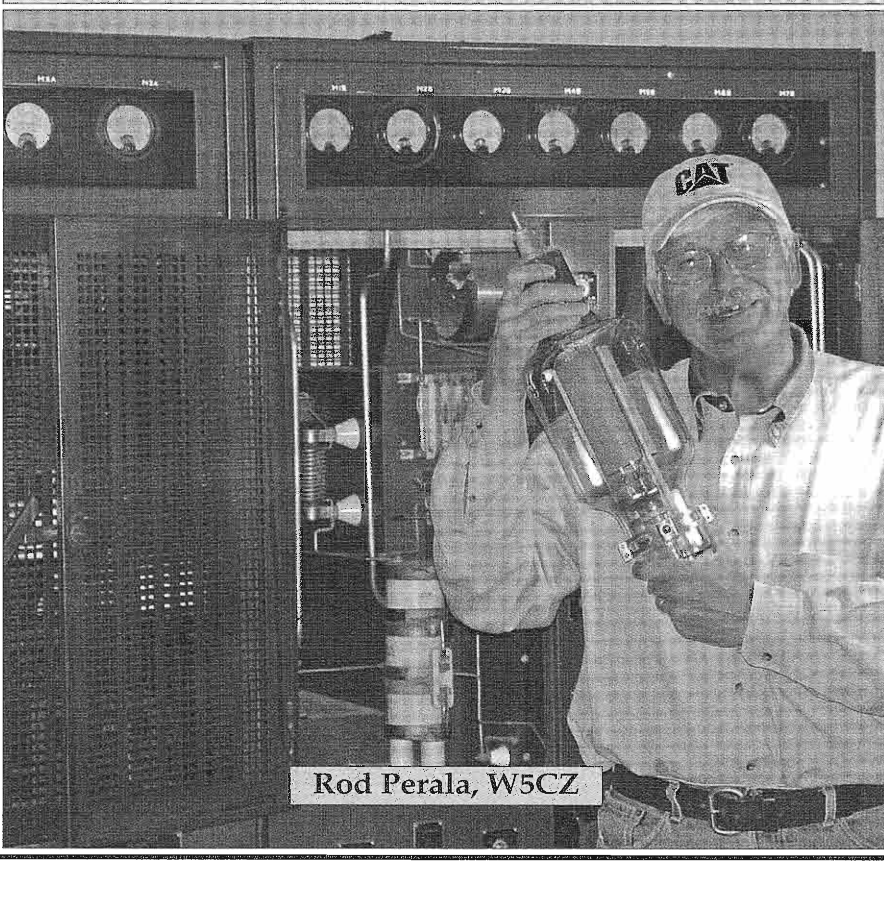
$3.85

ELECTRIC RADIO

celebrating a bygone era

Number 204 May 2006



Rod Perala, W5CZ

ELECTRIC RADIO

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

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

Electric Radio is all about the restoration, maintenance, and continued use of vintage radio equipment. Founded in May of 1989 by Barry Wiseman (N6CSW), the magazine continues publication for those who appreciate the value of operating vintage equipment and the rich history of radio. It is hoped that the magazine will provide inspiration and encouragement to collectors, restorers and builders. It is dedicated to the generations of radio amateurs, experimenters, and engineers who have preceded us, without whom many features of life, now taken for granted, would not be possible.

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

Editor's Comments

Vintage Field Day, June 3, 2006

The annual Electric Radio Vintage Field Day will be on June 3 this year. I am planning to operate from a high mountain location this year if the weather cooperates, and I hope there is at least as much participation as in the last few years, and hopefully more participation. This is not a traditional contest, so there are no rules except what are provided by FCC, and there is nothing to "win." We start at 8:00 AM EDT and continue until 12:00 PM EDT. The object is to take vintage military, commercial, and Ham equipment into the field and have fun operating AM. The best frequencies to use are our usual spots inside the AM windows. I would greatly appreciate getting photos to use in ER from operators around the country who participate this year. You can operate from home too; all are welcome.

Electric Radio Mailing and Some Upcoming Changes

Many readers have questions about the monthly Electric Radio mail handling and what looks like inconsistencies in delivery. Unlike magazines with much larger circulation, Electric Radio is printed and mailed the month it is issued. The monthly issues all go out at the same time, somewhere between the 6th and the 10th of the month, depending on where the first weekend of the month falls and how busy my printer is with other projects. I don't handle the ER mailing from Bailey, CO; they are sent out directly from the printer's office in Cortez, CO. All the mail classes including first class, the periodicals class, the overseas and Canadian issues go out together. All of the dealer copies are sent by UPS ground. Once a mailing is turned over to the post office or to UPS it is out of our direct control.

Delivery time varies greatly depending on the class of mailing. I know this is frustrating for many subscribers. The slowest of all is the Periodicals class, and readers need to allow a minimum of 3 weeks for average delivery. Periodicals-class

[Continued on page 28]

TABLE OF CONTENTS

Cover: Rod Perala (W5CZ) is holding a Western Electric 279A final amplifier tube from his newly acquired 1937 Western Electric 353-E1 broadcast transmitter. The transmitter will be featured in his new museum in Indian Hills, Colorado. Look for a story about this in next month's issue.

The BC-669 Transmitter-Receiver

By Chuck Teeters, W4MEW
110 Red Bud Lane
Augusta, GA 30907
Cteet70@aol.com

When you get interested in AM and old military stuff, one of the fun radios is the BC-669. It could have been the 1946 "Poster Boy" for the War Assets Administration Ham radio surplus sales. It looks like a radio should have looked back then, was tabletop size (with a big, strong table) and had both a transmitter and receiver. It more than qualifies today as a boat anchor due to weight, and being a direct descendant of a Hallicrafters HT-12 marine radiotelephone. Hallicrafters had entered the marine radio market in 1938 with the HT-3, and by 1940 had three models, with the HT-12 the most powerful at 50 watts. When the United States entered into WWII in late December 1941, the HT-12 was drafted into military service as the BC-441, and with a few changes became the BC-441A in early 1942.

Bill Halligan built the first BC-441As, but with Signal Corps contracts overloading his factory he asked for assistance in the production by someone with experience in marine radio. A conference with Hallicrafters, the Signal Corps, and the Field Artillery (the potential user of the radio) resulted in a rework of the BC-441 contract and a new radio contract, the BC-669. The BC-441 production would be subcontracted out and Hallicrafters would develop the BC-669, a BC-441 with six more channels, a wider frequency range, 1.6 to 4.5 MHz, and a remote control unit. A separate dual-input, 110-VAC or 12-VDC power supply was added. (The BC-441 power supply was built-in.) Other manufactures, such as Jefferson-Travis and Ray Jefferson would help build the BC-669 and the PE-110 power supply and other basic components (BC) of the Signal Corps Radio (SCR) 543, which was the nomenclature for the complete new radio set.

The Hallicrafters-designed BC-669 of WWII.

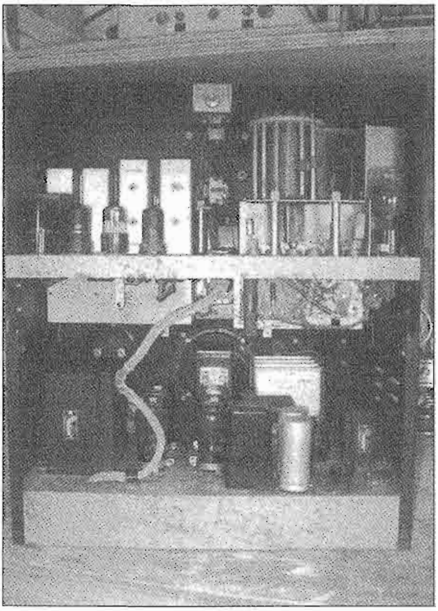
A limited production run of BC-669s was built at Hallicrafters and shipped to Philadelphia for final testing with a set of SCR-543 components. The Signal Corps accepted the radio in May 1942, and production of the BC-669 radio and components started in early June 1942. The initial distribution for field tests was to the 987th Field Artillery. The tests showed a need for mechanical beefing up in the channel switches, relays, cabinet mounting clips, switch couplings, coil sliders, and a need for more component mounting boards. The changes were incorporated in the production line, and the set became the SCR-543-A, with the BC-669-A radio.

A second set of changes was made 6 months later, again all directed towards beefing up the set for field use. This time it became the SCR-543-B with each change adding pounds to the radio. In late 1942 the Anti-aircraft Artillery was reorganized as a separate service. They were the major user of the SCR-543, when along came the Coast Artillery, who wanted the BC-669 in place of the earlier BC-441. This called for increased production, and Electrical Research Laboratories Inc., on the north side of Chicago, got a production contract to build the upgraded SCR-543-C with the BC-669-C radio. The radio was now at 162 lbs. (from its original 130 lbs). While the radio was heavy and old fashioned, its dependability, simple operation, and ease of repair made it a favorite right up to the end of the war in 1945. Apparently, only a few hundred BC-441A through D were built, but over 5000 BC-669As,-Bs, and -Cs were built, with well over half of the total being C models. A few remained in military service up into the early fifties. You can tell the sets that the military held onto by the MFP (Moisture and Fungus Proofing) stamp and MWOs (modification work orders), which were done after 1945.

Even with all the changes, the BC-669 still looked like a Hallicrafters, with its German silver receiver tuning dial, (like the SX-16,17, and 18) and big "h" in the speaker trim. The other manufacturers dropped the "h" in their production. Then, they added "RJ" or "JT," and ERL added a big "E" with a lightning streak base. Hallicrafters complained to Signal Contracting, but since the speaker trim was wood, a non-essential war material, and not covered in the production contract, nothing was done.

After the war, Hallicrafters made some small changes in the BC-669, the most noticeable, the elimination of the remote unit and the addition of a telephone-type handset on the front panel. They labeled it the HT-14, the "Commodore," and put it in their 1946 advertising. It was not a good selling set, too big and expensive for small boats and not enough power for big boats. They stopped HT-14 production in 1947. Most surplus '669s came through MARS. The Boy Scouts of America also had dibs on surplus, and they liberated some sets for summer-camp communications. From a post war Ham standpoint, the BC-669 could only work 75 phone, and most Class-A phone ops were not interested in a low powered set. When 160 meters opened back up in 1950, and 75 phone was opened to Class-B operators in 1951, the BC-669 became a bit more popular, but it never commanded a very high price, or had much of a demand. The BC-669-C that I picked up in Greenwood, SC was tuned to 1950 MARS frequencies. It obviously had not been used for many years, and had been stored in a damp environment, but it sure looked like a 1945 Ham AM radio should, so I bought all 120 pounds of it. It, like most surplus sets, was lacking a power supply.

I had KG4HAD riding with me, so between us we got it on my work bench when we got home. I spent the next two days cleaning and then removing shock mounts, bulkhead mounts, cabinet latches and miscellaneous unneeded hardware, to the tune of 21 lbs. The BC-669 can be separated into the upper and lower chassis/cabinet sections. The lower section has the receiver audio output transformer and speaker, the t-r control relay, the modulator consisting of four 6L6s in Class-AB1 push-pull parallel, and a 12J5 speech amplifier, all transformer coupled and set up for a carbon mike input. The high-voltage, oil-filled filter



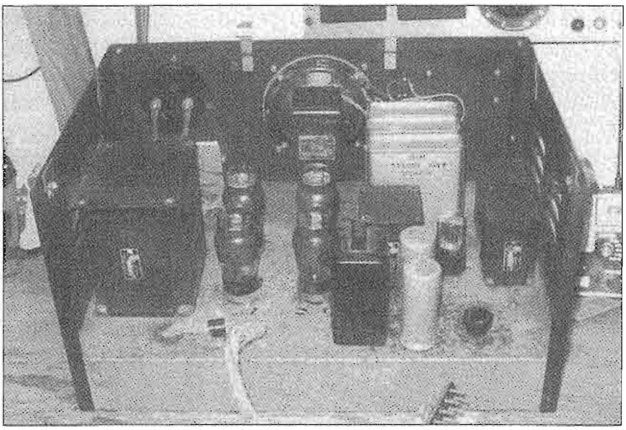
Rear view of the BC-669 cabinet showing the RF deck on top and modulator on the botton (Photo by Mary Rebecca Teeters).

caps, and the chokes and voltage dividers are on the lower chassis also. The transmitter meter and switching, which can read grid and plate current of the RF final amplifier and modulator plate current, are also there.

The two connectors on the front of the lower unit are a 10-pin AN for the remote unit audio input/output, and a 12-pin AN connector, normally supplying power from the PE-110 power supply. The chances of finding mating connectors was nil, so the audio plug was replaced with a WWII 1/4" headphone jack (mil JK-55), and a 3/16" three-circuit mike jack (mil JK-68). The power connector was replaced with an octal socket. The power requirements are 12 volts at 5 amps for the filaments, 230 volts at 40 mA for the receiver HV, and 480 volts at 400 mA for the transmitter. I didn't have a suitable filament or transmitter plate transformer, so I called Larry (W3LW), and he had both and would deliver the iron the following week on his way to Florida. (This also meant I would have some technical and physical assistance for a few days)

The top deck is the RF section. The transmitter has a 6L6 crystal oscillator and parallel 807s for the PA. The receiver has a 6SK7 RF amplifier, 6SA7 mixer, 6J5 oscillator, 6SK7 385-kHz IF amplifier, a 6H6 detector, AVC, and noise limiter. There is a 6SK7 1st audio and a 6K6 audio output tube. All very standard, except for the 6SK7 1st audio, the 385-kHz IF, and there is no BFO for CW reception. The transmitter has a massive 6-position switch for crystal and tuned circuit coil tap selections. The crystals are the big FT-171s like the BC-610 uses, and each channel can be tuned anywhere between 1680 and 4450 kHz. The receiver has a band switch that selects either a 1680 to 2700 kHz or 2700 to 4450 kHz frequency range. The receiver band switch also provides a choice of either crystal or tunable control of the receiver oscillator. The receiver has an RF gain control labeled "noise control," an audio gain control, and a noise limiter switch labeled "static filter." The static filter switch also cuts in a broad 1 kHz tank circuit in the grid of the audio output tube to restrict the high and low audio frequency response.

