maintainance.



From left to right: Steve Barnes, K6PFW; John Hurst, KU6X and Jim Wilson, NU6H. This photo was taken at the Los Altos swap meet in April of this year.

Carter Elliott, WD4AYS, in his vintage station that consists of mostly Collins equipment.

Variable Frequency Crystals for Use in Amateur Transmitters

by Joel Levine, WB2BMH
67 Derby Ave.
Greenlawn, NY 11740

Crystals are amazing devices. These compact little packages control the output frequency of a transmitter without the visible indicators of heat and light. You can pull them and plug them and each time the crystal will oscillate on the same frequency. Manufactured from naturally occurring crystals, their reputation for stability and reliability have earned them the nickname "the rock". As a Novice in the 1960's, restricted to crystal controlled transmission by FCC regulation, these sugar cube shaped components were my key to the pleasures of ham radio.

The notion that crystals can change frequency seems to violate a law of physics. After all, when crystals first became available in the late 1920's and early 1930's they were hailed as a costly but effective method to assure frequency stability and accuracy. Most hams of the 1930's era did not own accurate wavemeters and the calibration of receivers could not be assured to guarantee in-band operation. Within a few years the crystal controlled Colpitts oscillator replaced the unpredictable self-excited circuits popular with hams of that era. Even though crystals were expensive, at $4.00 to $20.00 apiece in hard to earn depression dollars, (note: my father, W2RKC, earned $25 per week in 1937) the huge advantages of stability and frequency predictability guaranteed the wide-spread acceptance of crystal oscillators.

The great disadvantage of crystal control was the limitation of operation to a single frequency. One approach to multiplying crystal usefulness was frequency multiplication. A frequency multiplier is an oscillator or amplifier which is tuned to a harmonic of the crystal frequency.

This approach worked because the pre-World War Two ham bands were direct harmonics of one another. (This changed after the war; five meters and two and a half meters made way for other services and hams were given six and two meters; later the 15 meter band was added and during the 1980s, 12 and 17 meters.)

Doubling an 80 meter crystal oscillator to 40 meters did not change the original (or fundamental) frequency of the crystal; it provided a second output frequency which may or may not have been within the part of the band you wanted to operate. The alternative, variable frequency oscillators, remained expensive, prone to frequency drift and beyond the financial reach of many hams well into the 1950's.

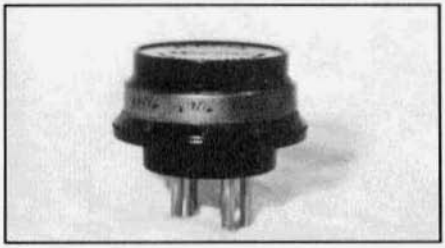
My flea market searches have uncovered two approaches to varying frequency with the use of crystals; the first approach was the Bliley VF-1 (Variable Frequency 1) crystal. Offered in *QST* during the late 1930's, this crystal had a top mounted dial which varied the frequency up to 5 Khz. We generally think of a crystal as having a fixed frequency determined by the size, material, cut of the crystal and ambient temperature. While this is generally true, another factor is the tension on the plates which make the electrical contact; vary the tension and the frequency will change within a small range.

VF-1 variable frequency crystal

The top mounted dial on the VF-1 rotates a screw which compresses or releases the spring holding the crystal. I have two VF-1s and the calibrated marking on the top of the crystal coincide accurately with the output measured on a frequency counter. Bliley offered three models with fundamental frequencies in the 160, 80 and 40 meter amateur bands.

There were disadvantages to the VF-1. The 5 khz frequency range was only enough to move between the QRM on CW. On AM transmissions 5 Khz will not move you outside of the bandwidth of the signal. Listed at eight to ten dollars apiece in the 1937 ARRL Handbook, the VF-1 was a poor man's VFO. By comparison, a standard single frequency BC-3 crystal listed for $3.95 to $4.95 in the same catalogue. My own experiments with the VF-1 indicate that output dropped as frequency increased so the VF-1 was not us able for a full 5 Khz of variation with all oscillators.

An entirely different approach to variable frequency operation crystal control is the Deka-xtal manufactured during the late 1940's by Scientific Radio Products of Council Bluffs, Iowa. This device, which looks like a flying saucer, mounted 10 crystals in a single crystal holder with a rotatable switch located on the top. Turning the top piece switches in successive crystals with frequencies spaced throughout the band. In 1948 the Deka-xtal cost $5.95 without crystals and $14.95 with ten crystals selected by the manufacturer.



Deka-xtal, 10-position crystal

This is not really a variable frequency crystal because the frequency of each selection is determined by a different crystal. However, this device utilizes crystals to approximate VFO operation while assuring the stability and accuracy of crystal operation. I have units with fundamental frequencies in the 160, 80 and 40 meter bands. With frequency multiplication, the Deka-xtal was useful after the war on all ham bands up to ten meters.

The Deka-xtal was not popular; it was introduced at a time of decreasing VFO price and improving VFO performance, and it was relatively expensive. Temperature compensating components in the oscillator circuits designed to change value as the VFO warmed up produced significantly better stability than was previously available. However, the problem of poor stability was not truly solved until the heat generated by the tube's filament was eliminated by conversion to cooler operating solid-state devices. Even today, the highest levels of stability in solid-state devices can be achieved only by placing the crystal in a temperature controlled oven.

The Deka-xtal did not spawn imitation by the major crystal manufacturers like JAN, Bliley and Texas Crystal. In addition to improving VFO price/performance, inexpensive surplus crystals may have contributed to the apparent lack of interest. Costing as little as one dollar per crystal on the surplus market, it was less expensive to purchase ten surplus crystals than to purchase one Deka-xtal.

Of course, crystals were never eliminated from circuits requiring the properties of frequency accuracy and stability. VFO controlled transmitters of the 1950s and later used crystals for converters in various circuit configurations. A later development, the phase-locked-loop, produced accurate and stable outputs by utilizing the crystal as a reference oscillator in a circuit of frequency dividers and logic.

Crystals were an important component during the vacuum tube era. I encourage other collectors with this interest to document these interesting and technologically important devices. **ER**

Improved Audio for the Collins 75A-4

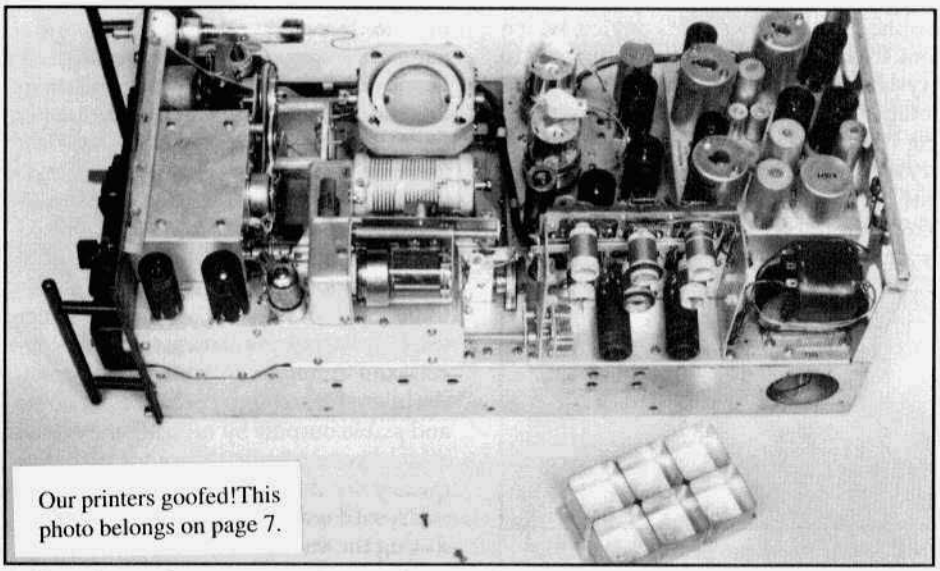
by Bill Beatty, K7CMS
4721 N. Bamboo Cir.
Tuscon, AZ 85749

There are several reasons that a 75A-4 doesn't sound as good as other communications receivers with single ended 6AQ5 audio. The first is its audio output transformer, T5. Collins designed some inverse feedback around it but this can be improved in the quest of better fidelity. Another inverse feedback loop, within the first loop, is R109, 390 K, between the two plates of V13, 12AT7, and it also is a cause of distortion.

The best cure for the former problem is to replace T5 with a good 4 watt audio output transformer and then experiment with the amount of inverse feedback by adjusting the value of R71, presently 33 K. Or you can leave T5 in and use less inverse feedback by moving R71 from pin 3, the 12AT7 first stage cathode, to pin 8, the 12AT7 second stage cathode. Since one less stage of audio is in the loop, the primary of the audio output transformer will have to be reversed. Then the value of R71 can be experimented with, although 33 K is the value I ended up with in my 75A-4.

R109, 390 K, should be removed.

Now the audio should sound much better, but louder than before. In fact, some hum or other leak-through never heard before may be apparent. One of the purposes of so much inverse feedback was to throttle back the gain to cover up this stuff! I added a 470 K in series with C100 feeding pin 7, the second 12AT7 control grid, to cut back the gain. It may be necessary to change some lead dress and run a separate shielded cable to the AF Gain pot to clean up any residual low level leakage. The results are worth the effort. ER



Our printers goofed! This photo belongs on page 7.

Believe it not, the cat's name is Smokey. Phil Goodman, K4FXB, who is well-known for his repair/restoration work in the Atlanta, Ga. area, sent this photo in. I wonder how many of his 9 lives Smokey has used up!

AM FREQUENCIES

2 Meters - 144.4, calling freq., activity in most cities; **6 meters** - 50.4 calling freq. **10 meters** - 29.0-29.2 operating window; **12 meters** - 24.985 calling freq.; **15 meters** - 21.400 - 21.450; **17 meters** - 18.150 calling freq.; **20 meters** - 14.286 for the nightly net starting at 5:00 CA time; **40 meters** - 7160, 7195, 7290 are the main freqs. Westcoast AM'ers net every Sunday afternoon, 4:00 PM on 7160; **80 meters** - 3870, 3880 and 3885 are the main freqs. Westcoast swap net Wednesdays nights, 9:00 PM on 3870. AM Swap net Thursday nights, 7:30 PM on 3885; **160 meters** - Gray Hair net every Tuesday at 8:00 PM EST on 1945. Mostly sporadic summertime activity, but during the winter signals can be heard anywhere on this band.

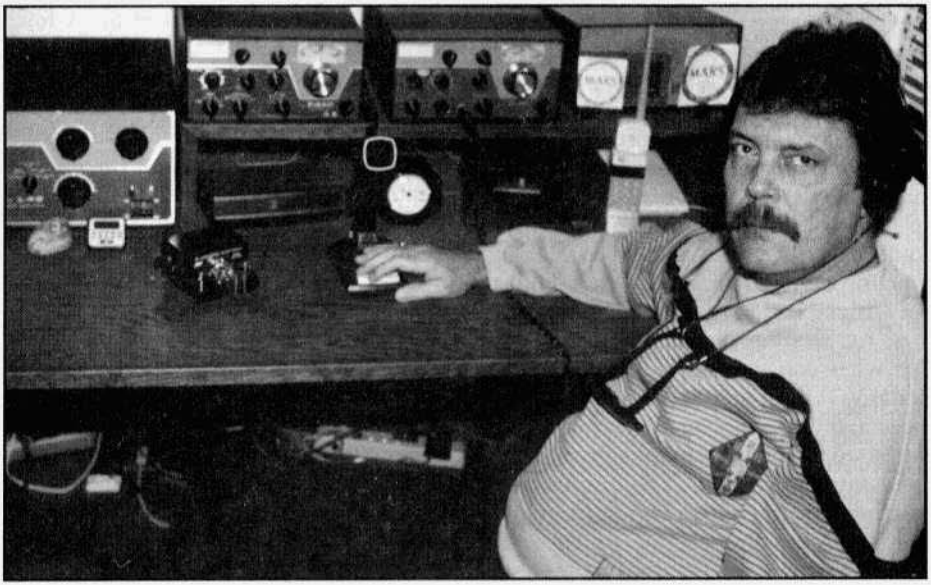
Drake Tube and Antique Radio Net

The Drake net was started by Criss, KB8IZX and Don, WZ8O. The first session was held Saturday January 23, 1993 on 3865 at 8 PM EST and the net has been going strong and growing ever since.

Criss says it started as a joke between himself and WZ8O. They were totally amazed to get 45 check-ins the first night. He added, "I knew there were a lot of Drakes out there but it still amazes me that so many Drake owners were on frequency that night."

The net operates much like the other 'users' nets in that they have a technical session and a swap session and they welcome all check-ins, with the only prerequisite being an interest in Drake equipment.

If you have Drake gear or an interest in the company, consider tuning into the net.It's very friendly and you should enjoy the experience.



Criss Heston, KB8IZX, who founded the net along with WZ8O.

Transmitter Metering for the Blind

by Dick Houston, WØPK
159 Sortais Road
Durango, CO 81301

In last month's *ER* Mike Dent asked for help in devising a way he could read plate current for tuneup - without his becoming part of the high-voltage circuit! I have had a bit of experience in design of such things, so I sent him some info. I mentioned to Barry the possibility of an article on the subject if he thought enough people would be interested. He thought it would be a good idea, so here goes ...

First some background - in the Washington, D.C. area in the early '50's I designed and built a complete volt-ohm-milliammeter for a blind ham friend. It was a rather large thing because it was built well before the age of integrated circuits and transistors (I assume that it is OK to use those naughty words in *ER* so long as I'm talking about instrumentation!) It was a most interesting project and I even learned enough Braille to make the calibrated scales. The thing worked very well and was a success except for one thing - it was a total dud for my friend! I'll tell you why shortly.

The unit contained a voltage-controlled audio oscillator, an amplifier, and a speaker to provide a tone that the user could hear. The front end consisted of a function switch, a range switch, and a network of series resistors, shunt resistors, AC rectifier diodes, and a battery; just what you would find in a conventional VOM. All values were such that at the maximum range in any position the output to the oscillator was a given voltage - say one volt DC. The output tone frequency or pitch then varied from low to high, depending on the control voltage, which in turn depended on the value being measured.

As described so far the unit would have worked OK for tuneup, for which the operator would just have to tune or adjust for maximum or minimum tone frequency. The big problem was a way to calibrate for actual voltages, currents, etc. It turned out that the solution was simple. I merely used a front-panel linear pot in a simple adjustable voltage divider circuit that produced one volt at the high end of the pot.

Turning the pot then produced the same range of output voltage as did the metering circuit. This voltage was fed to one side of an SPDT switch and the metering voltage was fed to the other side. The arm of the switch went to the voltage-controlled oscillator.

In operation, the user connected the unit into the circuit as required, then operated the switch back and forth while turning the pot until the tone was the same with the pot in either position. The pot position was then an indication of the output of the metering circuit. A long pointer was mounted on the pot shaft and calibrated Braille scales, one for each type of measurement, were slipped under the pointer as required. The blind user merely read the Braille numbers at the nearest calibration points and made a mental interpolation between points (just as a sighted user would do when the meter pointer falls between printed calibration points on a regular meter).

That's the whole story on the unit - except for why it was a failure. When I took the thing to my friend's house for a demo, I found that he was essentially tone deaf!! In the musical do-re-mi scheme of things, he could just begin to notice a tone difference with a do-mi interval!! Oh well, it was published in a general radio publication of the day, so maybe it did help somebody.

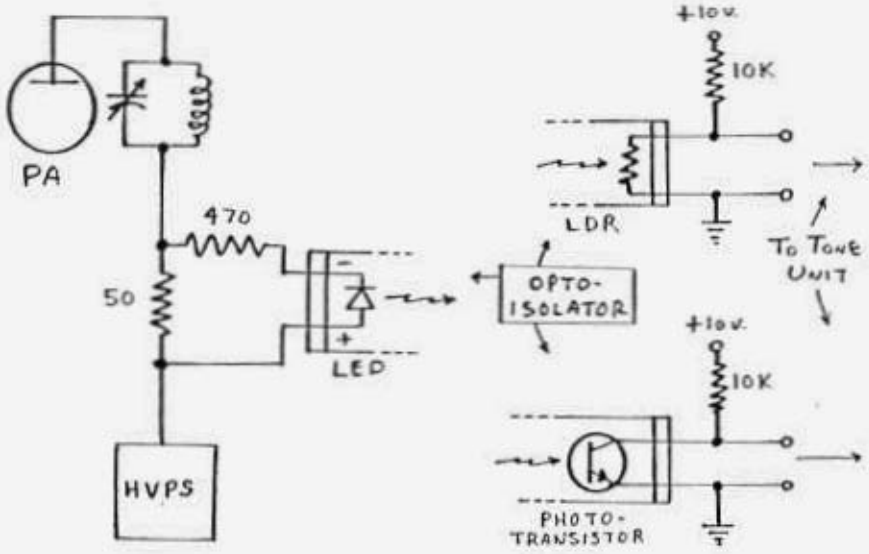


Figure 1

Enough of that - let's get to Mike's info. Mike already had the tone unit, so all he needed was a way to divorce himself from the high voltage. There is a very simple and inexpensive electronic item that can do just that and do it very simply. It is called an optoisolator. It may also be called an optocoupler. Despite the apparent opposite nature of the two terms, they both do the same thing - they permit transmission of electrical info from one end to the other with no actual connection (except for light) between the two. Light being a good insulator, if I may put it that way, there is no actual electrical connection between the input and output circuits. The ordinary isolators in the catalogs show voltage isolation ratings from 1000 volts to 3500 volts. In general a unit called an optocoupler may or may not provide high-voltage isolation - that's the difference between the two devices.

An optoisolator consists of a light-producing device of some kind and a light-detection device of some kind mounted in a lightproof housing. There are several kinds of devices that are used, but I'll limit this discussion to the LED for producing the light and the light-dependent resistor (LDR) or phototransistor for reception of the light. All *ER* readers are probably familiar with LED's. An LDR is simply a resistance element whose resistance varies with the amount of light falling on it. The resistance is very high in the dark and goes lower as the brightness of the light increases. The phototransistor is very similar to an ordinary transistor, but the current flow is controlled by light falling on the base area instead of by current injected into the base. Some units also have a base lead for other purposes. In operation both the LDR and the phototransistor do the same thing - they pass more or less current depending on the brightness of light striking them.

To read the plate current meter, as Mike needed to do, from here on the problem is just to connect the optoisolator into the plate current circuit so that varying plate current will cause the LED in the isolator to vary in brightness. Then the output

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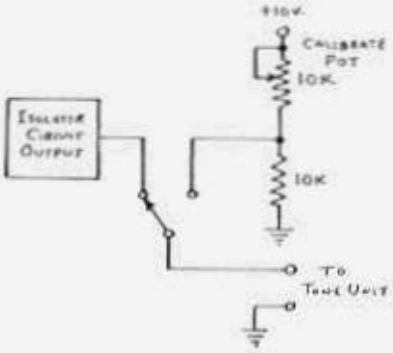


Figure 2

side of the isolator will be connected in a circuit that will produce a varying output voltage that can be interpreted by the tone device. That will suffice for peaking and dipping with the driver and PA tuning.

Figure 1 shows the circuit with typical resistor values. Actual values will depend on the current to be measured, and they are easily calculated with Ohm's law, so we'll just talk generalities. To sample the PA plate current, we'll put a resistor in series with the plate current lead. The resistance will be calculated to produce a small voltage drop at the maximum plate current - let's call it 10 volts (the actual value isn't critical). This voltage will be subtracted from the PA plate voltage, but with a PA plate voltage of several hundred volts, the result will be negligible.

Now we use that 10 volts to drive the LED through a current-limiting resistor. Most LED's have an internal voltage drop of about three-quarters of a volt, most can handle 35 mA or so, and a typical operating current is about 20 mA. So we'll select the series resistor to produce a drop of about 9.25 volts when the current through it is 20 mA. That's all there is to running the LED. On the other end of the isolator we'll put the LDR or the phototransistor in a voltage divider circuit so that the changing current flow through the device will produce a variable voltage, which will then be fed to the tone device. Figure 1 shows resistance values based on these figures - they may be different in a specific case.

One thing I want to stress before going on is that the output circuit MUST be WELL-GROUNDED. Optoisolators do a good job, but things DO break down, and precautions should be taken to protect the operator in any case.

For peaking and dipping, the circuits described so far are all that is needed. But for loading the final to a specific current point some means of calibration is required. Since with a given rig it isn't necessary to determine many values of current, but just the one that is correct loading for that transmitter, a much-simplified version of the VOM calibration I described earlier will do quite well. Figure 2 shows the circuit involved. The adjustable voltage divider circuit provides a voltage in the same range as the voltage coming from the optoisolator output. An SPDT switch permits feeding the tone device from either the optoisolator or the calibrating circuit.

A sighted operator will tune and adjust the rig for the proper PA plate current. He or she will then adjust the calibration pot so that the tone frequency is the same with the switch in either position. That calibrates for that specific current. The blind operator then need only adjust loading or whatever so that the tone frequency is the same in both switch positions, and the rig is set to the correct PA current. If there were a need to adjust to more than one specific current, say for low and high power, additional voltage dividers and a switch with more positions could be used.

That's about all. If anybody decides to build such a device and doesn't feel comfortable with the calculations involved, I'll be glad to help. The address is: 159 Sortais Road, Durango, CO 81301, and the landline number is (303) 247-9159. **ER**

Instant Antenna

by Skip Green, K7YOO
P.O. Box 595
Winona, MN 55987

As many of you are aware, I do a lot of traveling as part of my job. Like most people I always try to mix a little "monkey business" with this in the form of amateur radio. As you may imagine, the biggest difficulty I have faced is in getting a decent radiator up at my hotel or apartment during portable operation. The gear hasn't been a big problem but I am always trying and experimenting to find an antenna that is both portable and effective. I have tried mobile antennas, the Cushcraft R-5, rotatable dipoles (driven element from and old beam) and random wires, but they all present either a logistical problem or don't radiate very well. What I've finally settled on is both simple and very inexpensive. Last year we went to my parents for Christmas and a present my dad received provided the inspiration. What he got was a telescoping golf ball retriever. The minute I saw this beauty I envisioned the ultimate in portable antennas. For those of you who are not familiar with the device, it consists of 4 or 6 sections of 3' long aluminum tubing that telescopes out to 12' or 18' depending on the model. At the end of the smallest section is a small cup just the right size for retrieving golf balls from your favorite water trap. Best of all, these units are only 15 to 18 dollars at your local Fleet Farm! If anybody knew these made dandy antennas, the price would undoubtedly be much higher.

Some conversion is required to use these for antennas. The first step is to cut off the little plastic cup on the end of the "antenna" (unless you want to continue to rescue golf balls). Then disassemble the sections by removing the small plastic pins that keep the sections together when fully collapsed. Save the pins for reassembly later. Next, use a hacksaw to slit the top of each section (about 1") except the top one and procure some hose clamps that will fit the top of each tube and the bottom of the first, or largest section. The final step is the most important. All of the retrievers I have purchased are anodized to give a hard durable finish. Unfortunately anodizing does not conduct very well. At the junction of each tube the anodized finish must be removed. I used the glass bead blaster here at the plant, but sandpaper and Scotch Brite would be equally effective. To form an effective conductor, the inside top of each tube and the outside bottom must be sanded. A small Dremel tool with a sanding roll would also work well. Finally, clean up the sections and reassemble them (don't forget the small pins) and place a hose clamp at each junction.

To mount the telescoping antenna. I fabricated a bracket from an old mobile mount (insulated of course) and bolted a "C" clamp to it for attachment to a windowsill or balcony railing. I am sure many of you will have your own ideas for mounts. Fiberglass rod, treated wood dowels or plastic pipe and "U" bolts should all work equally well.

In my most recent trip as 4X/K7YOO I worked over 60 countries (including A21 and XU3) using this unit off a balcony railing with a small counterpoise wire dangling down from the grounded side of the base. I extended it to the full 18' and used a tuner/loading coil setup at the base of the antenna to resonate it on 40, 20, 17, 15 and 10 meters. On my next trip I will mark the antenna and telescope it to the correct resonant length for 20 meters on up (not forgetting the anodizing removal!) I was just being lazy and letting the autotuner do the work! I can now walk on the airplane with my high tech "fishing pole" and nobody is the wiser. ER

Rebuilding The Heath AT-1

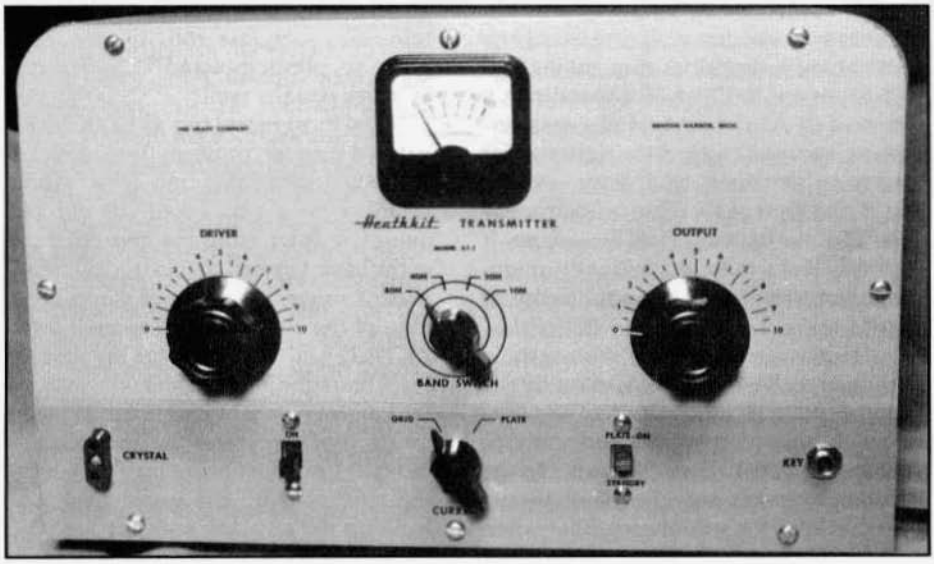
by Dave Ishmael, WA6VVL
1118 Paularino Ave.
Costa Mesa, CA 92626

During my Novice career in 1960 (WV6LXW), there were lots of DX-20s, DX-35s, DX-40s, and a few DX-100s, but I don't recall seeing one AT-1. I used Alan Burgstahler/WA6AWD's DX-20 for many of my Novice and Conditional QSOs. As a result, I have never looked at the AT-1 with much affection. Maybe a curious passing glance if I saw one at the local amateur swapmeets, but nothing more.