While waiting for Larry (W3LW) to arrive with the power transformers, I connected up my bench power supply to the receiver. It's easy to do, as the filament and plate supplies for the transmitter and receiver are on separate pins of the power connector. With the power connected, the receiver came to life with a roar of noise. Adding an antenna, signals showed up all over the dial. The receiver worked perfectly, calibration, controls, etc. I had not cleaned switches, tube sockets, or relay contacts. As you can see from the pictures, some of the tubes are rusted to the point you can not tell what type they are, and corrosion shows every where including under the IF transformers. The receiver has between 10 and 15 micamold

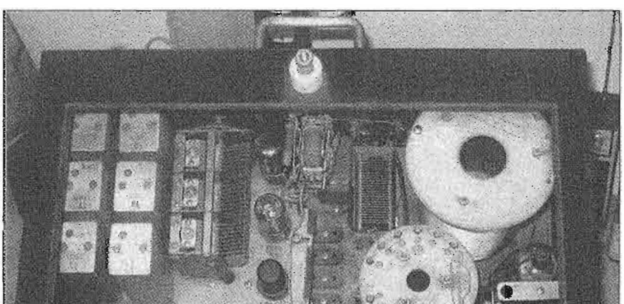


Here is the lower deck, showing the modulator, speech amp, and filter caps. (Photo by Mary Rebecca Teeters).

caps, like the ones in BC- 348s that are always failing, but there was not a bad one in the bunch, nor a bad resistor. I could set the dial to 2500 or 3330 kHz, turn on the receiver, and WWV or CHU was there.

A check of sensitivity showed less than 8 microvolts required for a good signal; being a bit better at 4 MHz than 1.7 MHz. Selectivity measured 14 kHz at 20 db down. Running for 3 hours, drift was under 2 kHz from a cold start. The audio response was 280 Hz to 7200 Hz, plus or minus 6 db. With the static filter switched in it was 480 Hz to 2100 Hz. with a peak at 1100 Hz. Distortion measured 17% on a 30% modulated signal. The only complaint I have with the receiver is the lack of a BFO, and a dial that is calibrated only ever 50 kHz. Other wise it is a great old receiver, probably comparable to an S-20R or S-40, with not very spectacular selectivity, but hearing anything on the band.

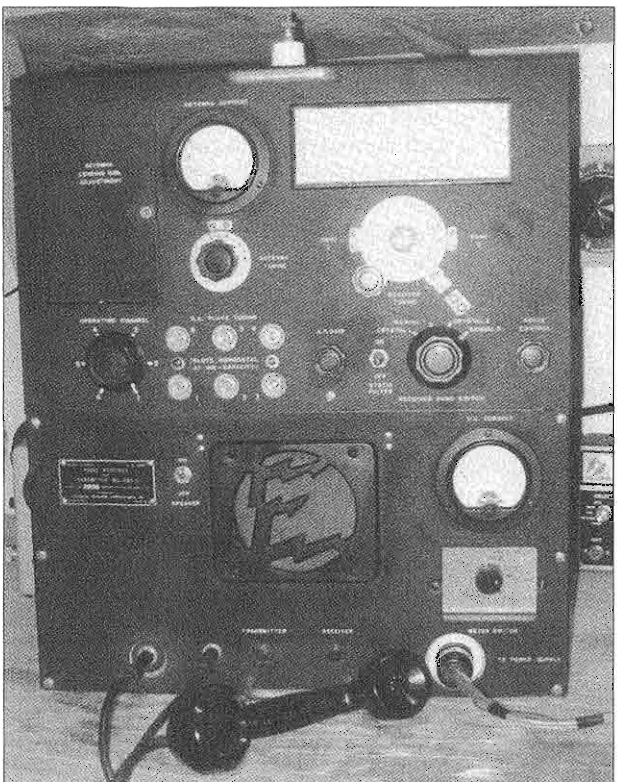
When Larry arrived with the transformers, we built up a power supply that would run the '669. The first thing we found when power was put to the '669 was that as good as the receiver was, the transmitter and modulator were non functional. First, a shorted bathtub 0.1 cap prevented the t-r relays from working. Second, there was no plate voltage on the 6L6 crystal oscillator, due to an open 20-k, 10-watt, wire-wound plate feed, and an open 47-k, 2-watt screen resistor. Replacing the resistors and cleaning the 6-position crystal switch got the oscillator working. The PA had 5 mA. of grid current but would not draw any plate current. The plate voltage was OK, but there was no screen voltage on the 807s. Two 30-k, 10-watt, wire-wound screen dropping resistors were open. A 50-ohm, 10-watt, common cathode protective-bias resistor was intermittent also. Apparently, the water bath over the years had corroded the wire-wound resistors. Replacing the resistors got the 807s drawing plate current, but there was no dip when we tuned the plate. A check with the grid dip



This is the top RF deck. The receiver is on the left and the transmitter is on the right. (Photo by Mary Rebecca Teeters).

meter showed no resonant points. It required a complete cleaning of the tank coil, sliding taps, and the switching circuit to get the PA to tune, but it would still not load. It took a cleaning of the loading taps, and the switching and loading coil to get the PA loaded.

The loading is an autotransformer connection to the shunt-fed final tank coil. It then goes through an RF ammeter and tapped loading coil to the antenna relay. For a low-Z feed, the loading coil tap is set to zero inductance. With a 50-ohm load, the antenna current was .92 amps. The Bird wattmeter said 45 watts. With a 20-foot vertical, I found a resonant point on the loading coil and got a peak of 1.6 amps of antenna current. With output, we went after the modulator. Turned out to be another open 1k wire-wound, this supplying 3-1/2 volts to the carbon mike input transformer. Now, with an Fl mike connected we had modulation. On the scope, it was close to 100% and symmetrical. Replacing the dummy load with the 75-meter dipole, we had a nice QSO with W4OCC and KØBF, and got good reports from both Ernie and Butch. The PA plate current runs about 165 mA and moves up with modulation. The-modulator plate runs 190 mA and flickers a bit with modulation, which is right for a Class-A modulator. Antenna current moves up about 5% to 10% with modulation, also about what it should be.



Another view of my BC-669 with new power and audio connectors on the lower deck. (Photo by Mary Rebecca Teeters).

Putting a bit of the RF output into the HP 334A distortion analyzer, we ran a frequency response test. It was down 6 db at 340 Hz and 5200 Hz. I doubt if the carbon mike would generate any frequencies anywhere near that range, however. A second harmonic check with W1SUJ, across town, gave negative results. So far, the rig will talk to anyone I can hear, and it gets good reports. Most of the stations I've talked to don't notice the carbon mike sound. On 160 it works great also, in fact a bit better than 75. The output is about 55-60 watts, as compared to the 45 watts on 75. So, as soon as I can get some strong friends over, I will move the BC-669 from the workbench to the shack and be all set to work the local AM rag chews in a WWII-surplus style, so as Sam–KF4TXQ–would say, "Life is another radio."

ER

On The Air With My BC-441D

By Jerry Fuller, W6JRY
PO Box 363
Forest Ranch, CA 95942

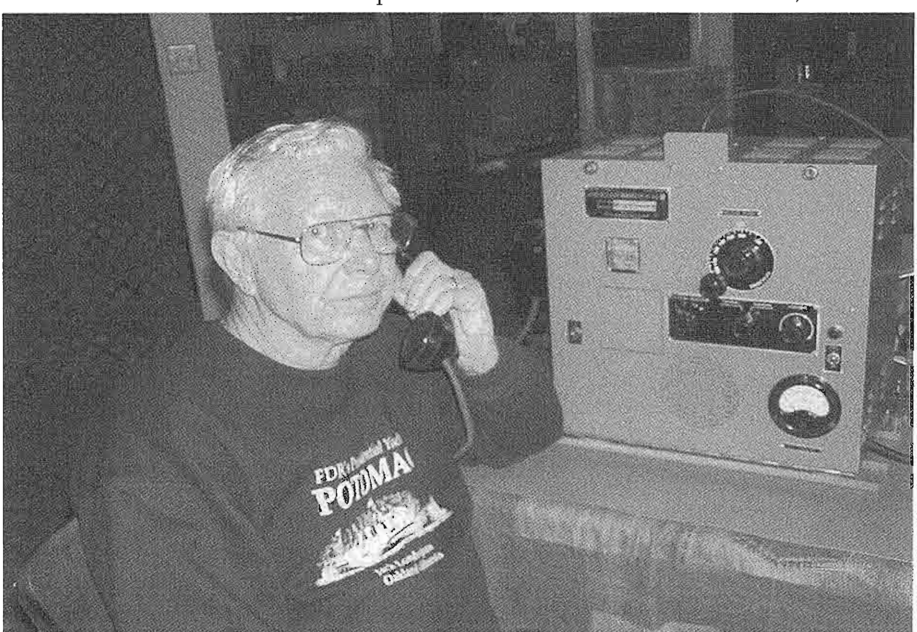
I recently picked up an interesting military radio which I had not heard of before, a BC-441D. I looked through my military books and did not find anything on it, but I could tell that it was a marine-band radio-telephone transmitter/ receiver and looks like it was designed by Hallicrafters as the HT-12, allthough the set had been made by a company I had never heard of before, the ISLIP Radio Mfg. Corp. of Islip, NY. It had a serial number of 77.

It tunes from 1700kHz- 2800kHz, and is crystal controlled with 4 crystal positions. It is put together quite well, the front drops down and the radio is built on the front panel. The power supply is in the bottom of the cabinet. I put a 1920-kHz crystal in it and tuned it up on 160 meters, and it seemed to work just fine, with about 30 watts output after all these years. It was probably made around 1942.

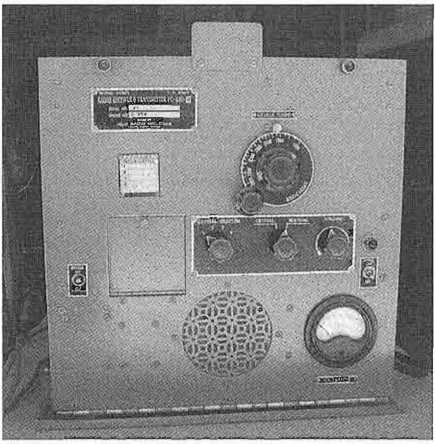
The BC-441D was in pretty good shape when I got it, the relays in it needed cleaning and all of the inside was dirty and also needed cleaning. The cabinet was dirty and scratched and I could tell that it had been around salt water because of many raised spots on the finish.

I took every thing off the front panel, the name tags, knobs, etc. and repainted it. I cleaned up the name plates and knobs and sprayed them with clear Krylon®. I sanded and repainted the cabinet with Battleship Gray paint which was an exact match!

After the cosmetic restoration was done, I reset the sliders on the plate tank coil for the 160-meter band, and tried



W6JRY is on the air with his restored 1942 BC-441D.



Above: Before-and-after photos of the BC-441D that show how nice it looks after it was cleaned up and repainted in the right color.

several FT-243 crystals in it which worked fine, it tuned up nicely with about 30 watts output into my 160-meter, inverted-L antenna. I have received good reports on it audio-wise and signal-wise. It has been fun to operate. *ER*

Below: The power supply cabinet looks new after its restoration was over and everything was back in place.

More On the History of Cathode Modulation

By Dave Gordon-Smith, G3UUR
Whitehall Lodge
Salhouse Road
Norwich, Norfolk
NR13 6LB, UK

In his two-part article on cathode modulation, which appeared in ER (#190 & #191), David Kuraner (K2DK) credits Frank Jones with the invention of cathode modulation. However, letters in the Correspondence and Open Forum columns shortly after the publication of Jones's cathode modulation articles in *RADIO* and *QST* in 1939 indicate that many disputed the claim made by the editors of these magazines that this method of modulation was new or, indeed, invented by Jones. So, who really devised this technique? Jones certainly promoted it in the amateur press, and by 1939,when he published his first article on the subject of cathode modulation, he appeared to understand the method and how it worked, well enough. Was cathode modulation as new and revolutionary as the editorial claims in *QST* and *RADIO* made out, then, and did Jones have anything to do with its invention?

The Doubt!

In December of 1939, a letter written by a pair of very irate amateurs from the New York area appeared in *QST*, complaining that the ARRL had given great credit to Jones for this new method of modulation, and yet had ignored completely their earlier article of February 1938, which had presented a cathode-bias modulated transmitter for the 5-meter band - see **Figure 1**. The authors, Geiger (W2FZQ) and McGrath (W2GNL), had submitted their article to the ARRL in 1937, and according to their covering letter had been air testing their design for some 3 years prior to submission. That makes their first use of cathode modulation sometime in 1934. This was not a case of exaggeration to support their claim of previous use, because they had mentioned the length of time they had spent perfecting this design in an earlier letter to the ARRL. They also cast

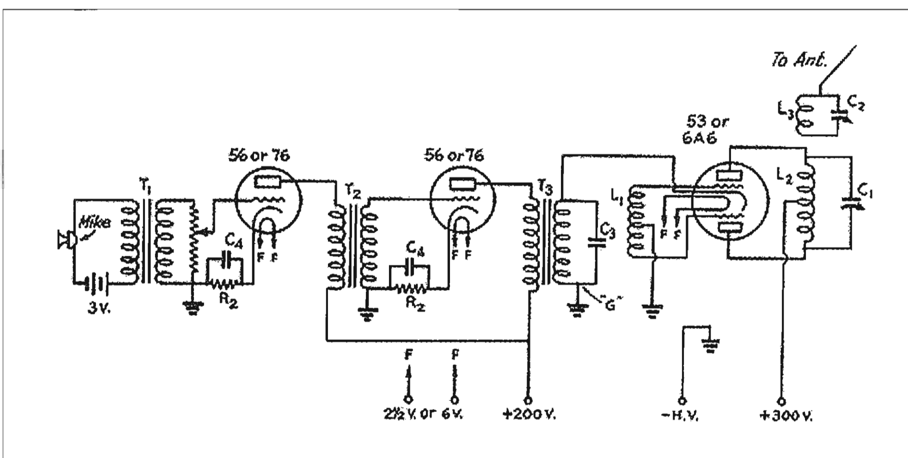


Figure 1: The Geiger and McGrath cathode-bias modulated 5-meter transmitter (from QST, February 1938).

doubt on the claim, made in Jones's book on cathode modulation, that he used the technique back in 1934. They scrutinized the book concerned – *Five Meter Radiotelephony* - to which he referred in his book *Cathode Modulation*, and found no evidence that he understood cathode modulation was taking place at the time he wrote it. In fact, Jones continually referred to this form of modulation as "grid modulation" in *Five Meter Radiotelephony*, despite the point that the carbon microphone was inserted in the cathode lead of the tube!