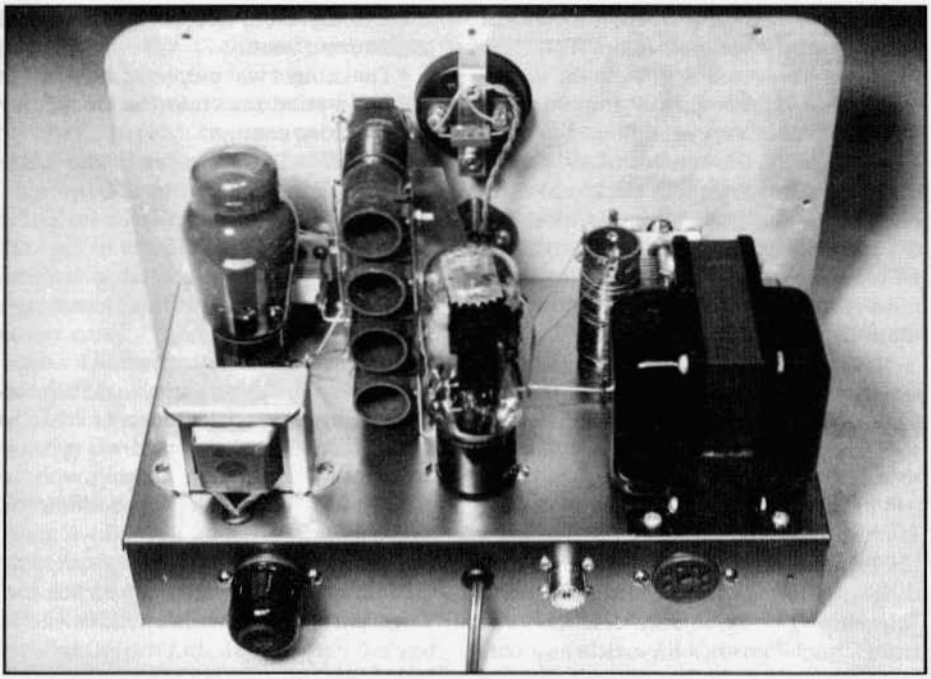
After I built my first 6AG7/6L6 xmtr (ER#43) and later a 6AG7/6E5 QRP xmtr, I started looking at the AT-1s a bit differently. I even started advertising for one. Chuck Penson/WA7ZZE's article "The AT-1:Heath Gets on the Air" (ER#46) was the final straw - I now had to have an AT-1!

The problem at this point was so did everyone else on the planet!! The article "The Lure of Classic Radio" by Marty Drift/WB2FOU and Jim Musgrove/K5BZH in the March '93 *QST* helped to increase the price of AT-1s by saying in part: "Many Novice transmitters are prized possessions. The Heath AT-1 may sell for well over $100." Ouch!! Pictures of Marty Drift's restored AT-1 just made my "AT-1 fever" worse. I answered Bob/KAØRRX's AT-1 ad in the March '93 QST by mail (there was no phone number) and mine was the 27th inquiry for his AT-1! I traded Mort/W6KLT for two AT-1 parts units. Both had sheet metal mods to the front panels and chassis and were missing the power transformers and meters and neither was suitable for rebuilding. I finally located an original AT-1 from John/KAØDEZ. John's AT-1 was in original condition and had no sheet metal mods - it was a perfect candidate for rebuilding.

My goal in rebuilding the AT-1 was NOT a museum level restoration. I wanted a near-mint working example of an AT-1



Front panel of the rebuilt AT-1.



The chassis was painted with Rust-Oleum after a good wire brushing with an electric drill.

and I took a few "liberties" getting there. Readers familiar with the AT-1's wiring can easily spot the under-chassis differences. I don't like using the word "restoration" because of these differences and the methods that I used in rebuilding my AT-1. The following are highlights of my AT-1 rebuild:

*The chassis and front panel were completely stripped. The octal sockets, coils, DRIVER/OUTPUT tuning caps, BAND/CURRENT switches, terminal strips, and many components were unsoldered and cleaned.

* The front panel was cleaned in a mild solution of soap and water and then polished with a couple of coats of Meguiar's Car Cleaner/Wax. I was pleasantly surprised how well the front panel cleaned up.

* The top of the copper plated chassis was badly corroded while the bottom was OK. The chassis top and coil support bracket were wire brushed with a fine wire wheel. I then painted the top of the chassis and coil support bracket w/Rust-Oleum #7714 copper. This is the first copper chassis I have painted and I am happy with the results. The painted copper is just a tad "brighter" than the original but you can't tell the difference in the color pictures.

* The meter was badly rusted and the glass was stained on the inside. I disassembled the meter by carefully folding back the eight tabs on the rear. The bezel was then bead blasted and painted black. The meter glass and meter scale were cleaned and the meter put back together. I folded the eight tabs back using a large flat bladed screwdriver. The meter came out very well but boy do I HATE the way these meter work - I had almost forgotten how bad they are until I tuned up the AT-1. The DX-20/DX-35 has the same type of meter.

*The transformer was run on the bench with the 6L6G/5U4G filaments con-

continued next page

nected, HV winding open, for several hours before I cleaned it up. The tube filaments represent a 21W load. In my experience, Heath power transformers have NOT been very reliable and I spend a few hours on the bench checking them out before putting them back into a rebuilt unit. The power transformer was then partially disassembled. The endbells were bead blasted and painted black. The xfmr leads were "too short" so I rewired them using vinyl wire.

* I replaced the 5U4GB and 6L6GB with the correct "period" tubes, the 6L6G and 5U4G. The AT-1 "looks" a lot better with the "right" tubes in it. All tubes were tested.

* I did not have an original assembly manual to rebuild the AT-1 with so I used the original AT-1s to make some wiring diagrams and rewired accordingly. I also "blew-up" the underside chassis view from Chuck Penson's *ER* article as a wiring guide - it worked quite well.

* New binder head 6-32 hardware was used to assemble the AT-1. The original used round head.

* The cabinet was painted gray wrinkle. It's not a good match to the Heath gray but it's close enough.

The following are some of the "liberties" I took in rewiring the AT-1:

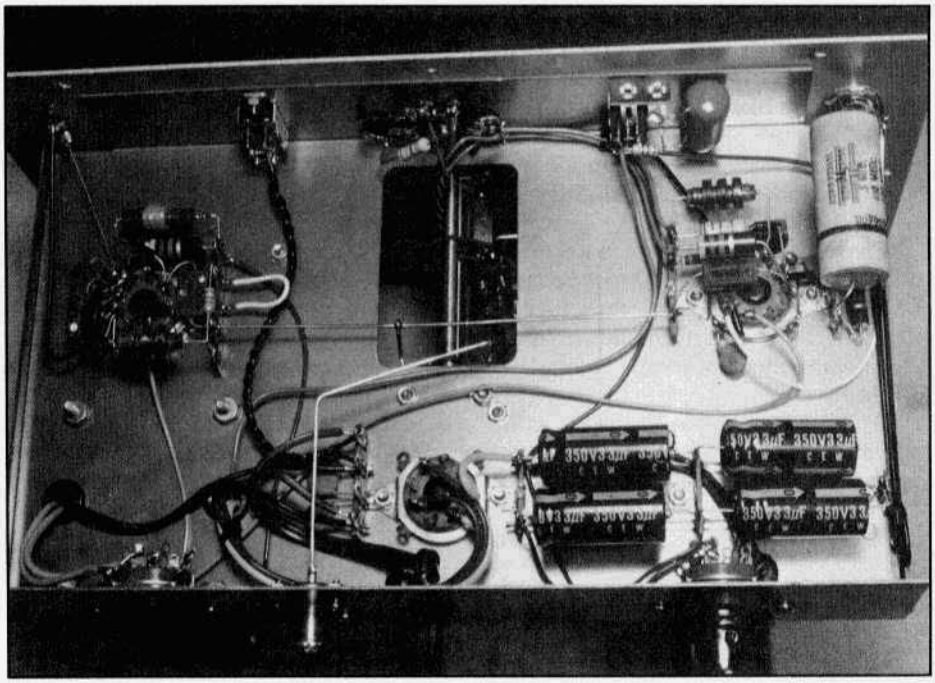
* 33uF 350VDC electrolytics instead of the original 8uF 350VDC.

* Two 47K 2W equalizing resistors were added across the 33uF input caps. The original used none.

* The new electrolytics are much smaller than the originals so a terminal strip was added next to the 5U4G socket so that the "spare" 5U4G socket pins don't serve as terminals. I did the same thing with the 6L6G socket and the key click filter components.

* I added the DX-20 RC network to the STDBY switch to protect the switch contacts. These relatively cheap slide switches are not very reliable, but the RC network helps.

* The ground lug for the 33uF filter



Underside of the restored chassis.

caps is used as the common ground return for the HV center tap, accessory socket, and key jack.

* The meter was bench tested and the 51-ohm current shunt resistor was changed to 43 ohm so that the 100 mA full scale was accurate.

* The 6AG7 oscillator stage was changed to cathode keyed.

* Possibly the worst "liberty" I took was the use of a Radio Shack replacement AC power cord!

After 22 hours, it was time for the "smoke" test. Following good Heath practice, I made a few resistance checks before turning on the power. In addition, I learned a long time ago to use a variac and voltmeter to minimize smoke in the shack while bringing up the primary power. After checking filament voltages and the HV winding, I switched from STANDBY to PLATE-ON. I heard the 6AG7 start up on the crystal frequency in the monitor receiver. Closing the key, I peaked the DRIVER for maximum 6L6G grid drive and adjusted the OUTPUT for a dip in 6L6G plate current. The output into a 50-ohm load was 0.5W! Whoops!! I like QRP but this was ridiculous.

The problem was an open 90uH 6AG7 plate choke. After replacing it from one of the parts units, the output power into a 50 ohm load was now 8-10W on 80/40M.

When I use xmtrs in the AT-1/DX-20 power class, I use the rcvr to monitor my signal and serve as a sidetone. The original AT-1 6AG7 oscillator is not keyed - it runs all the time - only the 6L6G stage is cathode keyed. I really got tired of the 6AG7 oscillator running all of the time so I changed it to cathode keyed. However, some of my 40M crystals were now too "chirpy". The original circuit uses a 15pf/100pf divider in the 6AG7's grid. I replaced the 15pf with a 5-25pf trim cap and tuned it for minimum chirp. Dave "the ear" Mills/AJ70, 7 miles from my QTH, gave me good tone reports on both 80/40M and said that there was no evidence of chirp. The same was true for other 40M QSOs.

Using the AT-1 on 80M is a delight - depress the key and adjust OUTPUT for maximum output on a Heath AM-2 relative power meter. Above 80M, the DRIVER must be peaked. If you use the AT-1's PLATE meter to dip the 6L6G, adjust the OUTPUT for dip and then set the meter switch to mid-position/straight-up. The meter banging from stop-to-stop during QSOs will drive you "crazy" if you don't! I'm always afraid that the meter is going to "beat itself to death"/"self-destruct"!

This xmtr is now my favorite among the AT-1, DX-20, and DX-40. Quite a change in attitude in (only) six months. I like the AT-1's mechanical design and, electrically, it is a classic 6AG7/6L6 xmtr. Chuck Penson's enthusiasm for the AT-1 is well founded and his article is responsible for at least one AT-1 "convert" - thanks Chuck. **ER**

YOU MUST HAVE JUST MISSED GEORGE HERRING DOWN THE WALK--- HE SAID SOMETHING ABOUT GETTING ACROSS THE PLATE CAP OF A 6146

continued on page 32

A Premier Quality Homebrew Stereo Amplifier

The Rebirth of the Classic Williamson

Part One

by Bill Kleronomos, KDØHG
P.O. Box 1456
Lyons, CO 80540

Some time ago I added a Compact Disc player to my 20 year old home audio system and it wasn't long before this new program source brought to light a number of deficiencies in my Pioneer integrated amplifier. Not only did it not sound as good as I thought it should, but its controls and switches were beginning to show the effects of years of wear. Having decided its eventual replacement was in order, I began reading a number of audio magazines in an effort to familiarize myself with the current state of audio technology. I felt like old Rip Van Winkle while I paid for some of my college back in the mid-70s by working at a stereo store as a repair tech. I hadn't paid any attention to the subject in the subsequent 20 years.