Following Jones's 1939 article in *RADIO* on cathode modulation, that magazine published a letter (March, 1940, p57) from Maurice E. Kennedy (W6KQ, ex-W6BGC) stating that the technique of cathode modulation was not new to him, either, and he'd been using it since 1924/5. He gave some details of his transmitter, but did not actually claim that he had invented it, nor did he give enough information to show whether he understood the difference between series and cathode modulation. It was obvious from the tone of his letter that he took exception to the suggestion that the method was new, and particularly to the claim that Jones had invented it! Charles Fiege (ex-2CZZ) also wrote to *RADIO* following the piece in the January 1940 issue about the "Inventors of Cathode Modulation." He mentioned that he had started using centre-tap (cathode) modulation back in 1923, after seeing how successful his buddy, 2ATS, was with this method! One of the other staff members at *RADIO* also recollected using centre-tap modulation back in 1931.

Nobody was actually claiming that they had invented cathode modulation, only that they had used it prior to the appearance of Jones's article. Jones, himself, made no claims that he had invented it, but certainly gave the impression that it was new and revolutionary.

The Evidence

There is no doubt that Geiger and McGrath published their article in *QST* some 20 months before Jones's first article on the subject appeared in *RADIO*. Geiger and McGrath openly admitted in their article that their method of modulation was a modernized version of the old "centre-tap" type. This is consistent with Kennedy's claim that he modulated his transmitter through the centre tap of his RF power amplifier filament supply. Going back through the old magazines, there is some evidence that "Centre-Tap Modulation", as it was called then, was one of several modulation methods in common use before indirectly-heated tubes came along, which fits in fairly well with W6KQ's claims that he used the technique from 1924/5 onwards, but there is a distinct scarcity of circuits to show how the technique was actually implemented. So, it could have been either series or cathode modulation depending on where the grid-return circuit was connected – see **Figure 2**. In this diagram the modulation is shown introduced via a series modulation transformer for clarity, but was more likely to have been a carbon microphone in the ground return or a series modulator tube back in the 1920s. W6KQ didn't claim to be the originator, either, and I suspect that it was such an obvious and cheap way to modulate a transmitter that it was in widespread use in those days. The use of AM on the amateur bands was new back then, and modulation transformers and chokes were very expensive. So, cathode or series modulation in the filament transformer centre tap was an easy way of amplitude modulating a carrier, along with absorption modulation and its variants. Heising modulation was used mainly by richer amateurs, who could afford the expensive high-current chokes, and grid modulation by those who wanted high power, but without the expense of large modulator tubes and

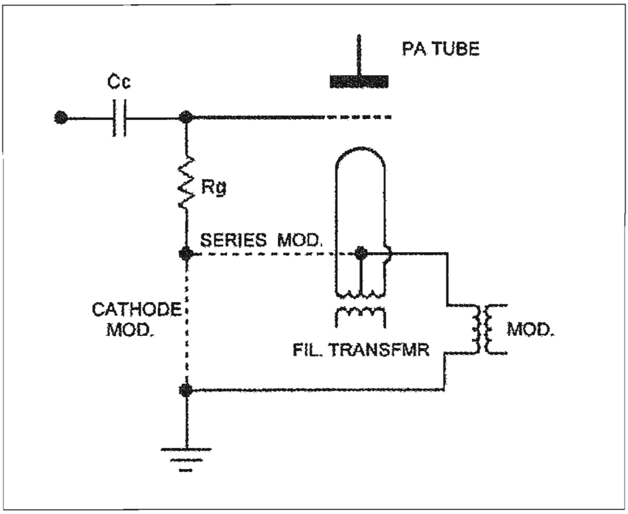


Figure 2: Circuit of a triode PA stage showing different grid return connections for series and cathode modulation.

transformers.

What Happened in the Intervening Years?

Developments in vacuum tube technology led to the use of increasing power levels on the amateur bands by the 1930s, and for those who could not afford to build plate-and-screen modulators the use of grid modulation was simple and economical. The use of cathode or centre-tap modulation would still have required a larger modulator tube than grid modulation, and in the Depression this could well have been a big deciding factor for anyone trying to build a medium or high-power AM transmitter. The fact that 100% modulation couldn't be achieved easily, and the envelope was a bit distorted, wouldn't have bothered most amateurs then. They were on the air on AM phone, and that was all that mattered! There were probably still amateurs using centre-tap modulation, or series cathode modulation, in the late 1930s when Jones wrote his first article on cathode modulation, but he could well have been unaware of them.

The Japanese Connection

Jones was a professional radio engineer, as well as an amateur radio operator, and would have been reasonably up-to-date in his knowledge of developments in radio technology. A good deal of research on modulation methods was done in Japan in the 1930s. During 1933, T. Hayasi worked on cathode modulation, and reported his work the following year (*"A NEW SYSTEM OF SIMULTANEOUS GRID AND PLATE MODULATION"*, *Report of Radio Research in Japan*, July 1934, Vol. 4, No. 2, pp57-60). His explanation of the technique showed that he fully understood how it worked, and simultaneous modulation of the grid and plate was specifically mentioned in the title and the body of the report. Evidently, Hayasi thought that the method was new, and claimed it to be so. This "new method of modulation" was reported in Europe (*WIRELESS ENGINEER AND EXPERIMENTAL WIRELESS*, Number 138, Vol. XII, March 1935, p151), so it would surely not have escaped notice in California. It may have taken several years to percolate through to Jones, but surely he couldn't have missed it entirely! It would have been very surprising if he'd missed the February 1938 article by Geiger and McGrath in *QST* as well. I think he chose to ignore the latter because he was well into writing his new book by then, and the staff of both *QST* and *RADIO* aided him by making exaggerated claims on his behalf.

Discussion and Conclusions

It is very difficult to decide whether to credit Hayasi with the invention of cathode modulation, or not. Certainly, he was the first person to publish an explanation of how it worked. Frank C. Jones definitely did not invent it. And, if amateurs were the first to use pure cathode modulation rather than series modulation, then this honour may actually belong to some unsung hero of the amateur ranks, who generously shared this knowledge with his fellow amateur enthusiasts with no thought of staking a claim on the idea himself. Centre-tap modulation worked, and for many years it was used successfully without anyone doing a systematic study of it. There appears to have been no recognition of the difference between series and cathode modulation in those early days of AM, and the circuits used by early proponents of centre-tap modulation could have been either. Hayasi was undoubtedly the first to explain in print how the technique worked, and this may be how Jones first heard about the idea. Jones was an excellent engineer, and recognised the advantages of this technique. He wasn't a genius, though, and his lack of candour about where the idea came from and his failure to recognise earlier articles on the subject are reprehensible.

Cathode modulation never really caught on in broadcasting. In the 1930s, the BBC was rapidly expanding its national network, and all the new transmitters that were installed then used series modulation to obtain good modulation characteristics economically. They could easily have used cathode or centre-tap modulation, but chose not to for good reason. Their experiments with the technique showed that the high-order sideband distortion did not fall off rapidly enough to give acceptable interference levels on adjacent channels when the drive and PA loading were set for full modulation. This is a point worth bearing in mind if you have complaints about broad transmissions with cathode modulation. All methods of amplitude modulation have some inherent distortion, as does the modulator itself, of course, but the type of non-linearity is important. Where the higher orders of distortion (higher harmonics of the modulation frequencies) fall off uniformly and rapidly, the further out high-order distortion sidebands disappear below the noise level, even for a strong signal, and the transmission will not seem to be too wide. But, when the non-linearity is such that the magnitudes of the high-order distortion sidebands level out, or are greater further out than those of some distortion sidebands nearer the carrier, then the transmission can seem very wide indeed. It is possible that the BBC found that the non-linearity of their cathode-modulated power amplifiers was of the latter type, and consequently abandoned it. The type of non-linearity may be very dependant on the combination of modulator and PA tubes used, and at low and medium power it might be possible to find suitable combinations that produce the right sort of non-linearity to be acceptable on our current, crowded bands. Don't let my comments discourage you from experimenting with cathode modulation. As far as I can tell, the BBC only tried cathode modulation with a series-tube modulator. There are other ways of achieving cathode modulation with chokes and transformers, which may produce better linearity more easily. Have a go, and see how it works out. You might be pleasantly surprised at what can be achieved with simple equipment, if the combination is right! Alternatively, if you want a sure-fire, low power, economical AM transmitter that doesn't require a modulation transformer, you might prefer to build K2ORC's series-modulated design (ER #178). For higher powers, however, it's worth experimenting with cathode modulation, just to keep the size and cost of the modulator down.

ER

Controlled-Carrier Modulation

By Bruce Stock, AB7YD
537 33rd Ave. S,
Seattle, WA 98144

Controlled-carrier is an idea that has been around for a long time, with the first QST articles on the subject appearing in 1935. Although it has been used on literally thousands of Ham transmitters over the years, there is still a lot of misunderstanding about its operation and usefulness. In this article I hope to shed some light on controlled-carrier modulation and perhaps stimulate some interest in its possibilities.

The operation of the most common form of controlled-carrier modulation (hereafter called just C-C) is simple: the AM carrier level is dynamically adjusted in relation to the loudness of the modulation. This allows you to run a reduced carrier level until you need the full power output. The advantages are reduced average dissipation in the RF tube and lower average drain on the power supply. Another benefit comes if you use a C-C transmitter to drive a linear amplifier, because the linear will also run cooler.

Although Drake, Knight and Hallicrafters used C-C modulators in their smaller transmitters, it is probably Heathkit who produced more C-C modulated transmitters than any other manufacturer. Heath used them in the DX-35, DX-40, the Cheyenne, the Seneca and the DX-60 series. In all of these designs, the C-C modulation was applied to the screen voltage of the final tube, so in effect all of those C-C modulators were a special type of screen modulator. In this article, I'm going to focus primarily on the C-C screen modulator form, but remember that C-C is not limited to screen modulation.

One question that usually comes to

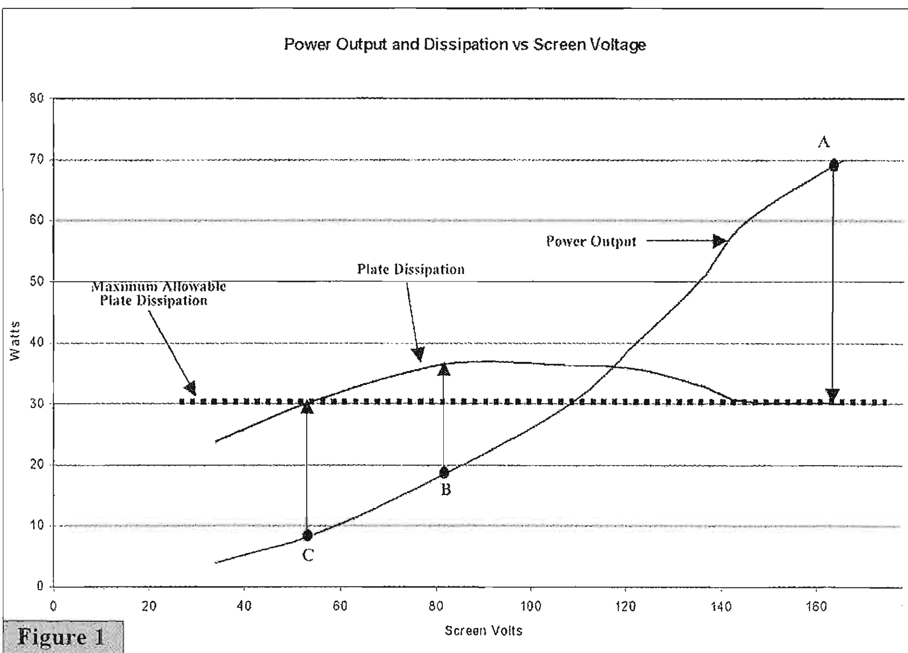


Figure 1

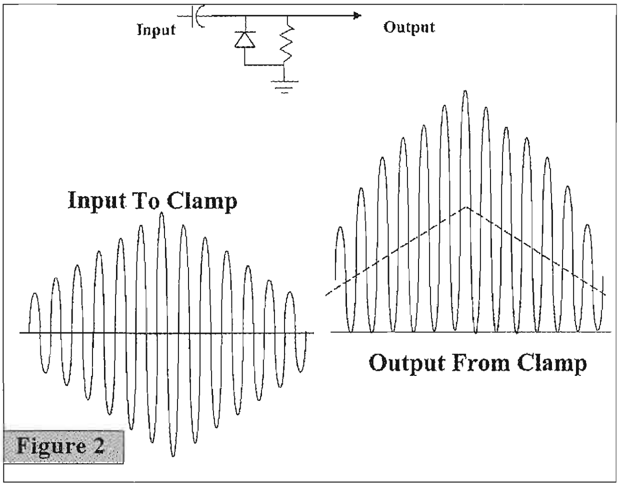


Figure 2

dropping. This is due to the reduction in efficiency of the tube as the screen voltage falls. At point B, the screen voltage has been reduced to the point where the carrier level is now 1/4th of the CW PEP value. This is where we would expect to set the screen voltage for a standard screen modulator, but notice that the dissipation at point B exceeds the safe rating of the tube (follow the arrow upward to the dissipation curve).

mind is: how does C-C screen modulation compare to other types of modulation such as standard screen modulation and plate modulation? For a given type of final tube, plate modulation will always produce the highest modulated peak envelope power (PEP), because the modulation voltage adds to the tube's plate voltage to provide the increased power output. Since screen modulation of any type does not change the fixed B+ level from the power supply, it can only produce modulated peaks equal to the CW PEP output of the tube.