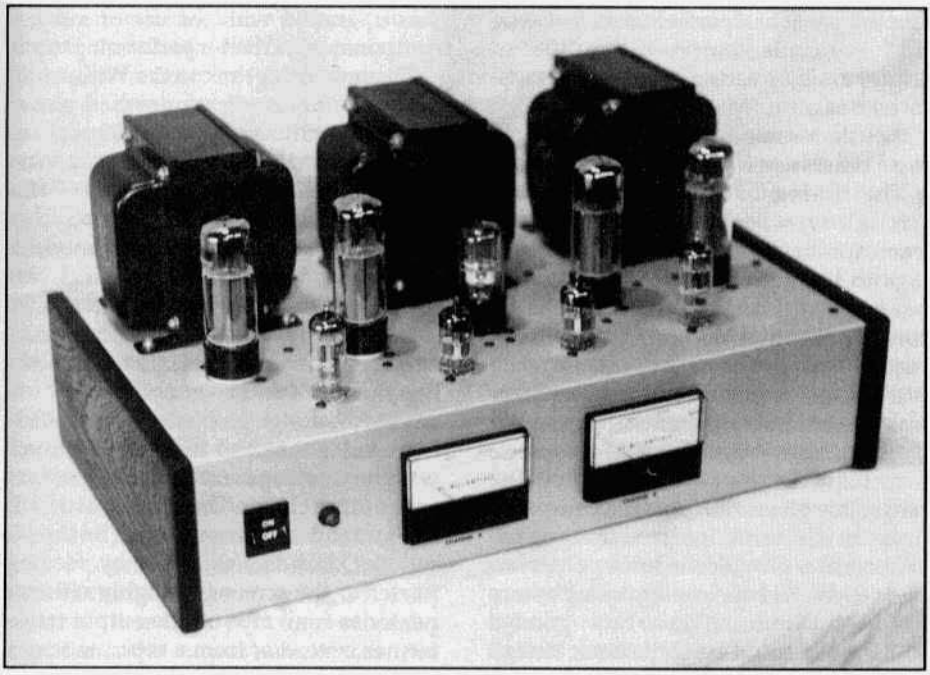
A surprising fact came to light in short order. Many of the currently manufactured top line amplifiers in the $1000+ price range, along with preamps and even CD decks use vacuum tube technology. Actually, I was astonished, in a way. Imagine opening up a new *QST* and finding companies have brought back their tube products of years past. "...The NEW Collins 75A-4C. . . Johnson announces the return of the Viking Ranger! . . ." Audio magazine reports at least 50 firms world wide are now making vacuum tube amplifiers; there's even one firm making a hollow state car stereo! There appear to be several reasons for this resurgence of vacuum tube technology. First is the feeling of many discriminating audiophiles that tube amplifiers compliment the sound of today's digital program sources in a positive way; that the sound is integrated in a wholly different manner than in transistorized units. Another reason appears to be that consumers of top end audio are finally getting smart, realizing that one can pay top dollar for an imported top line audio system but all the extra money generally buys is overpriced mediocrity: one gets more fluff, cosmetics, bells and whistles and the same basic electronic design of a less expensive unit. (Unfortunately, the same situation is true in the area of today's ham gear.) The last reason for the interest in hollow state is the snob appeal of a gleaming chassis with a number of large glowing bottles on top. What could possibly look more purposeful and powerful than something like a MacIntosh 240 or modern day equivalent? There is and will always be a magic and appeal to those large, heavy and hot behemoths that glow in the dark.

My wife eventually made the final decision for me, reminding me that I'd spent countless hours over the years homebrewing ham gear; why not build something for once that the whole family could enjoy?

The Design

There have been incredible numbers of amplifier designs published over the past few decades in varying degrees of performance and complexity. I looked over many of these as well as the designs of the well known commercially manufactured amplifiers of the 1950s. The circuit I kept coming back to was one that may have been built in larger numbers than any other - the "Williamson" amplifier that was first described in *Wireless World* in 1947. I found dozens of references to this amplifier in many publications of the '50's and many modifications, criticisims and upgrades. It was most likely the Williamson design that kicked off the "Hi-Fi" mania that swept the electronic hobbyist world in the '50's.

To understand what a breakthrough



Front/top view of the homebrew amp.

this amplifier was we need to get a little historical perspective on the subject. D.T.N. (Theo) Williamson was a young man in his 20's who worked in the English laboratories of the Marconi-Osram company as a tube development engineer. Sometime during the mid-'40's he became intrigued with the idea of developing an essentially distortionless amplifier and he spent many hours experimenting with different designs. He eventually came to several conclusions during this development. First, and most important, was how crucial the output transformer was in his overall design. And his design was simple in structure, containing no new technology. The realization of extremely high levels of performance in his design was almost entirely dependent on using a high level of inverse feedback (about 20 dB) around the entire amplifier, and included within the loop was the output transformer. Most other feedback designs of the '30's and '40's excluded the output transformer from the feedback loop; the feedback signal was commonly derived from the plate of one of the output tubes. The reason for this was that at the extremes of the audio range a large degree of phase shift occurs both in the output transformer and in an amplifier's circuitry, and this causes the applied out of phase feedback to be more in-phase and create instability and oscillations at those frequency extremes. Williamson's answer was to design an output transformer of exceedingly high specifications and to minimize the number of or eliminate cathode bypass and coupling capacitors in the circuitry. The basic structure of his resulting amplifier consisted of an all-triode design of four stages: single-ended voltage amp DC coupled to a phase splitter, followed by proven and reliable push-pull driver and output stages. A very simple design resulted with a number of subtle refinements that achieved tight control of phase shift over many octaves of frequency. The 22 year old Williamson had designed an

continued next page

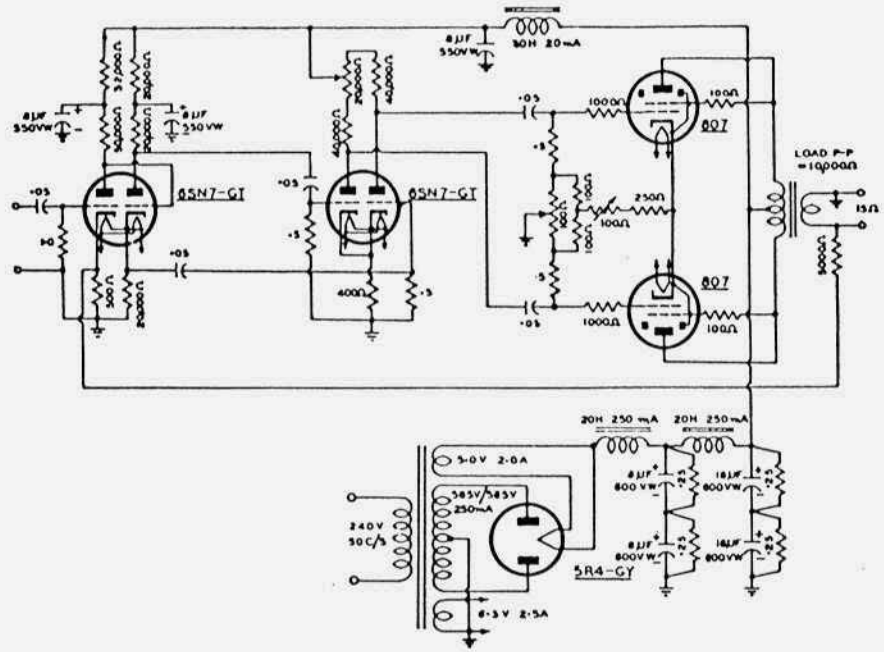
Homebrew Amplier from previous page

amplifier that had performance far better than any contemporary of the '40's, in large part by treating the output transformer as an integral part of the design rather than something merely 'hung on' to an otherwise well designed circuit.

The timing of Williamson's breakthrough was perfect - the world was transitioning from 78 RPM disc recordings to the new media of microgroove records, FM broadcast and magnetic recording. Even when using a 78 RPM record as a program source, the Williamson amplifier had a sound that was demonstrably better than any other then available. With a frequency response essentially flat from 10 Hz to the 100 Khz range, low phase shift, and distortion figures in the tenth percent range, the Williamson provides a level of performance hard to beat even by today's standards. I wondered just how good a Williamson could be if the basic design was upgraded with the use of modern components and better performing tubes.

The only drawback to the Williamson design for my application was its power output specification. At best, a pair of triode connected 807s can generate some 20 watts. OK in those days past of efficient horn speakers and monster bass reflex enclosures, but not adequate with the use of todays more compact high performance/low efficiency speakers.

In the early '50's, an American audio engineer named David Hafler was thinking along much the same lines. His answer to the design problem of great sounding triodes that had low power output was the development of the "Ultra Linear" output circuit. The concept of the UL design (and similar ones such as the so-called Q.U.A.D.) was that by feeding power to the screens of highly efficient pentodes from taps on the output transformer instead of from a separate screen



Schematic of the original Williamson amplifier, ca. 1947.

supply one could achieve a "semi-triode" form of operation. With taps placed on the output transformer's primary approximately halfway between the center B+ connection and end plate connections one could almost double the output generated by a strictly triode connected pentode and still retain a low order of distortion.

It wasn't long before both homebrewers and audio equipment manufacturers of the '50's figured out that the Hafler circuit made an ideal way to "juice up" the output of the original Williamson design, and several such designs were published. With pencil in hand, I decided that the Williamson/Hafler design was the one I was going to pursue - the specs were just what I was looking for.

Output Transformers

As I previously mentioned, the key piece of the Williamson, or for that matter, any other high performance audio amplifier is the output transformer. The best ones of the 1950's were never inexpensive, but at least there were a multitude of more or less off-the-shelf models available made by manufacturers such as Stancor, Peerless, UTC, Dynaco and others. There are far fewer manufacturers of suitable transformers today and yes, they are still expensive, but not more so in inflation adjusted dollars. Hooking up with a good transformer manufacturer today is a matter of finding their ads in magazines that cater to the market. Periodicals such as *Glass Audio*, *Sound Practices* and the nationally distributed *Audio* all contain ads by small specialty transformer shops. Several are here in the states, but a well known line is made in Japan under the brand name "Tango" and are sold by a U.S. distributor. Remember, it's important that one develop a high performance amplifier around a transformer as Williamson figured out nearly 50 years ago, so getting your hands on the iron first is a prerequisite. I can't overemphasize the importance of buying the best iron you can afford!

Through an ad in *Sound Practices* I became aware of a builder of hand-crafted transformers, named Mike LaFevre, who operates under the name of Magnequest in Philadelphia. Mike has several models of audio output transformers available for a number of applications. He has been a long time student of the craft having over the years obtained the original manufacturing prints from legendary manufacturers of heavy iron such as Peerless. He has learned the science from the guys who used to be in the business in years past, much as apprentices in the crafts used to. Mike's transformers use some of the more modern advances in materials such as Nomex insulation (of fire suit fame) and teflon lead wires, and are built with painstaking attention. After discussing my needs with him on the phone I ordered a pair of his MQ-431 models with a screen tap option. My billfold became lighter to the tune of some $300, and I had to wait several months for delivery, but the transformers eventually did arrive and I was able to start breadboarding. As a point of interest, Antique Electronic Supply carries a line of much less expensive high fidelity output transformers made by Hammond Manufacturing of Buffalo, NY. I obtained a spec sheet on their 100 watt rated model 1650R; it looked pretty good on paper and might be well worth considering. The important specifications in any transformer for the Williamson amplifier are the value of primary inductance and the primary to secondary leakage inductance (Williamson specified 100 Hys minimum for the former and 50 mh maximum for the latter). As with any transformer used in a push-pull amplifier, balance is important as well as the power rating - don't skimp on the iron!

If the transformer you choose has a greater primary inductance than the one I used, the values of the coupling capacitors may be increased proportionately. This is a place where cut and try on the workbench may be called for.

One final note on the subject of feed-

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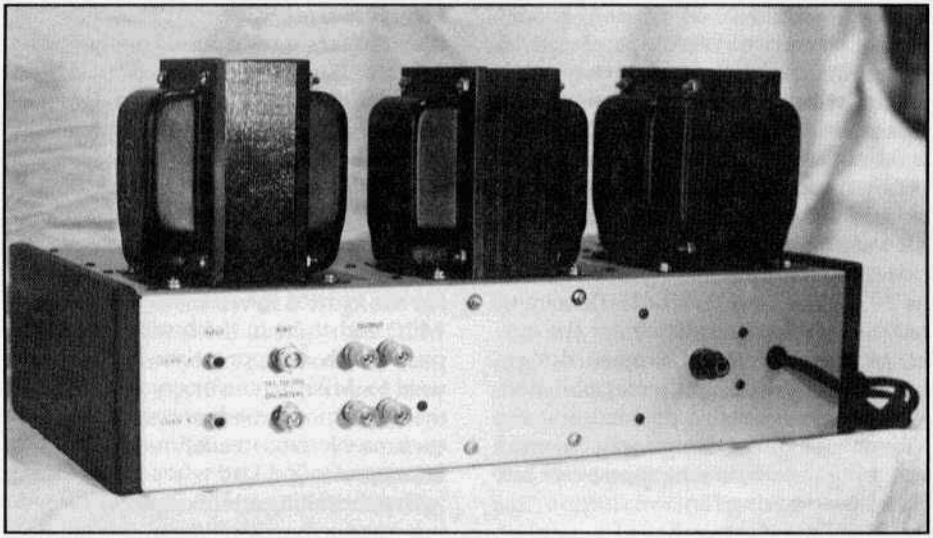

Rear view showing input/output connectors and balance controls.

back and the output transformer. If your completed circuit oscillates or motorboats, your first action should be to reverse the polarity of the transformer; swap the plate and screen leads from one set of output tubes to the other. As we all know, a circuit using in-phase feedback is called an oscillator!

CHASSIS

I could almost write an entire article on just the subject of selecting and finishing a chassis for a project of this type. It seemed pretty clear to me that considering the weight of all the iron [about35# worth] that was to be bolted on it, a steel chassis was going to be the only way to go. The other thing going in favor of steel was my plans to have the entire chassis nickel or chrome plated; this was, after all, a project destined for use in the living room. I went through all my parts catalogs and even called Bud only to find out that the standard steel chassis had apparently gone the way of platform shoes and disco, and at about the same time-Darn! 20 years too late again! After many more checks I made a number of breakthroughs at about the same time. Yes, one company still does make a line of standard steel chassis. They are Hammond, of Buffalo, NY- yes, the same folks that make the previously mentioned transformers. Not only do they still make the chassis, but also the matching perforated 'amplifier' covers that were de rigeur back in the '50's. But better yet, I made a few breakthroughs in the world of aluminum. It turns out that an old company in the business, Premier Metal Products of New York City makes a line of 11"x17" chassis that are substantially thicker and heftier than those made by Bud and others. Due to a different style of assembly, they also have flat sides without any overlaps and have reinforcing gussets welded into the bottom corners. I highly recommend these chassis for any homebrew projects that have a lot of weighty components. The only problem in dealing with Premier is that they have a $50 minimum factory order, so I had to order two chassis and bottom covers. And, oddly enough, their Bronx, NY headquarters won't accept telephone credit card orders, but their Los Angeles branch will.

There are far more options available for finishing aluminum than there ever were before. Many plating shops now have the ability to plate aluminum with nickel,

which can be left as is, or plated over with other metal such as chrome. Yes, one can have a chromed aluminum chassis, or for that matter, I always thought gold plating would be awfully nice! Regardless of whatever finish you choose, surface preparation is very important. Defects such as scratches will be painfully obvious on a finished product. I took the advice of a metal shop and laid out my parts on the blank chassis and did as much drilling and other metalwork as possible prior to sending it out. You run the risk of chipping off plating when drilling on it. What finish did I choose? I took my punched and drilled chassis to a metal finishing shop, and for $12 they buffed it out and put a grained finish on all the surfaces with the use of a machine that employs a giant "Scotchbrite" belt. I then sent it to a plating shop and had it hard clearcoat anodized. The appearance of the finished product is truly professional. Some time after I had completed final assembly, I went to a dealer that specialized in sales of small amounts of hardwoods to the carpentry trade and picked out a small piece of a type of African hardwood called 'Wenge'. This type of wood is very heavy, hard and has more of a natural black color to it than most others. I milled out and sanded a couple of pieces to the correct size, applied a clear oil finish, and attached them to the chassis with a couple of small brass woodscrews from the inside and a small amount of "Liquid Nails" construction adhesive. The completed amplifier looks better than many commercially made units, I think. **ER**

Editor's Note:

Parts two and three of this article will appear in the next two issues.

Mix the Old and the New

I thought you might be interested in hearing about an effort to mix the old and the new... namely tube type gear and international computer networks. About a year ago some of us who have access to the Internet (a worldwide computer network linking business, industry, the military and colleges) were engaged in a discussion of DX-100s on the rec. radio. amateur newsgroup. After more people joined in the discussion, Jim, KM6HK, (who has provided some of the photographs used in ER) created a mailing list where those of us of the hollow state persuasion could send a note, and have it relayed to all others in the group. Early members included: Mick, KD4CPL; Jim, WA7LDU; KM6HK and a few others.

Although Jim had to relinguish the role of list maintainer, Paul, N1AAC stepped in and is maintaining the group, which has now grown to almost 100 'subscribers'. Discussions have included crystal grinding, restoration techniques, the aforementioned DX-100 history and other topics. There are quite a few members with particular expertise, including Chuck, WA7ZZE, whose Heath articles have graced ER recently.

We welcome anyone with Internet access to join us by sending a note to Paul at: **owner-boatanchors@gnu.ai.mit.edu**

Make sure to include your return internet address in the text of your message to make Paul's job easier.

Computers and tube gear CAN go together! **John, wb5oau, brewer@anarky.enet.dec.com**

ER in Uniform from page 9

perhaps the Navy's requirement included only very rare frequency changes so that no added complication was justified.

The technical manual is only fair; while everything you expect to find is there, the discussion is superficial on the harder subjects where you most need help. For example you can really understand how the Collins Autotune mechanism works by studying the ART-13 manual – but not Aircraft Radio's retuner from the ARC-39 manual.

The ARC-39 breaks no new technical ground. It does, however, make good use of the ideas of the 1950's and deserves special mention for the extensive use of parts designed for the 'command' sets. Aircraft Radio probably had stocks of some parts and tooling to produce the others; recycling them in a new design certainly saved some money. As one of the early examples of cost controlled design and as a set with many good features and only the most minor of faults, the ARC-39 deserves to stand among the first rank of U.S. military radios. **ER**

Good Audio from page 13

The most common problem in operating sideband transmitters on AM is correctly setting the carrier and modulation level. If the carrier level is too high, there is no headroom for the positive modulation peaks, which are at four times the unmodulated carrier power level. As most of these transmitters are rated at 100 watts peak envelope power output on sideband, the AM carrier power rating will be 25 watts. The output meter on such transmitters may measure peak r.f. voltage, average voltage, or something in between. Averaging meters will not deflect at all during modulation, and so do not provide any indication of proper AM operation.

An oscilloscope is useful in setting the operating conditions correctly. When properly set, the oscilloscope will show sharply defined upward peaks about twice as high as the unmodulated carrier voltage, with the downward peaks just touching the axis. Any flattening of the upward peaks must be avoided, as the amplifier (or exciter) is going into saturation.

If the modulating audio signal is available for a monitor scope, a trapezoidal modulation display is useful for tuning a low-level AM-linear amplifier combination, with the audio signal providing the horizontal 'scope sweep. The amplifier is tuned and biased to straighten the sides of the trapezoid.

The audio processor on sideband rigs should be turned off, and the transmissions should be kept short, as AM operation imposes an undue strain on the power supply and output amplifier. Also, use push-to-talk instead of VOX on AM. **ER**

Koby, K5MZH, SK from page 2

nio; sons Ronald Bernard Koby of San Antonio and Ted Koby of Minnesota; brother Pierre Koby of San Bernadino, California; 12 grandchildren, 4 great-grandchildren; and numerous nieces and nephews."

Editor's Note:

Otis Nonken, K5SWK, was Koby's lifelong friend. Otis told me that they had worked each other for 35 years and had never had a dull QSO. To me they were a nightly 'instituition' on 3880. Their signals were always loud here in Colorado and it was always interesting to tune in on their QSO's.

Koby's passing has deeply affected Otis. In a recent letter he said, "God I wish I could go out to the shack and still hear his deep, deep, voiced modulation. I'd never complain again."

We will all miss Koby, K5MZH.

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FOR SALE: AN/PRC-6 (handi-talkie) 47-55.4 Mcs, gov't reconditioned, w/orig. manuals - $175/pr. + UPS. Bob Bakinowski, 1524 Saint Tropaz, Tucson, AZ 85713. (602) 624-8029

WANTED: Stewart-Warner nameplate for R-390A; have Collins R-390 and Motorola R-390A nameplates if anybody needs them. Geoff Fors, WB6NVH, P.O. Box 342, Monterey, CA 93942.

FOR SALE: TRF Tunaverter, solid-state converter, converts car radio to 75 meters, AM/SSB/CW reception, new, 3.8-4 Mcs - $20 ppd. Bill Riley, 863 W. 38th Ave., Eugene, OR 97405.

FOR SALE: SP-600 - $100; URM-5 sig. gen., w/accessories - $70. WANTED: Mounting for ARR-15; manuals for RBA, DAE and BC-474. Tom Brent, Box 1552, Sumas, WA 98295. (604) 826-4051

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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

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: Equipment, parts, books, manuals, list - $1. **WANTED:** 24 hour 'mechanical' clock; small S-Line cabinet; Collins "Signal" magazines. Joe Orgnero, VE6RST, Box 32, Site 7, SS 1, Calgary, AB, T2M 4N3, Canada. (403) 239-0489

FOR SALE: National R116.**WANTED:** Manual (copy OK) for P&H compressor model AFC-2; R-392 meter; T-368 speech amp parts chassis. Tom Mackie, WB2ILA, 807A Bristol Ferry Rd., Portsmouth, RI 02871. (401) 683-9504

WANTED: Pwr sply & manual for Singer SB-12B panalyzer; manuals for HC-10, RBL-6, GRC 106/122; HRO-60 index tuning knob. Mark Lipson, KA7GIE, 7809 146th Ave., N.E., Redmond, WA 98052. (206) 885-3589

FOR SALE: Heathkits HR-1680 and HX-1681, w/sply, manuals - $175; Utica 650, V650 - $50; Drake B-Line, exc. - $275. U-ship. Richard Lucchesi, WA2RQY, 941 N. Park Ave., N. Massapequa, NY 11758. (516) 798-1230

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

WANTED: Quality audio recordings of AM QSOs. Trade Eastern U.S. activity for elsewhere. Open reel, cassette, DAT. WA3VJB, Box 73, W. Friendship, MD 21794.

FOR SALE: Heath SB-620 Scanalyzer - $85; HRO-500 - $425; Eddystone 77OR-MKII - $225; CV157 SSB demod. (pickup) - BO; R1051B - $325. Nick Oliviero, (818) 367-5000 (eves)

WANTED: Top and bottom covers and original cabinet for R-390A; data on Cetron UXCVII triodes; manual for HP 606B. Clark Hatch, WØBT, 2546 SE Peck Rd., Topeka, KS 66605. (913) 235-2721

FOR SALE: Knight T-60 xmtr - $60; Knight VFO - $20; Ranger I, very good, w/PTT - $125; Sencore TO-5 - $60. Bill Jenkins, WA5MWJ, 11916 Donahoe Bend, Fort Smith, AR 72916. (501) 646-3859

FOR SALE: Collins 75S3B rcvr, rack mounted - $200; Galaxy GT-550 xcvr, w/matching sply, mint - $200; 813's, 805's - $15 each; CE 100V cabinet - $30. Levy, W5QJT, 115 NW Loop 410, Ste 248, San Antonio, TX 78216. (210) 366-3290

FOR SALE: Clean Drake 2-B rcvr, no manual - $75. I ship. Leland Smith, W5KL, 10 Hawthorn Dr., Harrison, AR 72601. (501) 741-0473

FOR SALE: Classis 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

TRADE: Your 75TH for my 75TL. Need the TH for the collection. John H. Walker, Jr., 16112 W. 125th St., Olathe, KS 66062. (913) 782-6455

WANTED: Schematic, alignment info, etc. for a Zenith Transoceanic. Model 5G40 listed on sticker and G500 penciled on chassis. Also looking for a clean National NC-400. Jim Hill, W6IVW, 3801 Palos Verdes Drive North, Palos Verdes Estates, CA 90274. (310) 378-4411 (h), 616-7646 (w)

FOR SALE: New reprint "Tubes and Circuits" by Wholesale Radio Laboratories, circa 1942-43 - $8 ppd. James Fred, R1, Box 41, Cutler, IN 46920.

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: Synchronous detector for 455 kHz IF rcvrs. Dramatically improves AM: Reduces fading distortion, selectable sideband cuts interference. Kit: $139. Built/tested: $199. Info: $3. Steve Johnston, POB 3420, York, PA 17402-0420.