C-C screen modulation and standard screen modulation seem similar, so why pick one over the other? The short answer is that C-C screen modulation allows you to achieve higher modulated peak envelope power without over dissipating the RF tube. The reason why is rather subtle, and it has to do with the way the efficiency of the tube falls off when the screen voltage is reduced.

The data in **Figure 1** was taken on a 6146B running in a DX-60. Point A is where you would run a typical RF final tube to operate at its maximum CW power output rating and still be within the allowable limit of dissipation (follow the arrow downward to the power output curve). As the screen voltage is reduced, the dissipation in the tube actually goes up even though the output power is

In both standard screen and C-C screen modulation, the screen voltage must be set somewhat lower than Point B so that the tube can again operate within its rated dissipation (Point C). The maximum modulated PEP of the standard screen modulated tube will be limited to 4 times this lower carrier level; however the C-C screen modulator can still achieve the full CW PEP output level because it automatically increases the screen voltage up toward Point B with modulation. Therefore C-C modulation allows the resting carrier to be set as necessary for safe dissipation and yet still attains the maximum available modulated PEP from the tube.

Practical Circuits

The Heath, Drake, Knight and Hallicrafters C-C modulators were all very similar in design, so I will describe only the Heath DX-60 circuit here. At the heart of each of these C-C modulators is an audio clamp circuit. **Figure 2** illustrates the action of a simple diode clamp. With the diode polarity as shown, the negative peaks of the incoming waveform (the audio signal) are *clamped* to ground. The output varies in amplitude with the input signal, but the negative peaks never swing below ground. Reverse the diode polarity and the positive peaks will never go above ground level.

Another way to think about the output waveform of the clamp is that it is exactly the same as the input waveform but has had a DC level proportional to the amplitude of the waveform added to it. This average level is shown by the dotted lines on the right-hand waveform. Hmmm, could we use this DC level to automatically increase our screen voltage with modulation amplitude? The answer is yes indeed.

When you look at the Heath DX-60 C-C screen modulator circuit of **Figure 3**, it is hard at first to see how the C-C action is produced. The secret is that the first triode section acts as an amplifying clamp circuit. The grid and cathode of the first triode act as the diode part of the clamp, with the grid serving as the anode of the diode. Thus, the audio waveform at the grid is clamped so that its positive peaks never go above ground level.

The first triode section also inverts and amplifies that waveform and sends it on to the cathode follower output section that provides the necessary drive power to modulate the RF tube's screen. The clamped audio signal rises upwards from the resting output level of the second triode. It is the average level of the audio signal above this level that causes the C-C increase in screen voltage of the RF tube. This is both very simple and quite slick.

The parallel R-C circuit at the output of the 6DE7 couples the modulator's output to the screen of the RF final tube. Without this R-C combination, the negative modulation peaks would never go below the resting carrier level. With it, the negative peaks can go all the way down to zero (or beyond, if you over modulate). The optimum value of the resistor allows both the positive and negative RF modulation peaks reach maximum simultaneously. If a different value is used, either the positive or the negative peaks will begin to flatten out before the maximum percentage of modulation can be reached. The value of C is chosen to produce a time constant similar to the R-C combination at the input of the modulator.

Heath experimented quite a bit with the values of the R-C time constants for the modulator. In the earlier transmitters the input time constants were rather short (5-10 msec); while in the DX-60 series they were lengthened quite a bit (to 110 msec). This time constant affects the hang-time of the carrier, which is the period of time that the carrier remains at the boosted level between words and sentences. Longer hang times make it more pleasant to copy because the background noise doesn't jump up and down so much at the receiver; however this benefit comes at the expense of somewhat more tube dissipation.

Some Food For Thought

In brief summary, the benefit of the C-C screen modulator is that it allows you to hot rod the modulated RF tube somewhat in order to gain the maximum PEP output consistent with tube dissipation. Both C-C screen and standard screen modulation provide an easy way to add AM capability to a transmitter, but the C-C screen modulator will provide a greater PEP output.

C-C screen modulators are simple, requiring only a microphone preamp such as a 12AX7, and a modulator tube such as the 6DE7. The 6DE7, 6DR7 and 6EW7 are all useful dual triodes, and each has a different dissipation rating of the output triode section.

If you have a transmitter with one of these C-C modulators in it, spend a few minutes with a scope looking at the audio going through the 6DE7 tube and you will get a much clearer understanding of its operation.

Some listeners have objected to the pumping up-and-down of their receiver's S-meter when they are listening to C-C modulation. Because of the changing carrier level, C-C modulation behaves somewhat like an SSB signal. And just like SSB, the proper way to receive it is with the receiver AGC set to a longer time constant. Unfortunately, some receivers only provide a fast AGC time constant when receiving AM.

Theoretically speaking, you could set the resting carrier of a C-C transmitter all

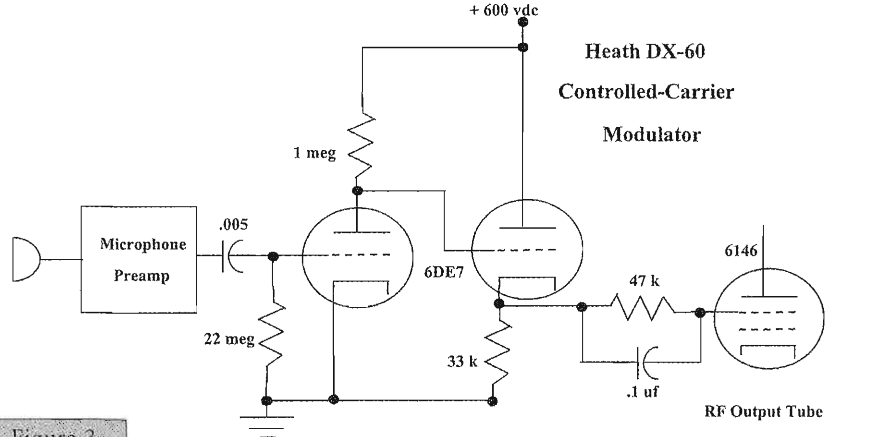


Figure 3

Controlled Carrier Modulator

the way down to zero. That's right, no signal coming out whatsoever until you speak! While this reduces the RF tube's dissipation to the absolute minimum, it is not a desirable condition because the aggressive rising and falling of the carrier causes the background noise to vary annoyingly at the receiving end (unless a very long AGC time constant is used). The AM C-C modulator in the Drake TR-3 transceiver comes close to this condition because its resting carrier level is only a few watts.

To consider the opposite case, the C-C resting carrier level could also be set all the way up to the maximum PEP level of the tube. In this case you would have to automatically reduce the carrier level with modulation, in order to keep from flat topping on the positive modulation peaks. You've probably heard something very similar to this when someone runs one of the modern solid-state transceivers on AM, but has set the carrier level too high. The solid-state rig's ALC keeps dropping the carrier level down in order to keep the maximum PEP within ratings, and that is what causes the downward modulation seen at the receiving end.

It is also interesting to think about ways to design a C-C screen modulated transmitter that would provide higher output powers. Since screen modulation does not increase the output voltage of the power supply, how can we increase the PEP output of the RF final? One way is to use more tubes in parallel. Every time you add a tube you increase the resting carrier level and the achievable PEP out. The Knight TR-150 is an example of this and it uses a 6DR7 to modulate two 6146 tubes in the final. The tradeoff is more RF tubes instead of a plate modulator.

One could also get more PEP out by raising the fixed B+ value to the final tube. This would of course increase the dissipation in the final, so you'd either have to pick a higher dissipation tube or else lower the resting carrier level to reduce the average dissipation.

C-C modulation isn't just for small transmitters, as you can see at: http://www.transmitter.be/con-419f2.html, where a 250KW broadcast transmitter uses C-C. In that transmitter, the output power is reduced several db when there is little or no program amplitude present.

That is probably more than you ever wanted to know about C-C modulation, but I hope there have been some interesting things here for you to think about. Keep in mind that a 2-tube C-C modulator is a quick way to add AM to a CW-only transmitter. I've used it to modulate military transmitters such an ARC-5 and a Bendix TA-12C with excellent results in both cases. ER

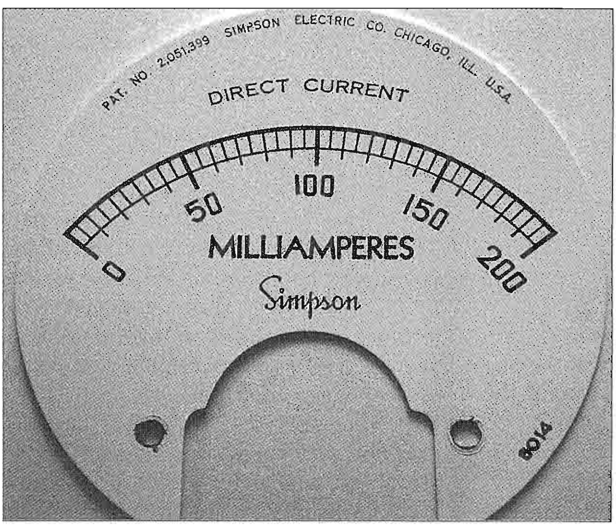
Modify a Meter Face for Your Homebrew Project

Another Meter Labeling Process

By Tom Marcellino, W3BYM
13806 Parkland Drive
Rockville, MD 20853
w3bym@logonmd.net

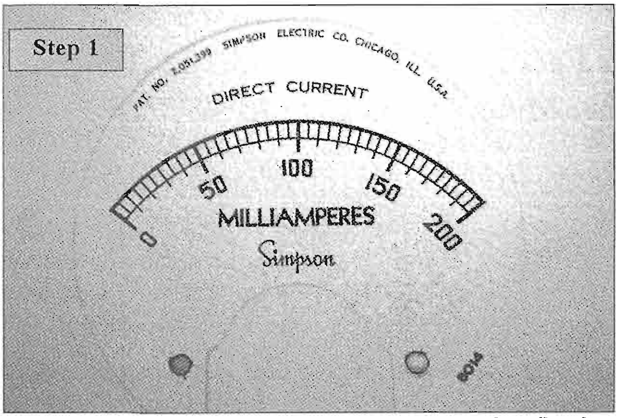
There are several methods that can be applied to modifying a meter face. In my many years of building equipment I've used several techniques. One I used with good results was to take an ordinary pencil eraser and remove the information not needed and then using dry transfer lettering apply the new information. Then along came the nice little tape label machines. With dry transfer lettering getting difficult to locate, this machine provided the required lettering. I presently use a machine that makes different size fonts and prints these with black on clear or white on clear 9mm tape. Many other tapes and color combinations are available for this machine.

Although we are dealing with vintage equipment, many ER readers have some high tech gear in the shack or somewhere in the QTH such as a PC, scanner and printer. With my set up, I can copy from the scanner and print directly to the printer. This is an excellent method because it maintains the physical size of the final meter face. If one has access to a copy machine it would work just as well. Before starting this process you will obviously have to select the meter. I have a thing for panel meters and can't resist laying down one or two dollars for a meter at the hamfest. I usually don't pay attention to the scale or electrical function of the meter because more often than not these will be modified for a project. Meters of high sensitivity in the 50 to 500 micro-amperes range are especially nice to have in the junk box. As a result I have several boxes of meters in stock for my homebrew projects.



The original meter dial scale before relettering.

The best advice I can give is to select a meter scale that fits your need. Don't use a scale where you will have to interpret the needle reading to get the results. I suppose there is software available that would provide for making the proper scale but in lieu of that the scale is the most important part of my process and must be retained. My method is a four step process. It involves several scan to printer operations with a final scan to an 8x10 white label sheet.

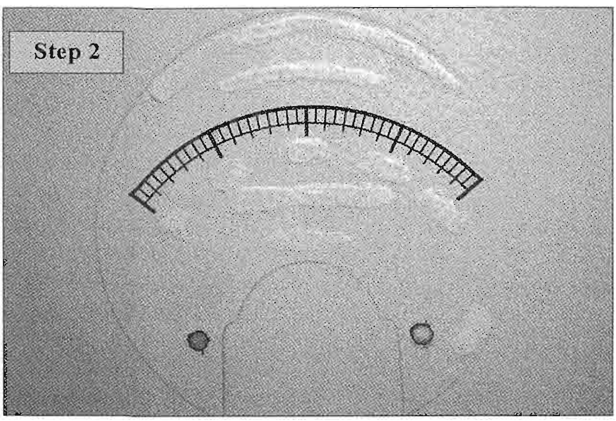


You now have the original exact meter face on a new piece of copy paper.

Step 2

Here's where you can remove all unwanted information. I use correction fluid, also called "white out," to do this job. Depending on the paper quality, the fluid will be absorbed at different rates. Using my copy paper, it took about three coats of the fluid to cover all the unwanted information. Caution: the printer ink will tend to dissolve with repeated brush strokes. Therefore don't go over the same area repeatedly until each coat has dried. This fluid has a dying time usually several minutes. The results are shown in the **Step 2** photo. These photos were purposely taken underexposed for the article but in real life are white on white.

The label is the final product which is attached to the back of the meter face. As shown in the original photo, page 17, the meter face has been removed from the meter. The next operation is important for indexing the finished meter face to the back of original meter face. Using a lead pencil or sharp ink marker placed in the meter face mounting holes make two



rings. These rings will show on the copy paper for all steps of the process. I used a piece of tape rolled on itself to attach the original meter face to a sheet of copy paper for step one.