FOR SALE: R-390A service, module repair to complete remanufacture, cosmetic restoration, 20 years experience, expert service, 1 week turnaround, very reasonable, any cond. accepted. Rick Mish, (419) 726-2249

FOR SALE: Thordarson 300 watt multi-match mod. xfmr - $25; Radio Master catalogs, '62, '64, '68, '72, '73, have several. Evan Haydon, 4308 N. 15, Lincoln, NE 68521. (402) 435-4083

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

WANTED: HRO-60 stuff. (2) HRO-60TS spkrs; coil set 'E' (900-2050 kcs); bottom plate and any National wooden coil boxes. Dan Brown, KA5DNH/1, 127 Rand Terrace, Newton, MA 02166. (617) 964-3037

FOR SALE: RAL-6 rcvr. **WANTED:** XCU-300 xtal calibrator. W7RBF, (602) 864-9987

WANTED: Drake T4XB and R4B orig. service manuals in VG condx, no copies. Bill, WA2TDR, (201) 744-3164

WANTED: AN/FRR 502 components. Looking for tuning units TN 5010, TN 5012, TN 5014, TN 275 and associated components such as the control boxes; also looking for RA-10 control box, RA-10 control spline, connectors and Bendix TA-12 B/C components including control box and modulator MP-28B. Want key for BC-474; also looking for No. 19 MK II and no. 19 MK III sets and accessories and BC-654A accessories. Sam Kelly, W6JJT, 12811 Owen St., Garden Grove, CA 92645. (714) 893-2092

FOR SALE: Globe King 500, w/5514 modulators and pwr sply, no cabinet - $300, with cabinet - $375. Jon Harrison, KA4RLV, 110 Harrison St., Sweetwater, TN 37874. (615) 337-9317

WANTED: Collins 75A-1, 32V-2 or 3, 51J4, 51S1; TMC GPR-92; Heath SB-620. Jay Spivack, N7JDT, 177 Telegraph Rd., #303, Bellingham, WA 98226.

WANTED: Coils sets E, F and slide-rule dials; technical manual for National HRO-60 rcvr. J. Luiz Bessa Neto, Rua Guilherme B. Mello 84, S. Paulo - CEP 04571-160 Brazil.

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

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: 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: Hammarlund HQ-110, w/orig. manual, VGC - BO. **WANTED:** Millen exciter 90801 or T-368 exciter. Merle Crowley, 37246 Orange Row Lane, Dade City, FL 33525. (904) 523-1226 (eves)

WANTED: Hallicrafters SX-122 rcvr, any condx; National XCU xtal calibrator plug-in. Alan Johnson, 6001 Goldsboro Rd., Bethesda, MD 20817. (301) 229-7069 (before 0200 UTC)

WANTED: RAX-1, URA-17, SRR-11or FRRk-21, PRC-74, NC-300. Good physical condx important. Joseph Pinner, 201 Ruthwood Dr., Lafayette, LA 70503. (318) 981-7766

WANTED: National regen. sets SW-4, SW-34, SW-45, SW-58 and NCC-10; coil rack for cash and/or excellent trades. Robert Enemark, W1EC, Box 1607, Duxbury, MA 02331, (617) 934-5043

WANTED: Manual (copy) for National NC-60 and Harvey-Wells R-9; 400 Hz filter for SB-303. Al Bernard, NI4Q, POB 690098, Orlando, FL 32869-0098. (407) 351-5536

FOR SALE: New RCA 802 tubes - $3; type 1616 - $2; type 2E26 - $1.50; type 673 (same as 575A except base) - $10. Write for special pricing on other tube types. Antique Electronic Supply. See ad inside back cover.

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

FOR SALE: Military monitoring antennas: broadband VHF/UHF discones, biconical types, 30 - 1000 Mcs, shipboard construction, 'N' connectors, preamps, antenna multi-couplers, cables and accessories. Rick Mish, (419) 726-2249

FOR SALE: Collins 32S1, mint condx in original box, w/orig. manual - $380. Mike Palmer, K5FZ, 16707 Creeksouth, Houston, TX 77068. (713) 444-7737

WANTED: Johnson accessories, code keys, SWR bridge, station monitor, etc. Even good clean rigs. Bob Kemp, POB 470, Lake City, MN 55041. (612) 345-5345 days

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WANTED: Service manual for Hammarlund HQ-105TR; RME 4301 SSB selector; RME 4302 spkr; Hallicrafters spkr R46B or R47 and R51 or R50. Doug DeWeese, 502 East 80th St., Tacoma, WA 98404-1014. (206) 472-3478

FOR TRADE ONLY: Unassembled kit - DX-60. Please send SASE for details. No calls. Bob Nickels, 1444 S. Rotzler, Freeport, IL 61032.

WANTED: John Meshna and Fair Radio catalogs 1950's - '60's, will pay $20 each; exc. April 1944 "Radio News". Sam Hevener, "The Signal Corps" 3583 Everett Rd., Richfield, OH 44286-9723. (216) 659-3244 before 8:30 EDT

WANTED: Manual/schematic for B&K 445, Eico 379, Eico 330, Semcor RG115, TS-888. Marvin Moss, W4UXJ, Box 28601, Atlanta, GA 30358.

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

FOR SALE: Heath Nostalgia - 124 page paperback covers Heath history in pictures and stories. $9.95 postpaid (plus tax in WA). Heath Nostalgia, 4320 - 196th SW., Suite B-111, Lynnwood, WA 98036.

FOR SALE: Complete AM stations. Valiant or Viking II xmtr with NC-300 or SX-101 rcvr - $250-$350 w/coax relay. PU only. Instructograph - $40. **WANTED:** Millen rack-mounted scope. Jim Jorgensen, K9RJ, 1709 Oxnard, Downers Grove, IL 60516. (708) 852-4704

FOR SALE: Collins kHz dials for 75A-1, 75A-2, 75A-3, 32V-1, 32V-2, 32V-3, KW-1, KWS-1 - $30 per dial or $35 exchange. Butch, KØBS, (507) 288-0044

WANTED: Dial scale for RME-41, 43 or 45 or parts unit for restoration project. Dave Mills, AJ7O, 6782 Marilyn Dr., Huntington Beach, CA 92647. (714) 843-6879

WANTED: Hallicrafters up to SX-28A, esp. SX-11/12/17/10. Jim Dillon, 4655 Thane Rd., Juneau, AK 99801. collect (907) 586-3223

FOR SALE: Stancor xmtr ST-202-A, w/coils and manual - $175. Buyer pays shpg and handling. James H. Barrows, W7BCT, 15121 41st Ave., S.E., Bothell, WA 98012. (206) 337-4880

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

FOR SALE: 30L-1 linear, w/(4) 572's installed and manual; Collins KWM-2, RE, w/PM2/MIL manual and spare set of tubes; Collins PM2 pwr sply, w/manual (needs repaint) - $70; J.H. Bunnell solid brass telegraph sounder, new condx - $75; LM-7 freq. meter complete, w/cal. book/opr. manual/shock mt./plug - $50; (2) desk rack cabinets, black wrinkle, 10.5" panel, 15" x 18" deep - $30 ea.; HT-32 Hallicrafters cabinet - $20; Eico 710 grid dip meter, w/all coils - $20; Heath GD-1A grid dip meter - $15; set of extra coils for Eico 710 - $10; Heath HWA-7-1 QRP pwr sply 13V, 1.5 A, w/manual - $20; Heath Cantenna, w/manual - $20; new Astatic AMC-1055 dynamic mikes mid Z, w/PTT SW and 20' cables, excellent communication mike - $10 each, 5 or more - $8 each; WW II mil. xtal case, w/102 pcs. FT-243 xtals 2-8 MHz - $20; rare Regency ATC-1 hamband converter, w/manual - $50; National MB40SL multi-band tuner - $10; 304TL sockets - $10 each; new/good tubes 810s, 100TH, 250TH, 866s, 872s, 811s, RK48As, 829Bs, 400A, 304TLs, 4CX250Bs, etc., etc.; Sola constant voltage xfmr 250 VA 120-240-V in/out - $40; UTC broadcast quality audio xfmrs A-10, 11, 21, 24, 26 - $10 each. **WANTED:** European style straight key, TBY, SCR 195/BC-222. Roger Faulstick, KD4AS, 210 Mariah Ct., Merritt Island, FL 32953. (407) 453-3312 FAX 453-2258

FOR SALE: Collins 51J-4, 3 filters, VG - $475; Collins R-648/ARR-41, original, VG - $175; Collins R-392, good - $145; R-390, R-390A for sale, repair service. **WANTED:** Nice SB-301, HP-23 supplies, mil-surplus KWM-2's for repair. WA5THJ, 1920 Maxwell, Alvin, TX 77511. (713) 331-2854

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

WANTED: 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, WA9IXP, Box 28803, Greenfield, WI 53228-0803. (414) 545-5237 (24 hrs) collect

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FOR SALE: DX-100- $100; RME HF 10.20 converter, both excellent, w/manuals and ready to ship; TEK 547 scope, cart, manual, restored and aligned - $200. **WANTED:** Early Drake rcvr, w/NB. David Bertman, AB7B, 1314 S.W. Hall, #E, Portland, OR 97201. (503) 223-5295

WANTED: Heath catalogs and Heath AT-1 xmtr. Bob Coburn, W1JJO, 4 Tinkham Lane, Londonderry, NH 03053. (603) 432-2615

FOR SALE: Heathkit SB-500, 2-M converter, (2) 6146's, very nice, w/manual - $115 shpd. **WANTED:** Collins V/A cabinet; large AM xmtrs. Bill, KE7KK, 6712 Lake Dr., Grand Forks, ND 58201. (701) 772-6531

FOR SALE: Rare WE-10-D HF, 1932 Airline rcvr - $1100. **WANTED:** NC-101X; S-35 panadaptor. W3D5E, (215) 378-1411

FOR SALE: Viking I, w/TVI mod, cabinet and original kit instructions, good condx, needs filament switch, 122 VFO, looks new, w/original brochure & instruction booklet - $110 for both; Speed-X #500 bug, chrome pitted, complete and restorable, scarce - $125; Vibroplex 5A (is vintage 'Lightning' bug) clean - $60; Hammarlunds - HQ-145, xlnt, w/orig. manual - $135; HQ-145 - $110; SP-400, w/pwr sply and cabinet, looks good, needs wrk - $100; Knight T-60 xmtr, w/photocopy of manual - $25; Eico #625 tube tester, good condx - $25 HW-16 parts xcvr - $15; plate xfmr, 115 dual pri. /3450 VRMS @ .3 amps sec. - $25; Altec 601-B 12 inch coaxial spkrs, tweeters blown, cones look like new, w/xvrs - $65/pr.; Radiocraftsman #10 AM/FM mono tuner, chrome pitted, bottom cover missing, clean faceplate - $20; Heath PT 1 AM/FM tuner, faceplace looks 'like new' - $15. You pay shpg. Offers considered on all above items. Franklin Albanese, 1610 Prince St., #7, Berkeley, CA 94703. (510) 845-2625 eves

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WANTED: Plug-in speech amp/modulator #250-40 for Johnson Viking Adventurer. Gil Parsons, WA8JIW, POB 192, Ross, OH 45061. (513) 867-8380

FOR SALE: Unusual Bendix 847D - $65; RCA portable 6BX63 - $45. S/H extra. Polaroids available - $1 each plus SASE. Bud Santoro, 3715 Bower Rd., Roanoke, VA 24018. (703) 774-9153

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: R-390A squelch modication: small external add-on module, super sensitive, works great on AM and SSB, 15 minute installation, instructions included - $25. Rick Mish, (419) 726-2249

FOR SALE: Replacement B&W 5100/5100B VFO dials. Replace your faded and aged one with an exactly styled snow white plastic version. Your transmitter will look like it just left Upper Darby! Idiot-proof instructions included. $10 postage paid. Marcus Frisch, WA9IXP, Box 28803, Greenfield, WI 53228-0803

WANTED: Manual (copy OK) for Lysco model 600 xmtr. Mine has some mods that I don't think are factory! Tnx. Gary Reiss, WAØJRM, Rt 1, Box 141, Wilcox, NE 68982.

FOR SALE: Johnson xmtr ceramic five pin plug-in coil forms , circa 1938-'41 - $2 each. WANTED: 80 meter HDVL coil. Wayne, NØTE, 1212 17th Rd., N.W., Burlington, KS 66839. (316) 364-5353

WANTED: Still looking for PE-103 dynamotor, MX128/ART-13 blank L.F. oscillator panel. Pete Hamersma, WB2JWU, 87 Philip Ave., Elmwood Park, NJ 07407.

WANTED: Manuals for 51S1, 55G1, HRO-60 dial scales E,F,G,H,J; HRO-5A spkr, coils DFHJ. Carter Elliott, WD4AYS, 1460 Pinedale Rd., Charlottesville, VA 22901. (804) 979-7383

WANTED: Collins 270G-3 or 312A-1 spkr, escutcheon for 75A-4 and Electro-Voice model 419 stand. David A. Clark, K5PHF, 9225 Lait Dr., El Paso, TX 79925. (915) 591-4184

FOR SALE: Transmitting/Receiving tubes, new and used. LSASE for list. I also collect old and unique tubes of any type. Looking for Taylor and Heintz-Kaufman types and large tubes and sockets from the old Eimac line; 250T through 2000T for display. Maybe you have something to trade? John H. Walker Jr., 16112 W. 125th St., Olathe, KS 66062. (913) 782-6455

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

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.

FOR SALE/TRADE/WANTED: Vintage tube CB's, all makes/models available; old radio books. LSASE for lists (specify). Charles Zafonte, RFD #1, Box 75, Fort Kent, ME 04743. (207) 834-6273 eves.