Step 1

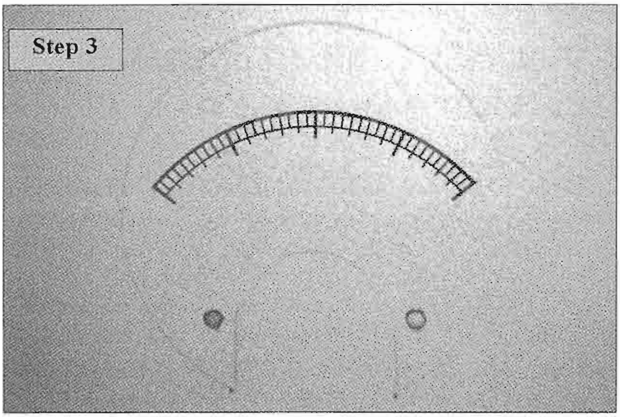
Place the meter face that is attached to the copy paper on the flat bed scanner. This results in the photo shown in **Step 1**.

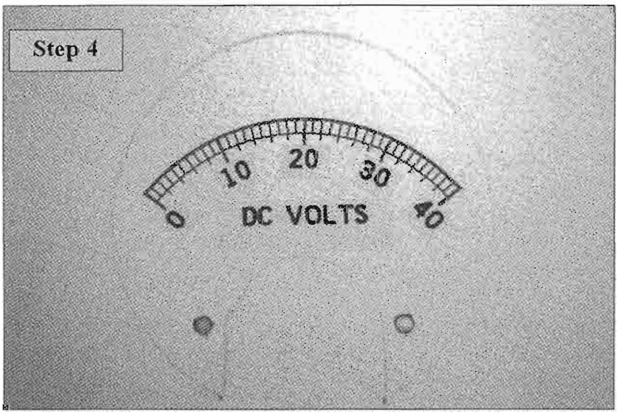
Step 3

When the Correction Fluid has completely dried, place this copy sheet on the flat bed scanner. This will result in the **Step 3** photo. At this point you should have just the meter scale and the two index rings showing on a new piece of copy paper.

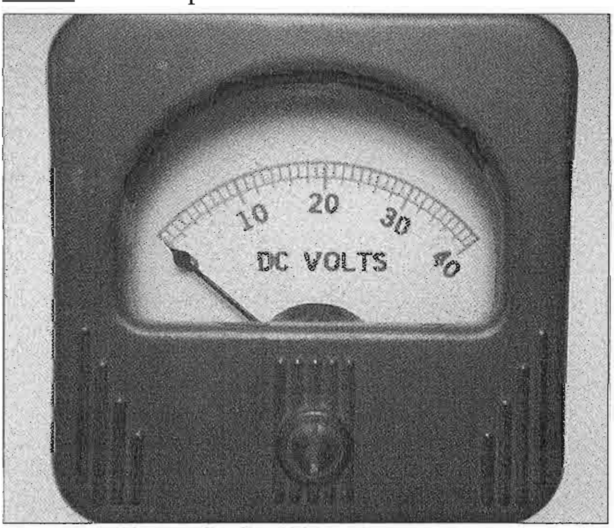
Step 4

Now is time to apply new information using the label machine. The photo for this step shows the clear tape outline and some darkness from the clear tape. This isn't a concern because it will disappear in the final scan. For a final check I scanned the copy sheet from **Step 4** to one additional copy sheet. This can be bypassed with the alternate choice of scanning directly to the white label sheet. But I prefer to do the final scan to save a piece of label sheet if there is a problem





Below: The completed meter with a relettered scale.



with the label information. Also the final scan-to-copy paper allows positioning in the scanner in preparation for the final scan to the white label sheet. Once the final product is on the label sheet, I use a small sharp pointed knife to poke through the two index holes. The label is removed from the sheet and using the index holes lined up with the back of the original meter face. Now just press the label to the meter face, trim off the excess and the job is done. Using the back of the original meter face preserves the front for original use or making another modified face. The label making machine, copy paper, correction fluid, label tape, and 8x10 label sheets are available from your local office supply store. I would suggest that the high end labels be purchased to obtain the better adhesive and long lasting non-yellowing white. If you want to make a meter face really stand out, a non-white label color can be selected. The whole process takes about one hour, and the final product is shown with the new meter face mounted in its black meter case. The process as described sounds very involved but it really isn't. The result is a professional looking meter face that will make your homebrew project look outstanding.

ER

The American VHF-AM Equipment Gallery

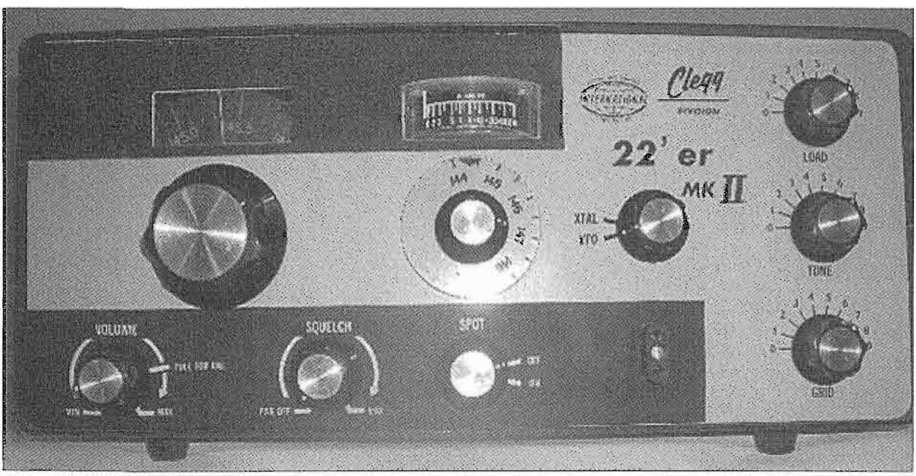
Part 3, The Clegg 22'er MKII, 2-Meter AM Transceiver

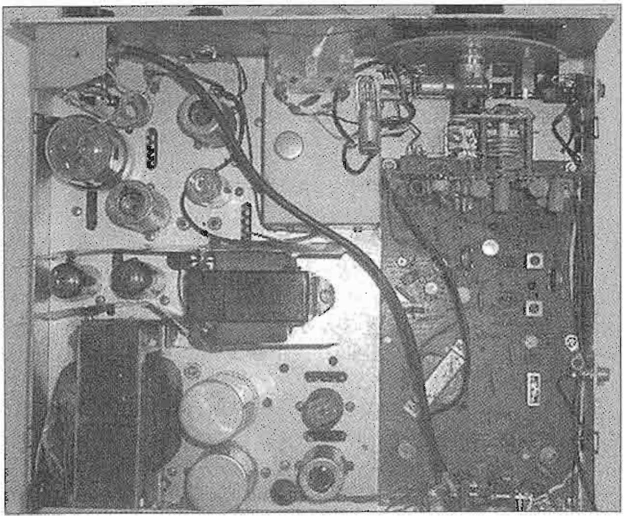
By Jim Riff, K7SC
9411 E. happy Valley Rd.
Scottsdale, AZ 85255
k7sc@arrl.net

When the well-known and common Gonsets came on the market in the 1950s, they established the standard for compact VHF transceivers. The combination of receiver, transmitter, and power supply in one package was a new and exciting concept. Many companies offered 2-meter components, but Faust Gonsett (W6VR, SK) combined them into one system and made mobile and base operation possible with one compact package. These Gonset Communicators have been written about extensively, so we will focus on the other companies who challenged this technology with their own designs.

In continuing the series of upcoming articles, I will cover 3 more of the 2-meter AM tube transceivers that competed for market share in the then fast growing 2-meter market. Today with the growing interest in 2M-AM activity in the US, these old tube boatanchors have become increasingly popular. The operation, maintenance, repairs, and just collecting of these giants has become easy and fun. ***The continued use of AM may help preserve our AM privledges on 2M!***

Clegg Products, of East Hanover, NJ, under the direction of Ed Clegg (W8LOY, SK), went through many changes during its lifetime. During the existence of the company, several owners were in control of the Ham products division, these included Squire Sanders Inc., International Controls Corp., and Ed Clegg himself. Clegg produced many VHF products during their years of operation, such as high quality receivers and high-power transmitters. The popular 22'er and its related family were early 1960s Clegg products, but the 22'er MKII, **Figure 1**, below, was a last ditch effort by Clegg's International Controls Division to participate in a fading AM market. As the transition to FM and solid state replaced the bulky tube designs, Clegg was caught in the changeover with the very limited production MKII. The 22'er





The Clegg 22'er chassis is clean, well laid out and very easy to service.

MKII has an excellent solid-state receiver, and a powerful, all-tube transmitter. Although capable of mobile operation, the MKII was too large and heavy to be used in modern automobiles. Not knowing where the market was headed, Clegg soon faded from the scene after a short attempt in VHF solid-state mobile FM transceivers.

The 22'er MKII is a superb performing, sensitive, and easy-to-use design that makes this a great collectable, and a fun 2-meter AM boatanchor. Some minor changes did occur during the production run of the MKII, such as front panel paint scheme variants and the application of various RF PA tubes. One change used the 8150 Compactron in place of the 6883B. Both tubes seemed to produce the advertised 25 watts output, and only the socket was changed in the design. The change did not change the performance, as these tubes yielded the most powerful RF signal of any of the transceivers of the day. Drift was a specification all of the equipment of the dayto be contended with. Both the VFO and the receiver needed several minutes to settle down to a stable operating condition, but that was typical of the technology of the day. The chassis was well-arranged and easy to work on, see **Figure 2,** left. One of the minor quirks was the operation of the power-on function, as the switch was located on the squelch control, and required that it be rotated fully counterclockwise to release the audio and acknowledge the unit was indeed functioning. The rarity of the MKII may be attributed to the lack of advertising done in the late 1960s, or the fact that this was the last hurrah for Clegg and they just did not care to promote if in face of the FM craze that swept the market.

Pros: Push-pull (Class AB) 6973 (6BQ5) modulation, high power, 25-watt RF output, sensitive FET-RF amplifier receiver front end, variable-ratio VFO and receiver tuning, VFO or crystal controlled transmitter, Murata mechanical IF filter, and had a dual-speed tuning knob on the receiver with an easy-to-read dial.

Cons: Very heavy, unique 6883B or 8150 (6146 derivative) RF PA, odd power on/off switch incorporated into the squelch control, runs very warm—but not hot—and manuals may only be available on CD.

Specifications: 117V and 12V operation, PTT, excellent .25μV sensitivity, 12-kc selectivity, weight 25 lbs., size 12 X 5 X 11 inches. They cost $395 in 1969.

Conclusions: Expensive and rare, these great looking boatanchors make fine workhorses for the growing 2-meter AM nets (144.450 MHz) forming across the country. They are reliable and easy to work on and make an all-around, pleasant 2-meter AM rig.

ER

The AM Broadcast Transmitter Log

Part 10, PDM and Ampliphase BC Transmitters

By David Kuraner,K2DK
2526 Little River Rd.
Haymarket, VA 20169
k3dk@comcast.net

As we receive more input from readers, additional broadcast transmitters can be presented. This month we feature one more 1-kW box which Bob Raide (W2ZM) has in his collection. It uses the original digital method of producing amplitude modulation. The Continental 314R-1 is one of the transmitters that introduced the technology to the broadcast industry over thirty-five years ago. We feature this particular transmitter because it is quite interesting, employs vacuum tube technology and he did convert it to the Ham bands.

Two other transmitters we will discuss are a bit more than most Hams would care to deal with since they are at the 50 KW level. The Harris MX-50 is a high power PDM rig. The RCA Ampliphase 50 KW is another attempt to create amplitude modulation for the standard broadcast band with greater efficiency than traditional plate modulation. Both of these high power transmitters were originally for AM broadcast service and converted for short wave broadcasting.

Along with this discussion of alternative modulation methods, we will discuss your options should your modulation transformer or reactor loose its smoke!

The Continental 314R-1

The Continental is using vacuum tubes to produce analog AM with what is actually a digital technique. Pulse Width Modulation (PWM) or Pulse Duration Modulation (PDM) switches the RF stage on and off. The transmitter has three 3-500Zs. Two are in the RF final stage and one is the modulator performing the on/off switching in what is called class D operation. All other stages are solid state.

This PWM/PDM has several advantages including much greater efficiency, very low distortion and no mod iron. The fact that there are no transformers or even choke reactors in the power supply, permits less than 1% distortion and a flat audio response similar to an FM transmitter. The modulation percentage is set by adjustments allowing both positive and negative limits to be set independently. It is normally run with close to 100% negative and 130% positive.

In order to achieve a flat audio response, the output network is a filter network rather than a conventional tuned circuit. The filter consists of three synchronously tuned parallel circuits with sharp skirts on each side of the center frequency. It permits the full audio spectrum to pass unimpeded. Remember that a conventional output network does influence the sidebands and audio response because of the circuits Q and will attenuate audio frequencies as they are further removed from the center carrier. Bob removed two turns from each filter coil to get the rig to tune to 160 meters. That was it!

The oscillator is driven with ½ watt. Just a bit more than a standard VFO. So, Bob uses a Viking 1 through an RF attenuator. The driver is a pair of mosfets coupled into the final by a broadband matching circuit. Audio feed is the standard 600 ohm input.

This box is much lighter and smaller that many of the standard broadcast AM transmitters. It weights in at 720 lbs and is 69" high, 32" wide and 25" deep.

The Magic of PWM/PDM

The modulation starts with a 70 kHz oscillator which has the modulator tube turn the final RF stage on and off at that rate with 50% duty cycle.. The modulation is applied when the on time of the digital pulse created by the switching is varied by the amplitude of the instantaneous analog signal. The average output power is now varying at an audio rate and is exactly proportional to amplitude of the modulating signal. This, of course, *IS* amplitude modulation.

The 70-kHz oscillator is actually a saw tooth or triangle wave form rather than a sign wave. The sloping ramp up signal is fed into a comparator circuit along with the modulating analog information. (A vacuum tube version of a comparator can be found in the peak flasher circuit of a professional AM modulation monitor.) As the value of the slope of the 70-kHz oscillator exceeds the analog signal value, the comparator commands the modulator tube to switch the RF on. It will stay on until the triangle or saw tooth value falls below the analog signal value. Notice how the pulse width is varied by this mixing within the comparator. See figures.

The transmitter will have the 70-kHz signal component as well as the original analog audio. A special filter is used to eliminate all of the 70-kHz component. Without this, 140 kHz of spectrum space would be used by this transmitter.

This technique is employed in currently used transmitters such as the Harris MW-50A, 50-kW AM transmitter which was originally manufactured in the early 1970s. This transmitter uses two 4CX-35000s in series. One as the RF stage and the other as the modulator. To get an appreciation for the size and power involved, consider this: an 807 (I mean the 12 oz kind) compared to a full keg. Yes digital techniques are being used with vacuum tubes to produce AM. However the MW-50A is no longer made as this vacuum tube technology is over 35 years old.

There are even better approaches for state-of-the-art AM broadcast transmitters which really get involved in the digital realm. Its hard to believe but there are now solid-state AM broadcast transmitters at the one megawatt level! They use a system called Digital AM Modulation. Audio is digitized and used to turn on separate RF modules which when combined produce AM. Let us be thankful for this advanced technology as it replaces the transmitters now showing up on the Ham bands.

In amateur circles, we have a sub-culture of AM activity using PWM/PDM modulation techniques with solid state circuits. The individuals spearheading this method of producing our beloved "Angel Music" are making new devoted converts as people hear just how great it sounds. But it all started with hollow state devices. The Continental 314R-1 is a beautiful testament. And there is no reason that a similar hollow state transmitter can not be HB. It would be quite an adventure. Remember, it has great audio, great efficiency and no mod iron. Three powerful incentives for the more adventurous among us to give it a try!

The RCA 50 kW Ampliphase

And, speaking of being adventurous, Chuck Teeters (W4MEW) actually experimented with a low power version of the RCA Ampliphase modulation scheme as described in Electric Radio #131, March 2000. For comparison to PWM/PDM, I will briefly describe Ampliphase Modulation also called out-phasing modulation.

The RCA Ampliphase used two phase modulated FM transmitters to produce AM as the phase difference between the two changed. About 3 dozen may have been placed into regular service about 35 years ago. It was extremely difficult to keep adjusted correctly. It claimed the advantage of lower weight and less initial and operating costs. Two RCA Ampliphase 50-Js still exist, intact, and are currently for sale. Several were remanufactured as plate modulated transmitters and used for short wave broadcasting. No original transmitter can be identified as still in service. For more information, refer to Chuck's original article.

While phasing for AM may not be practical for the amateur to implement,

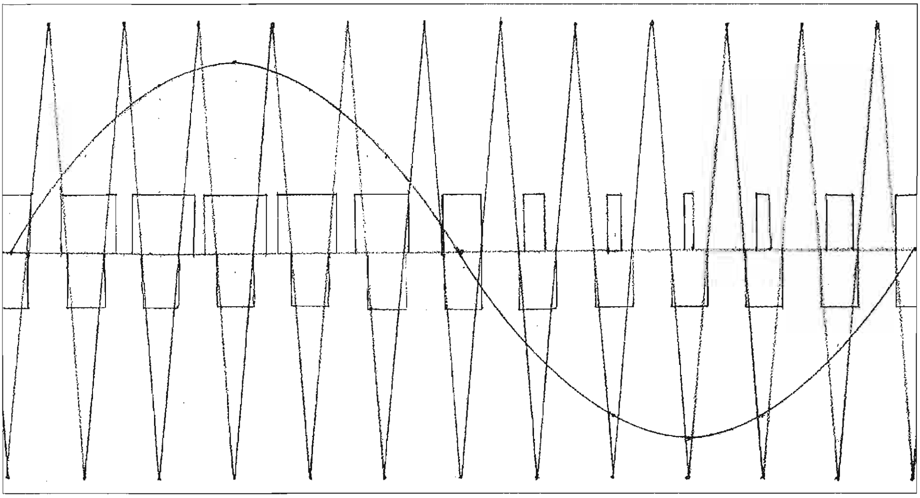


Figure 1. Pulse Width Modulation. The negative pulse train is shown for width comparison. The positive pulses vary in width, or time duration, with the modulation (sine wave). Note that the evenly spaced 50% duty cycle pulses start and stop as the triangle waveform crosses the zero volt, X axis. When both signals are fed into the comparator, the position of the X axis changes along the Y axis. The X axis is now changing with the modulating waveform. The triangle waveform crossings takes place at different points in time than does the half-on, half-off pulse train.

the Continental 314-R-1 is proof that PDM is both very practical and sounds great. Today with modulation transformers made from extreme-expensium and unobtainium, PDM is worth exploring for that HB project or if you should need to replace any modulation iron in that broadcast transmitter. Just remember that there may be a hidden reason that the BC rig was taken out of service, lying around for decades and given to you to haul away.

The Maintenance Log

Loosing some heavy iron in a broadcast transmitter is going to be a very expensive repair. HV transformers may be a bit easier to substitute and absolutely essential since you are dead in the water without themt. This leaves the modulator iron. The 50-H chokes of the size needed are not readily found nor are the modulation transformers. You may be faced with either purchasing new iron or getting your defective one rebuilt. If you're lucky you might find a substitute from some other broadcast rig being parted out.

If you can not find replacement iron, since you have the RF section still functional, why not modulate it with something other than plate modulation. A pair of 4-400s will produce very close to the legal limit when screen modulated. Both the 4-400 and 833A will respond very nicely to series cathode modulation. So keep the article I wrote in April 2005, ER #191, in mind. With this circuit, you would not need line level input, but do build it inside the transmitter's cabinet. Also, this may be the perfect opportunity to explore a PDM conversion. And, another suggestion will be offered when we explore some 1930s equipment.

Next month we will discuss bringing a common Ham transmitter up to broadcast standards.

73, Dave, K2DK

ER

The KDØZS Equipment Notebook

The New Viking Valiant, Part 2

By Chuck Felton, KDØZS
1115 S. Greeley Hwy.
Cheyenne, WY 82007

In Part 1 of this article that appeared last month in ER #203, I discussed my approach to setting up a transmitter's modulator. The designed-in problems with the Johnson Viking Valiant speech amp were outlined, and my redesigned speech amplifier and driver for the Valiant was presented. I briefly discussed the LED compressor circuit.

A system block diagram of the new Valiant is shown below in **Figure 1**.

Speech Compression

The outboard, aftermarket speech processors have a fast rise-and-fall peak compressor functioning as peak limiter, a long time constant AVC functioning as a compressor, and various forms of tone control or EQ so that the radio voice matches the inner voice; or something like that.

Unless a person has classical voice training, or plays a wind instrument, the support or intensity of the voice—I think of it as focus—varies a lot from word to word, or even syllable to syllable. With an uncompressed voice, this can cause loss of words and phrases because of marginal receiving conditions. As far as sculpting the voice goes, EQ, choice of mike, and your mike technique, there is infinite room for improvisation here. The velveteen voice of broadcasting, Barney Fife on the cop band, your mother-in-law on the telephone, all show that you could go a lot of ways, or not. Mobile mikes, used the way they were meant to be, give good voice presence and signal-to-noise ratio. A studio mike may also give good presence, but requires a studio, and in this case a preamp.

More Technical

In the new Viking Valiant, the LED is an audio compression "signal sender". It is packaged with the photocell, as pictured in **Figure 2.** It is schematically located at the modulator output, see **Figure 3**. The photocell is the compression control element and controls audio gain at the second audio amplifier, the triode half of the 7199 stage that was shown on page 40 of ER #203. **Figure 3** is the circuitry that follows the modulation transformer and shows how the NE-51H peak indicator, the selected LED, and the clipping threshold control are referenced to the HV bleeder center tap.

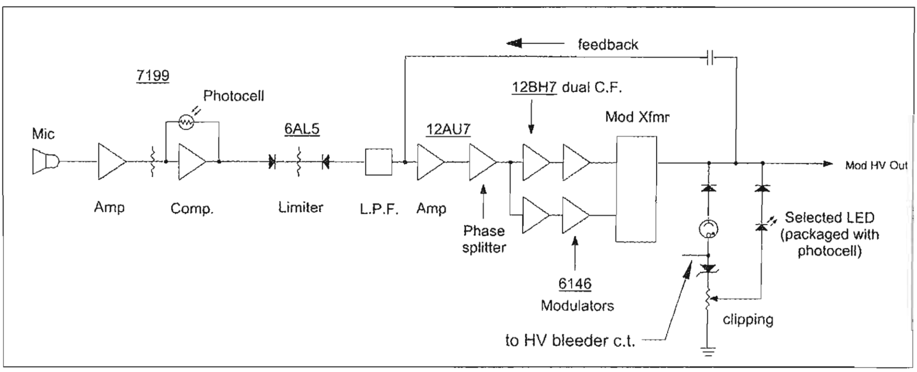


Figure 1: Block diagram of the new Viking Valiant transmitter.

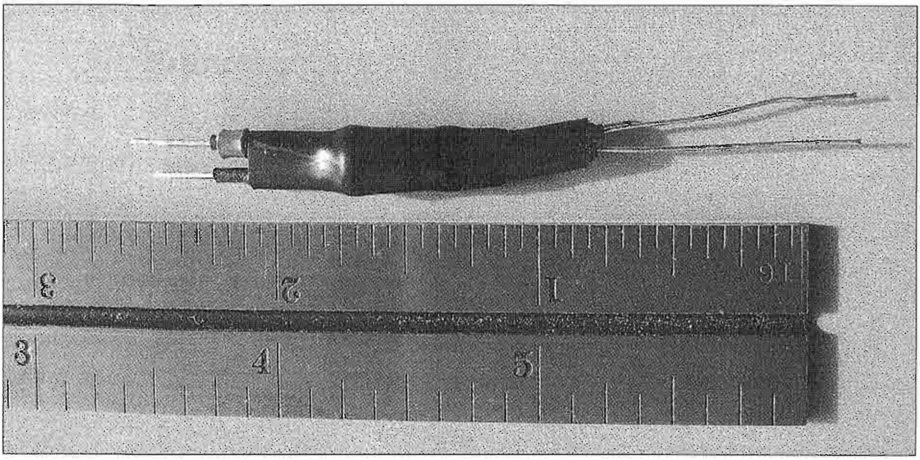


Figure 2: The LED/photocell combination is packaged into a light-tight assembly.

The compressor trigger threshold is referenced to the AC waveform at the modulator output. The plate voltage of RF final and modulator is about +800 volts. The RF final cuts off at about +100 volts. At 100% modulation the audio waveform goes from +100v to +1700v. A properly adjusted clipper/peak limiter will prevent the modulator from exceeding this. Distortion generated at these peaks is suppressed by unbypassed cathode resistor current negative feedback, and voltage negative feed back around the modulator-driver. These changes also suppress transformer ringing.

As the waveform drops below about +200v, it generates a negative-going control signal for the AVC/compressor. The AVC doesn't begin to function until the peaks of the voice are approaching 100% negative modulation. The real time modulation indicator (NE-51H blinking light) allows a feel of this very dynamic situation. The limiter will not allow 100% to be exceeded in either direction. The AVC control signal of negative going pulses is LC filtered to level the voice from syllable to syllable. In other words, it's slower than sounds such as the beginning of the letter T, but is faster than words. It averages over the course of a word, and lets the spikes through. The clipper takes care of those. Photocell response time is also a factor.

The AVC signal of several volts DC is applied to the LED-resistor combination. The LED-resistor light output appears to be linear with voltage. By about 10 volts, the resistance of the illuminated photocell goes from about 5 Megohms to 10-k ohms. This reduces the gain of the controlled 7199 triode stage to a very low value. This circuit can be applied to any tube or FET voltage amplifier. The method of obtaining control signal encourages high modulation percentage and prevents over modulation. It's the get-the-message-through design approach. In fact, there's little audible distortion that occurs, as long as you don't hit the clipper too hard.

Additional Improvements

Figure 4 shows changes to the bias adjustment circuitry. These changes were made to make it easier to set the bias voltages by having the pots operate in the center of their ranges.

The transmit/receive relay that switches the high voltage transformer will arc and snap much less with a .05µF, 1-kV damping capacitor across the contacts. The relay coil also needs a 10-µF, 250-VDC bypass capacitor from the supply side of the coil to ground for crisp

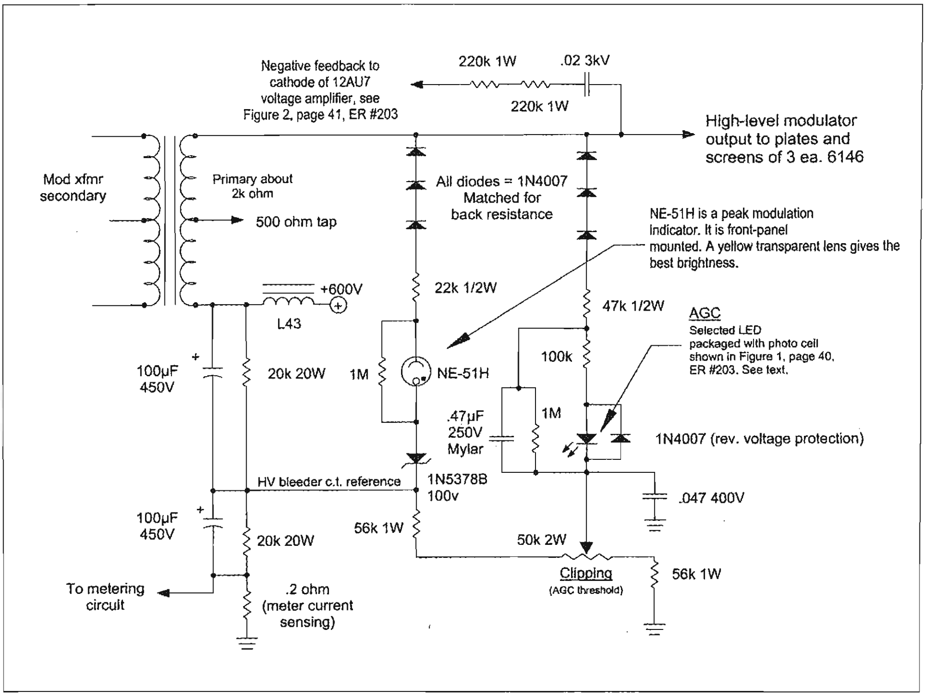


Figure 3: Schematic diagram of the circuitry following the modulation transformer.

operation.

Originally, spot and transmit frequencies were different on the higher bands. This was caused by long leads

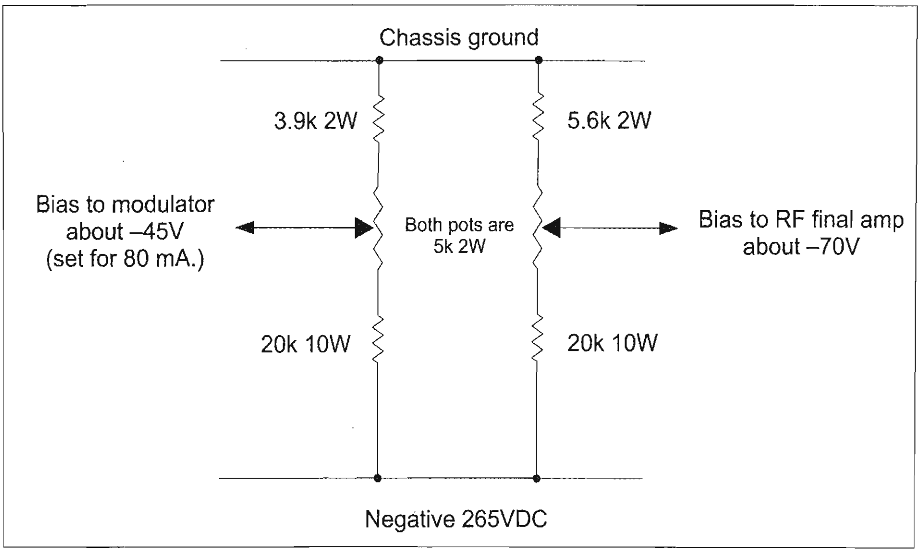


Figure 4: Bias adjust circuit changes.

between the mode switch and the VFO, which detuned the VFO output. Remove those leads, and couple directly from the VFO plate to the buffer grid with a 50-pF, silver-mica capacitor. This change improves VFO stability. The crystal option goes away, but it could be restored with a separate crystal oscillator.

I installed a new front-panel mike jack. It is isolated from the front panel, and grounded directly at the new 7199 audio amplifier base via both shields of a length of RG-55.

A Switchcraft insulated stereo jack, #N112B will fit a Collins mike plug!

The RF output tank components tend to die because of audio superimposed on the modulated RF. To cure this problem, add a sturdy 2.5 mH air-core choke to ground at the output jack. This keeps audio off of the output tank.

[Editor's note: Chuck is making his optoisolator available to readers from the ER Store as a preassembled package like the unit in Figure 2. Please see the ordering information on page 61.]

ER

AM Calling Frequencies

160 meter band: 1885, 1945 kc. In the Midwest, listen on 1980 and 1985 kc.
80 meter band: 3870, 3880, 3885 kc. In the Midwest also try 3891.
40 meter band: 7200, 7290 kc national calling frequencies. Also 7295 in the Midwest.
20 meter band: 14.286 Mc
15 meter band: 21.400 to 21.450 Mc. Try CQ on 21.4, move up for QSO
10 meter band: 29.0 to 29.1 Mc
Try CQ on 29.0, move up for QSO
6 meter band: 50.4 Mc
2 meter band: 144.450 Mc

Vintage CW Calling Frequencies

80 meter band: 3546 kc
40 meter band: 7050 (+/- "Fists" club)
30 meter band: 10120 kc
20 meter band: 14050 kc

[Comments, from page 1}
mail is in a separate category at the US Postal Service. It is handled differently and is much slower than even media mail. For reasons known only to the post office, the periodicals class can be unreliable and inconsistent due to the way they handle it. We typically replace between 10 and 20 lost or damaged periodicals issues every month. I have seen some subscribers receive their periodicals-class issues in 5 days, and the next month the same address takes 4 weeks. The reason a dealer in your local area has his copies before your periodicals issue has arrived is because he received them from the UPS truck driver, while the periodicals are still floating around somewhere in the postal system.

Note: Classified Ad Deadline Changes

Starting sometime this summer we will be sending the monthly issues to the printer earlier. My goal is to have all the periodicals-class issues delivered earlier to readers. What this means is that ***the classified advertising deadline will change***. The new deadline will be printed in every issue. Please be sure to check the new date every month to avoid the disappointment of not having your ads printed in an upcoming issue.

ER

For a lifetime AM International membership, send $2.00 to AM International, PO Box 1500, Merrimack, NH 03054. AMI is our AM organization and it deserves your support!

An on-line, searchable index to the entire history of Electric Radio Magazine may be found under the "links" tab at www.ermag.com or at Don Buska's web site:
http://home.wi.rr.com/n9oo/ersearch.html

The Art of Amplitude Modulation

By Ray Osterwald, NØDMS
PO Box 242
Bailey, CO 80421

KO6NM's article last month in ER #203 has started some controversy and a lot of thinking about the subject of modulation effectiveness, and that is a good thing.

There are certain physical relationships between an AM carrier and its sidebands, and they can be measured in different ways based on voltage and power.

In AM, one of the basic reference levels is 100% modulation. It represents the maximum modulation capability of a conventional AM transmitter. 100% AM modulation occurs when the magnitude of the modulating signal is such that the two sideband signals produced on each side of the carrier are spaced apart by the modulation frequency. They are equal in amplitude to half of the linear amplitude of the carrier, or 6dB down.

- An AM transmitter is basically a CW transmitter whose output somehow varies at an audio rate.
- Sidebands are the most important part of an AM signal. With modulation from speech or music, they become a complex RF spectrum, they carry the information to be transmitted, and their amplitude varies in proportion to the amplitude of the original modulating voltage.
- Power varies as the square of the voltage. 1/2 squared is 1/4, so each sideband has 1/4 of the power of the carrier.

This might seem like an outrageous statement, but contrary to what has been printed in many books the carrier level in a plate-modulated AM signal does not change when modulation is applied to an RF amplifier.

Figures 1 and 2 are spectrum analyzer photos showing power vs. frequency of a 2500 kHz RF carrier modulated with a 1-kHz audio tone. The vertical scale is 10dB per large division, and the horizontal scale is 500 Hz per large division. **Figure 1** is at 100% AM modulation and has the sidebands where they belong at 6 dB below carrier. **Figure 2** is at 20% AM modulation and is showing the sidebands 20 dB below carrier. The carrier level has not changed.

If you look at the same AM signal on an oscilloscope you are seeing a wideband display of voltage vs. time. It may appear as though the carrier level increases with an increase in modulation voltage, but it is an illusion. What shows is a complex waveform that is the result of the sidebands heterodyning with the carrier.

Typically we look at the relationship

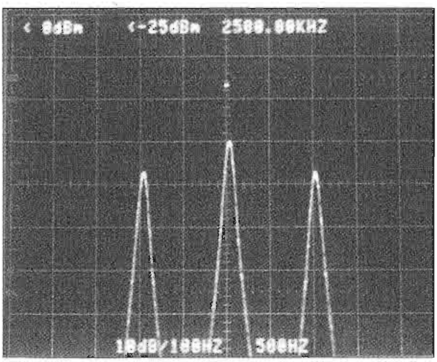


Figure 1: 100% AM modulation

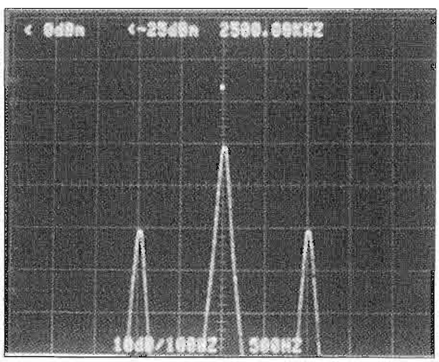


Figure 2: 20% modulation.

between carrier level and sideband level with a log reference to either power or voltage. Half (-6dB) of a 1000 watt carrier is 251 watts when referenced to power. Half of a 1000 watt carrier is 501 watts when referenced to voltage.

Thinking about AM in terms of voltage, the average RF voltage of the modulated wave over one cycle is the same as an unmodulated carrier. However, the average power does increase with modulation. You can use calculus functions to integrate the RF power over the same cycle. This will show that with 100% sine-wave modulation, the average RF power increases 50%. The power increase comes from sideband energy.

Current FCC rules rate AM and SSB transmitter output power going into an antenna system in terms of peak envelope power, PEP. This is a voltage-based measurement, and is simply how much power you get in terms of the RMS voltage across a load when modulation is at its peak. It's a convention; rarely does a Ham voice transmitter ever reach the peak value during average voice modulation. The peak is the maximum value possible at any instant in time.

Because power varies as the square of the voltage, the convention indicates that the PEP rating of this same 100-watt AM transmitter is four times the carrier power, or 6 dB greater, or 400 watts, but only if you are constantly screaming into the mic or use a lot of compression.

For an AM transmitter at 100% modulation of a 100-watt carrier, each sideband has 25 watts PEP. The power in both sidebands is 50 watts PEP. The total RF power is 150 watts, the rated carrier-based PEP is 400 watts, but does a carrier add to perceived loudness on receive?

Consider the way a receiver works. Let's keep the receiver antenna input referenced to sideband PEP and ignore antennas and propagation variables. The above-described 100-watt AM transmitter puts 50 watts PEP into a typical diode detector. The carrier merely drives the AGC circuit and the S-meter. (The carrier has an indirect effect on signal "loudness" because increasing AGC voltage will quiet a receiver. The effect is dependent on many variables.) A diode detector in a receiver converts power to voltage, the voltages of the two sidebands are said to add up, and theory says detector output should be the same for the 50-watt PEP AM signal as for the output from a 100-watt SSB signal if (a) the receiver bandwidth is 6 kc for both modes, (b) there is no interference or noise present, (c) that the AM signal is not degraded by changes in radio propagation. As yet, I have not proven this to my satisfaction.

Although Mike's graphic on page 8 of ER #203, "Composite of Relative Amplitudes" was not specifically labeled to indicate what the dB reference is, the carriers on the right vertical axis of the graph are labeled "watts," so we are looking at a power reference, and therefore the relative amplitudes in his diagram are correct. For a SSB transmitter and an AM transmitter modulated with a single tone, the percentage of occupied bandwidth per sideband is, of course, the same. The graphic does not have the horizontal axis labeled except to say that the chart is an audio sweep and a persistence view. Mike says that the width of the LSB-SSB signal was intentionally drawn wider than the width of the AM signal to emphasize the relative loudness of the two as you might hear in a receiver. The human ear is not a machine, and loudness amplitude should not be confused with PEP.

References:

Reference Data for Radio Engineers, 6th edition, Howard W. Sams, 1983.

Radio Handbook, Editors and Engineers, editions from the 12th to the 22nd. Editions featuring Bill Orr (W6SAI) as editor are especially good; see the 17th edition of 1967.

ER

VINTAGE NETS

Arizona AM Nets: Sat & Sun: 160M 1885 kc @ sunrise. 75M 3855 kc @ 6 AM MST. 40M 7293 kc 10 AM MST. 6M 50.4 Mc Sat 8PM MST. Tuesday: 2M 144.45 7:30 PM MST.

BFO CW Net: Tuesdays, 7PM local ET, 3693 kc. QSX WY3D in Southern NJ. Vintage gear welcome!

Boatanchors CW Group: QNI "CQ BA or CQ GB" 3546.5, 7050, 7147, 10120, 14050 kc. Check 80M winter nights, 40 summer nights, 20 and 30 meters day. Informal nightly net about 0200-0400Z.

California Early Bird Net: Sat. mornings @ 8 AM PST on 3870 kc.

California Vintage SSB Net: Sun. mornings @ 8AM PST on 3860 +/-

Colorado Morning Net: Informal AMers on 3875 kc daily @ 6:00 to 6:15 AM, MT. QSX KØOJ

Canadian Boatanchor Net: Daily 3725 kc (+/-) @ 8:00 PM ET. Hosts are AL (VE3AJM) and Ken (VE3MAW)

Collins Collectors Association (CCA) Nets: Tech./swap sessions every Sun. on 14.263 Mc @ 2000Z. Informal ragchew nets meet Tue. evening on 3805 kc @ 2100 Eastern time, and Thu. on 3875 kc. West Coast 75M net is on 3895 kc 2000 Pacific time. 10M AM net starts 1800Z on 29.05 Mc Sundays, QSX op 1700Z. CCA Monthly AM Night: First Wed. of each month, 3880 kc starting @ 2000 CST, or 0200 UTC. All AM stations are welcome.

Drake Technical Net: Meets Sun. on 7238 kc, 2000Z. Hosted by John (KB9AT), Jeff (WA8SAJ), and Mark (WBØIQK).

Drake Users Net: Check 3865 kc, Tue. nights @ 8 PM ET. QSX Gary (KG4D), Don (W8NS), and Dan (WA4SDE)

DX-60 Net: Meets on 3880 Kc @ 0800 AM, ET on Sun. QSX op is Mike (N8ECR), with alternates. The net is all about classic entry-level AM rigs like the Heath DX-60.

Eastern AM Swap Net: Thu. evenings on 3885 kc @ 7:30 PM ET. Net is for exchange of AM related equipment only.

Eastcoast Military Net: Sat. mornings, 3885 kc +/- QRM. QSX op W3PWW, Ted. It isn't necessary to check in with military gear, but that is what this net is all about.

Fort Wayne Area 6-Meter AM net: Meets nightly @ 7 PM ET on 50.58 Mc. Another long-time net, meeting since the late '50s. Most members use vintage or homebrew gear.

Gulf Coast Mullet Society: Thu. @ 6PM CT, 3885 kc, QSX control op W4GCN in Pensacola.

Gray Hair Net: One of the oldest nets, @44+ years ,160 meter AM Tue. evening 1945 kc @8:00 PM EST and 8:30 EDT. Also check www.hamelectronics.com/ghn

Heathkit Net: Sun. on 14.293 Mc 2030Z right after the Vintage SSB net. QSX op W6LRG, Don.

K1JCL 6-meter AM repeater: Operates 50.4 Mc in, 50.4 Mc out. Repeater QTH is Connecticut.

K6HQI Memorial 20 Meter Net: Flagship AM net 14.286 Mc daily for 25+ years. Check 5:00 PM Pacific Time.

Lake Erie Boatanchor CW Net: Sat. mornings, 7143 kc, 10:00 Eastern time. QSX op Steve (WA3JJT) or Ron (W8KYD).

Midwest Classic Radio Net: Sat. morning 3885 kc @ 7:30 AM, CT. Only AM checkins. Swap/sale, hamfest info, tech. help are frequent topics. QSX op is Rob (WA9ZTY).

Mighty Elmac Net: Wed. nights @8PM ET (not the first Wed., reserved for CCA AM Net), 3880 +5 kc. Closes for a few summer months QSX op is N8ECR

MOKAM AM'ers: 1500Z Mon. thru Fri. on 3885 kc. A ragchew net open to all interested in old equipment.

Northwest AM Net: AM daily 3870 kc 3PM-5PM winter, 5-7 PM summer, local. 6M @50.4 Mc. Sun., Wed. @8:00 PM. 2M Tues. and Thurs. @ 8:00 PM on 144.4 Mc.

Nostalgia/Hi-Fi Net: Started in 1978, this net meets Fri. @7 PM PT, 1930 kc.

Old Buzzards Net: Daily @10 AM ET, 3945 kc in the New England area. QSX op George (W1GAC) and Paul (W1ECO).

Southeast AM Radio Club: Tue. evening swap, 3885 @7:30 ET/6:30 CT. QSX op Andy (WA4KCY), Sam (KF4TXQ), Wayne (WB4WB). SAMRC also for Sun. Morning Coffee Club Net, 3885 @ 7:30 ET, 6:30 CT.

Southern Calif. Sun. Morning 6 Meter AM Net: 10 AM on 50.4 Mc. QSX op is Will (AA6DD).

Swan Nets: User Net Sunday 2200z winter 14.250Mc ±QRM. QSX op rotates Jim (WA5BDR), Jay (WB6MWL), Norm (W7RXG), Bill (W4WHW). Tech Nets: Wednesday 2300z 14.251Mhz / Saturday 1900z 7235 kc QSX op Stu (K4BOV)

Texoma Trader's Net: Sat. morning 8:00AM CT 3890 kc, AM & vintage equip. swap net.

Vintage SSB Net: Sun. 1900Z-2000Z 14.293 & 0300Z Wed. QSX op Lynn (K5LYN) and Andy (WBØSNF)

West Coast AMI Net: 3870 kc, Wed. 8PM Pacific Time (winter). Net control rotates between Brian (NI6Q), Skip (K6LGL), Don (W6BCN), Bill (N6PY) & Vic (KF6RIP)

Westcoast Military Radio Collectors Net: Meets Sat. @ 2130 Pacific Time on 3980 kc +/- QRM. QSX W7QHO.

Wireless Set No. 19 Net: Meets second Sun. every month on 7270 kc (+/- 25 Kc) @ 1800Z. Alternate frequency 3760 kc, +/- 25 kc. QSX op is Dave (VA3ORP).

Ham Radio's Twins

The Elmac Twins

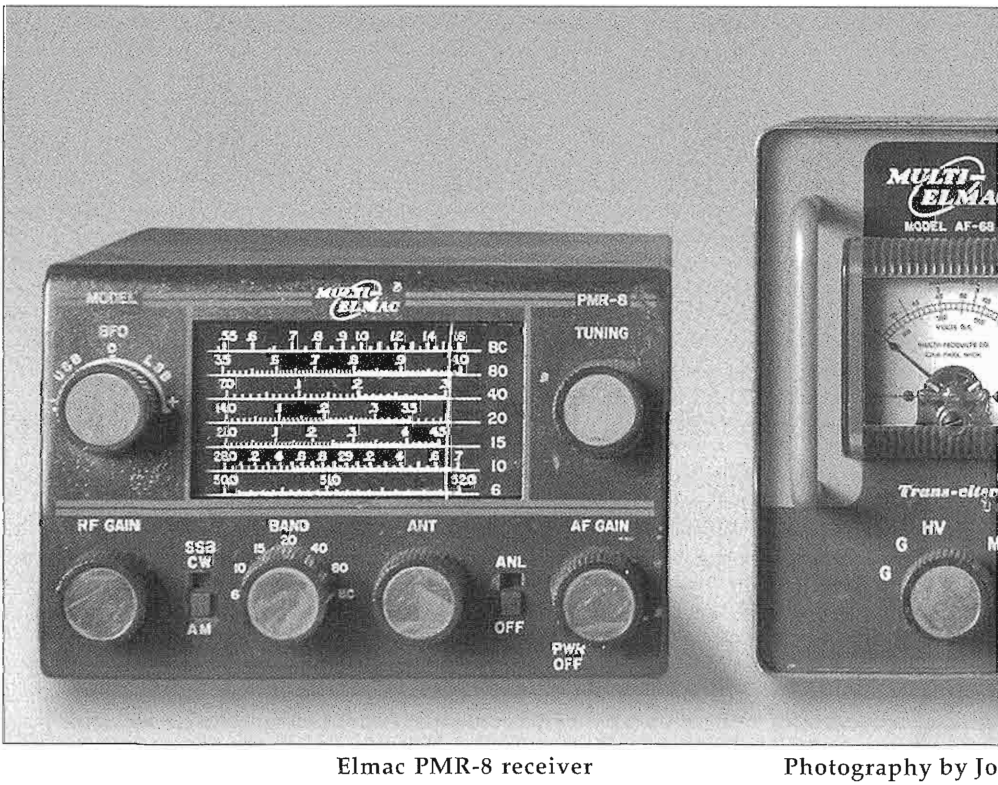
By Harold Smith, W4PQW
1435 Bush St.
Pensacola, FL 32534

The Multi-Products Company of Michigan started production of the Elmac twins in the early 1950's. The first items were the Model A-54 transmitter and the Model PMR-6A receiver. They were followed in 1955 by the Model AF-67 transmitter and the Model PMR-7 receiver, both noticeable improvements over the first models. The A-54 and AF-67 transmitters both worked 160 meters through 10 meters. The last set of the series came out in 1960, the AF-68 transmitter and the PMR-8 receiver. This set worked from 75 meters through 6 meters. Transmitters worked AM and CW modes. Receivers all had broadcast bands and worked AM, CW, and SSB modes.

All Elmacs required an external power supply and were available in three versions: 6V DC, 12V DC, and 115V AC. Other items available for the receivers were an external speaker and S-meters. My favorites in the series are the PMR-8 receiver and the AF-68 transmitter.

To better understand the complexity of this equipment, look at it through the eyes of the designer. The receiver must have the following specifications:

1. Must be double conversion.
2. Must cover broadcast, 80, 40, 20, 15,



Elmac PMR-8 receiver Photography by Jo

10 and 6 meters with nine tubes.

3. Modes must be AM, SSB, and CW.

4. Selectivity must be +/- 3 kHz at -3dB.

5. Sensitivity must be .5 μV.

6. Audio output must be 1 watt.

7. Must be able to operate on 6 or 12 VDC or 120 VAC.

8. Must have automatic noise limiter, BFO, and antenna trimmer.

9. Must be able to work as a stand-alone receiver or be compatible with companion transmitter.

With these technical requirements it must also have physical dimensions of 7 X 6-3/4 X 11 inches and weigh no more than 8-1/2 pounds. It must look nice and sell for less than $200.00 (in 1960.)

The 8-tube transmitter will have the following specifications:

1. Must cover frequencies of 80 through 6 meters.

2. Modes must be AM and CW.

3. Must have crystal or VFO frequency control.

4. Must have power input of 60 watts.

5. Must have push-pull AB 2 modulation.

6. Must be designed to use as a complete transmitter with Pi net output and to be used as an exciter for higher powered transmitters and as an audio driver for high power modulators.

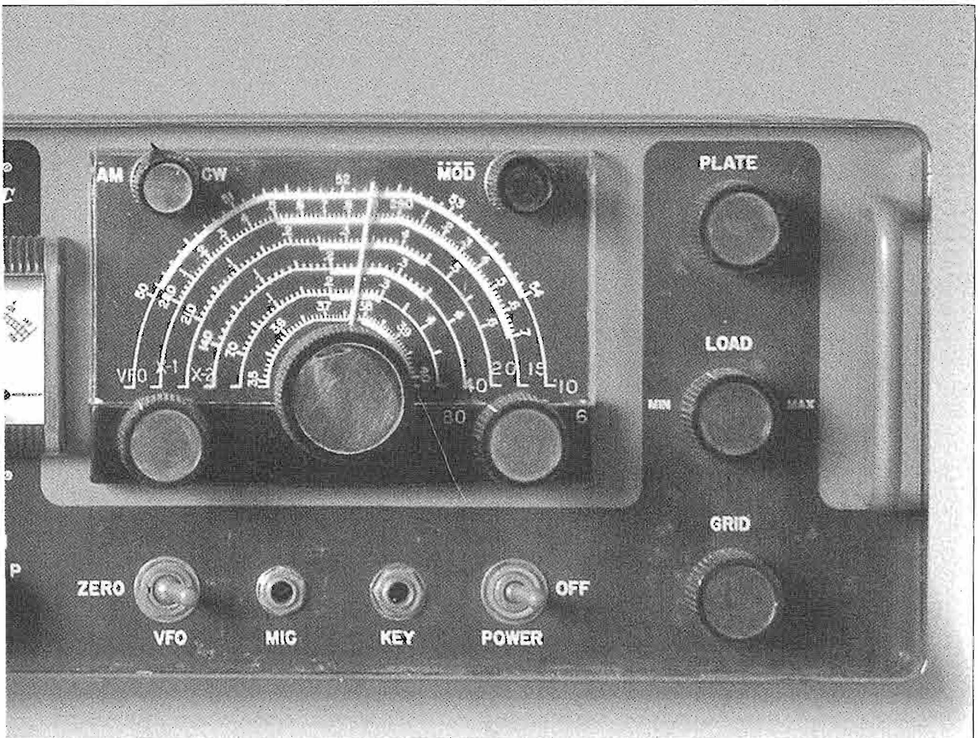
7. Must operate with carbon microphone for mobile operation or crystal microphone for fixed station use.

8. Must operate on 6V or 12V DC or 115 volts AC external power supplies.

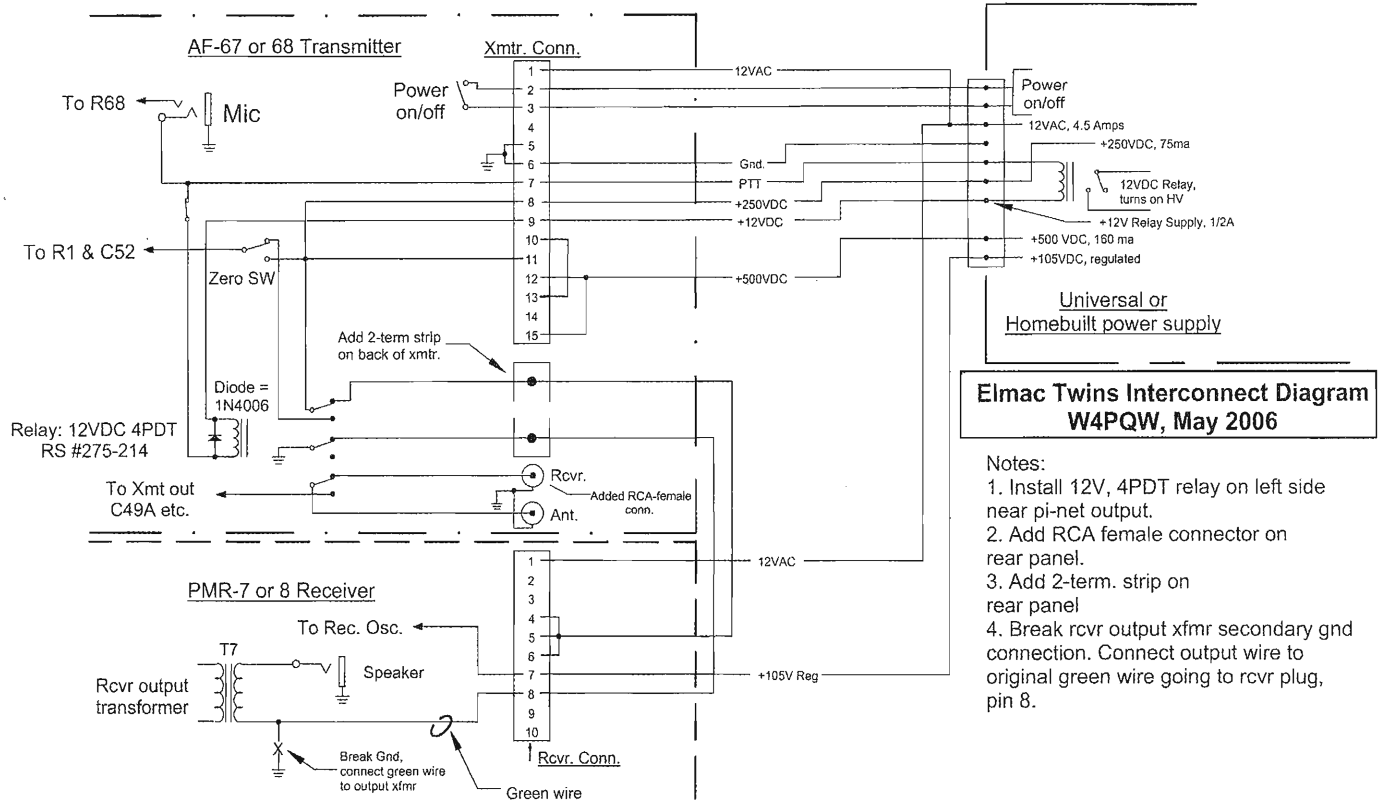
9. All pertinent stages will be metered.

10. The dimensions are 13 X 2 inches wide, 6 X