WANTED: XCU-303 xtal calibrator and spkr for National NC-303 rcvr. Jeff, W7ID, (208) 323-9267

FOR SALE: National NC-188 - $90; Drake R4 - $200; BC-348Q - $125; TCS rcvr, w/ps - $125. Cliff Fleury, AI7Y, 64174 Tumalo Rim Dr., Bend, OR 97701. (503) 382-9162

WANTED: Broadcast equipment catalogs and transmitter brochures from 1930-1955. Magazines wanted: "Broadcast News" (RCA), "Pickups" and "Oscillator" (Western Electric). Sam, W6HDU, 1031 San Antonio Ave., Alameda, CA 94501. (510) 521-1429

WANTED: Please help me find a nice NC-303 or 75A-2. Joe Eide, KB9R, (715) 834-4582

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!

FOR SALE: Repair & refurbishment of older tube-type amateur equipment. Fully FCC licensed; 35 years experience. Chuck Banta, N6FX, Claremont, Calif. (LA area) (714) 593-1861

WANTED: Schematics and/or manuals for following - copies OK- Knight T-60, Knight VFO, Hallicrafters S-41. B. Lee Cornwell, KD3KD, HCR 1, Box 95, Mt. Pocono, PA 18344. (717) 839-2710

FOR SALE: National NCL-2000 linear w/ spare finals, excellent - $500; Hallicrafters SX-43, fair, restorable - $50. KØOCC, Atlanta, (404) 396-1312

FOR SALE: SAMS Photofacts and parts for collectors. Electrolytics, high voltage capacitors, power resistors, plugs, switches and more. Free catalog. A.G. Tannenbaum, WA2BTB, POB 110, East Rockaway, NY 11518. (516) 887-0057, FAX 599-6523

FOR SALE: Narrow bandwidth (600 Hz) mech. filters for CW reception with Collins 51J-type rcvrs - $45 each. Limited supply. Joel Thurtell, 11803 Priscilla, Plymouth, MI 48170. (313) 453-8303

WANTED: Power xfmr for Eico 720 CW xmtr. James G. Herkimer, WB2ANO, 338 Village Blvd., So., Baldwinsville, NY 13027. (315) 635-8016

FOR SALE: Have you received your 1993 catalog of coil forms, literature, tubes and other radio parts? If not send $2 to Antique Radio Labs, R1, Box 41, Cutler, IN 46920 for your copy.

WANTED: Article describing parallel 4X150A untuned grid amp. This was published in QST, CQ or perhaps a handbook issue. David Bertman, AB7B, 1314 S.W. Hall, #E, Portland, OR 97201. (503) 223-5295

FOR SALE: Hallicrafters HT-44 xmtr, w/AC sply, manual - $150, offer/trade. Mike, WA7NPA, POB 208, Washougal, WA 98671. (206) 837-3560

WANTED: Manuals for HQ-140XA; RME DB-20 preselector; Heathkit HX-10 xmtr; Heathkit T-3 signal tracer; S-meter for SX-42. Many thanks. Mike Taylor, KA6OIO, 225 N. Adlena Dr., Fullerton, CA 92633. (714) 871-6665

FOR SALE: RIT for KWM-2 and S-Line. No modifications for KWM-2; 75S- needs one wire - $59.95. SASE for info. John Webb, W1ETC, Box 747, Amherst, NH 03031.

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

WANTED: 51J4 top dust cover, filter choke 678-0432-00, mech. filters F500B-14, F500B-31; R390A Stewart Warner (1960) RF deck, EAC (1967) IF deck; old Western Electric, RCA, Gates broadcast equipment catalogs, General Radio Co. catalogs and Experimenter magazines. John Tiedeck, WA2SDE, 212 Grandview Rd., Media, PA 19063. (215) 566-8049

FOR SALE: G-50 - $50; rack mounted 20A - $50; SX-25 spkr, poor - $13; BC-459A, w/ FT234A & connectors - $50; BC-454B, w/orig. box - $45; parting SX-42. Joe Sloss, K7MKS, (206) 747-5349

WANTED: Johnson Desk KW o '500; Globe King 500; Globe VFO; tuning/loading dial assemblies for KWS-1; Valiant case. Howard Edson, 1505 No. M St., Tulare, CA 93274. (209) 688-8506

FOR SALE: Johnson Viking II meter - $10; Hammarlund HQ-129X spkr - $40; Hallicrafters SX-43 spkr - $25; Penta 6569 tubes (3) - $75 each. Steve Harmon, N9HGF, (812) 474-0842

TRADE: My Stancor ST-202A, TBS-50/TBS-50D, Globe DSB-100/755 VFO and R-100/URR for old radios. A. Bruno, 24 Butternut Dr., New York, NY 10956. (914) 354-8899

WANTED: CE 200V; 600L; NCL-2000; NCX-1000; HRO-7; Collins 30K. Trade RCA-AR88LF, w/cash for any above or straight purchase. Tnx. Gary, KE6MS, (310) 696-0177

WANTED: Hallicrafters SX-100; Hammarlund HQ-140X. Excellent to mint. James B. Geer, WB5LXZ, 604 King Dr., Bedford, TX 76022-7124. (817) 268-1985

WANTED: NCX-5 w/AC pwr sply, mic & manual. State price and condx. Russ Hunt, W9HZD, 14 Siros, Laguna Nigel, CA 92677. (714) 363-8119

WANTED: T.R. McElroy pre-WW II catalogs and flyers; also 25 x 38 inch Chart of Codes. Tom French, W1IMQ, "the McElroy collector", 120 Great Road, Maynard, MA 01754. (508) 897-2226

FOR SALE: Small quantity of Bud 5-pin and B&W BVL, 1500 series and 3400 series coils and bases; also some B&W coils from 10 KW amplifier AN/MRC-2 (look like giant BC-610 coils) and extra BC-610 coils and tuning units (none for 160 meters). LSASE for list. Robert W. Downs, WA5CAB, 2027 Mapleton Dr., Houston, TX 77043-2410.

FOR SALE: McMartin LR-1001A broadcast limiter compressor - $65. **WANTED:** Manual copy for Collins 51N-2 rcvr. Gus Enquist, VE3MAL, RR 1, Redbridge, ON, P0H 2A0 Canada. (705) 663-2387

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: Exc. to mint 32S3, WE and 516F-2 - $450. U-ship. Gary Elliott, NO5H, 808 Clarice St., Delhi, LA 71232. (318) 878-8032

WANTED: Repairable or parts units tube-type SSB/CW gear, accessories or power supplies-Heath, Drake, etc. Byron Tatum, WA5TIIJ, 1920 Maxwell, Alvin, TX 77511. (713) 331-2854

FOR SALE: Hallicrafters SX-24, works - $95 OBO; Hallicrafters PM-23 spkr - $35; CDE TRA-4 rotor w/control, cable - $20; Swan 500 w/ 177XC sply, cables, book, clean vintage SSB - $225 OBO; HyGain 12AVQ 10, 15, 20-meter vertical, w/book - $35 OBO; Viking II cabinet - $20; R-392 PTO - $10; Heath HA-10 amplifier, rough - $75 OBO; Westinghouse 861 tube - $25; 27 uH high power roller inductor, w/ counter - $35. U-ship. WA7HDL, (208) 756-4147

WANTED: S-Line R/E 32S3A, 75S3C, 312B-5 & 516F-2 set; 75A-4 S/N 5000, R/E KWM-2A, w/516F-2; REAL HF-380 or HF-8020/8515-1 or 8515-2. Mimi Kobayashi, 2212 Rockefeller Ln., Redondo Beach, CA 90278. (310) 379-6052

FOR SALE: 1000 NIB tubes in 3 22"x60" shelf units with "We Recommend Sylvania Tubes" logo. Make offer. Dan Radcliffe, KP9BP, 8201 Plainview Pkwy., Sussex, WI 53089. (414) 255-9165

WANTED: Transmitting tube types 212, 308, 845, 211 (VT-4C) and/or sockets; also Western Electric amps using 300-B tubes. Ed Billeci, 2310 S.E. 113th, Portland, OR 97216. Phone/FAX (503) 281-4734

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

TRADE: Excellent R-392 for SP-200/BC-779 or R-392 plus cash for SP-200/BC-779. Ray, (407) 633-3971 after 1 PM

WANTED: Johnson Desk KW, with or without desk; Johnson Invader 2000; Hallicrafters SX-115. Steve, WB4IJN, 601 Black Oak Blvd., Summerville, SC 29485. (803) 873-7847 X 200 (d), 821-6931 (n)

FOR SALE: DX-100 - $135; Valiants - $200 and $125. PU only. J.M. Roseman, W9UD, 2716 W. 3rd St., Coal Valley, IL 61240. (309) 799-7447

FOR SALE: Very rare National SW-3, collector quality - BO; NC-300 cosmetically near perfect, no calibrator - $195; Hallicrafters S-53A, orig. - $35. Gary, KE6MS, (310) 696-0177

FOR SALE: Heathkit amateur radio repair by RTO Electronics, 4166 Maple St., Berrien Springs, MI 49103. (616) 473-3201

FOR SALE: Put a class knob on your classic Collins 75A-4. 'Jupiter Superknobs' are solid brass, six times heavier than fragile plastic original vernier knob - $149 + $5 shpg 48. Joel Thurtell, 11803 Priscilla, Plymouth, MI 48170. (313) 453-8303

WANTED: "Radio News" 2-1944, Signal Corps issue, complete. Will pay $35 for clean one, $50 for new one! Gene, KD4YIZ, 1-800-619-0900.

WANTED: Transmitting triode 6C21, used or new condx. Ted Bracco, Quincy University, 1800 College Ave., Quincy, IL 62301. (217) 228-5213

WANTED: Manuals for RDZ-1, RAS-5; BC-223; new 813 tubes; DY-28 dynamotor. Greg Richardson, POB 405, Gallipolis Ferry, WV 25515.

FOR SALE: Hallicrafters SX-11 (1937 Super Skyrider), near mint - BO over $250. Tony Schlude, 285 Luther Dr., DePere, WI 54115. (414) 336-9780

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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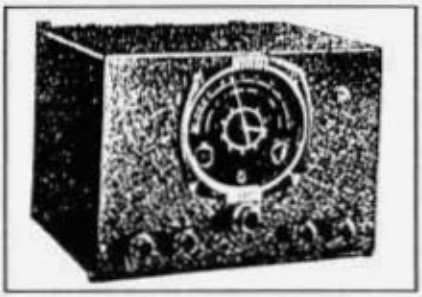
WANTED: Will pay top dollar for one VG to mint Navigator. Marc, VE3GDX, (519) 969-5620 eves.

FOR SALE: HQ-180-C, completely restored and aligned, new silk screened front panel; also have extra HQ-180 front panel assembly (refinished). Ron Eisenbrey, 115 First St., Sugar Land, TX 77478. (713) 491-7823

TRADE: Good/excellent R-390A for 51J4, 75A-3/4 also considered. Ed Cole, 6060 4 mile Canyon Dr., Boulder, CO 80302. (303) 444-7296

WANTED: Gonset G-76 xcvr. Jim Grandon, K8IMR, 201 N. Hawley St., Eustis, FL 32726. (904) 589-8422



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

WANTED: LV xfmr for DX-100 or a DX-100 for parts. Philip Bourk, NØCFF, 7700 Hwy 2, #10, Commerce City, CO 80022. (303) 286-9127

WANTED: Original cabinet for National NC-300; also Johnson T/R switch or equivalent. Thank you. Andy Miller, Salinas, CA. (408) 753-2505

FOR SALE: Hallicrafters HT-9 xmtr, not working but seems to be complete - $150 PU only; Hallicrafters HT-18 vfo mounted on 19" rack panel - $55 plus shpg. Gerald Parker, KØGPX, Box 520, Casselton, ND 58012. (701) 347-5018 eves

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FOR SALE/TRADE: PE103; also a few other goodies including a DX-100. John Cannon, W9TLU, 618 North First Ave., Maywood, IL 60153. (708) 345-2929

FOR SALE: SP-600J; DX-60B, w/HG 10B vfo; DX-40; NC-173; BC-610, w/coils & TUs; 3 KW tuner. Joe Perratto, 1341 SW Evergreen Ln., Palm City, FL 34990. (407) 220-7362 call anytime.

FOR SALE: WW I portable telephone/buzzer, flameproof keys, NOS 1955, various others, 8 page list - $1 plus SASE. J.H. Jacobs, 60 Seaview Terr., Northport, NY 11768.

FOR SALE: Drake R-4A, MS-4 spkr, manual, extra SWBC xtals - $200; Drake SSR-1 gen. coverage rcvr, manual - $150. All are ultra clean and working. UPS additional. Gus Stellwag, 117 Edgewood Dr., Orangeburg, NY 10962. (914) 359-0769

WANTED: One of the various forms of SP-200. Will pay up to $350. Please no basket cases. Ray, (407) 633-3971 after 1 PM

FOR SALE: Just received 30 more pieces of Heathkit, Knightkit, General Radio, Ballantine and others. SASE for list. James Fred, R1, Box 41, Cutler, IN 46920. (317) 268-2214

WANTED: Drake, Collins, Hammarlund gen. coverage rcvrs in good condx. Levy, 8 Waterloo, Morris Plains, NJ 07950. (201) 285-0233

WANTED: Citizens Radio Call Book magazine for 1920-1921-1922-1923; Citizens Radio Amateur Callbook magazine (Flying Horse cover) for 1924-1925-1926; Department of Commerce Radio Stations of the U.S. for 1913 plus supplements, 1914-1915-1916; 1909-1910-1911-1914 list of wireless telegraph stations, included U.S. amateur stations -- was called "Wireless Bluebook". Bob Arrowsmith, POB 166, Annandale, VA 22003. collect (703) 560-7161

FOR SALE: Custom made vinyl covers to keep the dust out of your priceless vintage gear - $12 for any desk top unit; KWM-2, w/ps, excellent - $650; SX-111, very clean - $150; SX-101A, clean - $100, PU only; Clegg Venus, w/ps, clean - $125; SX-117 & HT-44, w/ps, spotless clean - $550. Don, K9TWO, (317) 788-4337

FREE: BC-610H with most accessories; complete model 19 teletype unit. Pick up only. Wm. S. Berg, Park Falls, Wisc., (715) 762-3956

FOR SALE: Limited quantity of orig. manufacturer new knobs for Collins 75A, 32V and KWS-1 series, 1:1 main tuning - $25; large pointer (1.75" skirt) - $12; medium pointer (1.5" skirt) - $10; small non-skirted pointer - $5. Shpg included. Money back guarantee. Jerry, AB8U, (513) 429-5457

FOR SALE: Heathkit SB-10 - $80; SX-110 - $80; S-120A - $35; NC-88 - $75; NC-303 - $175. Looking for HQ-180, AR-88, SP-600 and manuals/copies for AR-88, HQ-105TR, NC-98, NC-173, RME-4300, Drake T4 and R4. See our ad this page. Gary, W7FG, (918) 333-7893

WANTED: Community college instructor wants early model HRO Sr. and coil set for my station, to share this era of receiver technology with my electronic communications students. Also interested in an exciter representative of this time period. John Zitzelberger, WB6JJE, 5257 Lewis Rd., Agoura, CA 91301. (818) 991-8358

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

FOR SALE: Heath HW-12 80-M xcvr, rough - $50; Heath HP-23-A pwr sply - $75. **WANTED:** Matching spkr for Hammarlund HQ-180 series rcvr; B&W 381 or Johnson 250-39 electronic T/R switch; info to add 160-M to Hammarlund HX-50 xmtr. Lance Wilken, KNØUSQ, 545 Woodland Ave., Fairmont, MN 56031. (507) 235-9195

WANTED: 813 tube socket. Bill Goodrich, W8LNL, 1417 Covedale Ave., Cincinnati, OH 45238. (513) 251-3004

FOR SALE: Real audio for your R-390A. Send me your audio chassis (no junkers please) and I'll ship you a ready-to-play chassis. If you're not happy (for any reason) return the chassis (within 30 days) for a full refund. Specs will equal or exceed those specified in ER #42 article - $119 shpg prepaid. Allow 30 days for delivery. Bill Kleronomos, KDØHG, DBA Longmont Labs, 224 Main St., POB 1456, Lyons, CO 80540. (303) 823-6438

FOR SALE: HQ-145, mint - $175. **WANTED:** Radio Shack DX-400; Uniden CR 2021; RME 4350; TMC GPR-90/92; RCA model CRM R6A; SX-101 MK II. Rick, K8MLV/Ø, 1802 W. 17th St., Pueblo, CO 81003. (719) 543-2459

FOR SALE: Collins 30L-1 linear - $300; KWM-2A, w/516F pwr sply - $250; 312B station monitor - $75. All for $550. Michael Runyan, KK7F, S. 1117 Fiske, Spokane, WA 99202. (509) 535-5548

WANTED: 1930's and '40's Radio Premiums; RCA Dynamic Demonstrator; Hallicrafters SX-9; RCA tube 1847. Bill Ross, 875 Gordon Terrace, Winnetka, IL 60093. (708) 441-6462

FOR SALE or TRADE: Hammarlund SPC-10 SSB adaptor, w/instruction book. WANTED: Babcock MT-5B mobile xmtr, w/manual. B.G. Martin, N4YYP, 127 S. Oliver St., Elberton, GA 30635.

WANTED: Hallicrafters SX-24 or SX-25. Call Hoover, (803) 726-5762 anytime

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WANTED: SCR 68 WW II radio; need VT-2 tubes, top dollar paid. Steve Bartkowski, 4923 W. 28th St., Cicero, IL 60650. (708) 863-3090

FOR SALE: J-38 telegraph key, vintage, unused, mint - $35 plus $2.90 postage. Lee Frank, POB 60011, Harrisburg, PA 17106-0011.

WANTED: Cabinet and manual for 51S-1. Will trade rack panel assembly for same. Stan Hojnacki, WA2NPL, 103 Wilson Ave., Blackwood, NJ 08012. (609) 435-8975

TRADE: R-1051E HF rcvr, no manual, VG condx, for Collins 30L-1 equal condx. Jim Cunningham, K4DEE, (407) 679-8086

FOR SALE: 75A-4; KWM-1; 32S-1; Heath AR-3. Joel Levine, WB2BMH, 67 Derby Ave., Greenlawn, NY 11740.

WANTED: Radio historian and former editor of Ham Radio Magazine is researching and preserving pre-1958 amateur QSL card and log books. Don't let our records be lost! Gladly pay all shipping and packing. Douglas Stivison, NR1A, 45 Norman Rd., Upper Montclair, NJ 07043. (201) 509-0585

WANTED/FOR SALE: Vintage tube CB's. Send card or call with models you have for sale. SASE for list. Steve White, WB5UGT, Box 1086, Clute, TX 77531-3814. (800) 374-6477 (9008) leave message.

FOR SALE: Hallicrafters S-38C; WE ground magneto ; keys, flame-proof, J-37, 38, 45, etc. 8 page list of etc. items - $1 plus SASE. J.H. Jacobs, 60 Seaview Terrace, Northport, NY 11768. (516) 261-1576

FOR SALE: For xmtr collectors, Lysco model 60 antenna tuner and Lysco model 107 xmtr, xtal control, as is, both units - $35 + $5 shpg; E.F. Johnson Messenger Two Twenty Three, Robyn T-123B Citizens Band Transceiver, RCA Mark VII Radio Phone CRM-P3A-5, any of the three , as is for $25 each + $7.50 shpg. James Fred, R1, Box 41, Cutler, IN 46920. (317) 268-2214

WANTED: Hallicrafters SX-100 service manual and schematic, prefer original, copy OK. John Thomas, 1130 Pleasant View Lane, RR 3, Colorado Springs, CO 80921. (719) 481-4564

WANTED: Johnson Viking Navigator and Ranger I meter. Hank, W2IQ, (615) 397-9796

FOR SALE: HRO coil (1.7-4 Mcs), Bogen mono. 20-w Challenger, R46 spkr, Laf. HE 73 precon. - $25 each plus shpg. Henry Mohr, W3NCX, 1005 Wyoming St., Allentown, PA 18103. (215) 435-3276 (8 AM - 2)

FOR SALE: Drake 1A - $90; (2) NIB, sealed, 1943 833s - $100. **WANTED:** Heath HO-13 or SB-620. Will pay top dollar for a nice one. K4NJS, (803) 585-2810

FOR SALE: Clegg Zeus 2 and 6 meter xmtr, w/pwr sply, 180 watts, very clean - $275. Stuart T. Carter, W4NHC, POB 033177, Indialantic, FL 32903-0177. (407) 727-3015

WANTED: Radio Masters catalogs up edition 1955. Roland Matson, RFD #1, Box 2943, Kennebunk, ME 04043.

WANTED: Cushcraft Squalo 6-M mobile antenna. Chris, K2PGB, 46 Columbia Ave., Hopewell, NJ 08525.

WANTED: Collins 51J4 rcvr, w/case, spkr & manual. Barry Nadel, Box 29303, San Francisco, CA 94129. (415) 346-3825, FAX 346-0468

WANTED: Unbuilt kits by Heath, Johnson and Knight. Gene Peroni, POB 58003, Philadelphia, PA 19102. (215) 665-6182 days

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FOR SALE: HRO-50, HQ-129X, Lafayette HA-225 rcvrs. John File, POB 566, Tolono, IL 61880. (217) 485-3439

WANTED: Heathkit analog computer. Charles Seitz, WA2DYA, POB 339, Bartonsville, PA 18321.

WANTED: Hammarlund HQ-170A or HQ-170A-VHF; also Collins 75A-3. John, WB2SMA, 423 Line Rd., Aberdeen, NJ 07747. (908) 566-1312 after 9 PM EST

FOR SALE: Homebuilt speech amp (6A3 drivers) w/TZ40 modulators, 1100-V pwr sply, driver and mod xfmr (Inca multi-match 300-W). Al Hart, W6VBM, (818) 762-6842

FOR SALE: Tektronix RM 503 oscilloscope manuals, originals - $20 ppd. Also other Tektronix manuals. Alton Bowman, 4172 East Ave., Canandaigua, NY 14424.

FOR SALE: Generator panel for D.W. Onan 60A, part no. 500 D 160 NU BXD - $135; brass key, surplus, new - $25; auto xfmr, 7-A - $20; Bolgen Hi-Fi amp - $45; Price relay, type 3305-3, 2-pole, 230-V AC, new - $20; Price relay, 2-pole, 115-V AC, type 158-B - $20; chokes and fil. xfmrs, many sizes - call. Joe, W6CAS, (916) 731-8261

WANTED: Military AN/FRR-59A either/or AN/WRR-2A. John Richardson, 1163 Highland Pl., Dubuque, IA 52001. (319) 556-5504

WANTED: TCS complete. FOR SALE: GP-7 tuning units; Sonar CD-22-M AM xcvr. W8AU, (216) 832-8612

WANTED: 2A3, 274A or B, 300A or B, 350A or B, VT 230 new or used. I need several of each. Also looking for others and military surplus tubes. Tim Metz, 221 Wheatland, Fairview, OK 73737. (405) 227-2456

FOR SALE/TRADE: Rare Eledico SSB-100 mobile xmtr; DX-160 rcvr/spkr; 872A tubes (NIB). Doc, WA2IFS, (201) 728-2454 before 01:30 Z

WANTED: Tube audio amplifiers: Western Electric, RCA, Heathkit, Fisher, Dyanco, etc., any condx, literature, parts. Need Heath W5M. Mike Nowlen, WB4UKB, 12911 New Parkland Dr., Herndon, VA 22071. (703) 481-9614

FOR SALE: Collins KWM-1, 516F-1, KWM-2A, 75A-1, 75A-4. Joel Levine, WB2BMH, 67 Derby Ave., Greenlawn, NY 11740. (516) 757-7641

WANTED: Collins 32V-3, 75A-3 and spkr; mech. filter for 75A-3; meter for Collins 51J3/51J4. Brian Roberts, K9VKY, 3068 Evergreen Rd., Pittsburgh, PA 15237. (412) 931-4646

FOR TRADE: 75A-4 mech. filter for J-21 or J-40 mech. filter. **WANTED:** W/E emblem for S-Line; parts radio NCX-5. Smitty, AD6V, (209) 255-1177

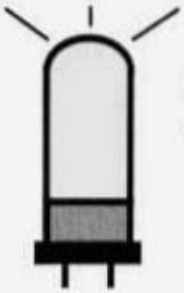
WANTED: Manual or copy for Navy facsimile recorder RD-92A or RO-172/UX. Naturally pay any reproduction costs or your price for manual. Also need Amperex 2H20, Amperex 6-36 and 1635 tubes. Robert Hall, KEØJK, RR01, Box 1401, Dunnegan, MO 65640. (417) 654-2577

WANTED: WW II German equipment and tubes, manuals and other parts. Bob Graham, 2105 N.W. 30th, Oklahoma City, OK 73112. (405) 525-3376

FOR SALE: 23-channel CB radios, all solid-state radios. Guaranteed in good working condx - $25 plus shpg. Burl, (214) 736-2391

FOR SALE or TRADE: HT-37; SX-71; SX-101A; HT-44; ps; SX-117; R-1000 rcvr. Ray, (314) 428-1963

FOR SALE: Class B audio driver xfmr for Viking II and DX-100 - $12.95; replacement audio driver xfrm for Ranger - $8; 600-V orangedrops, most values - $.40-$1.95; 600-V Sprague electrolytics, 20 and 10 mFd, axial leads - $9.95 & $8.95; 2.5 mH RF chokes, 160 mA - $3.65; vintage 2000 ohm headphones - $17.95; NOS polished ceramic ant. end insulators - $2.95, center insulators with rope hole - $5.95; single-section variable caps, 365 pF, U.S. made - $7.95. Antique Audio. Write or call for our free 1993 catalog. See our display ad on page 36.



SECOND
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ELECTRIC RADIO
145 CR 123
Hesperus, CO 81326

TO: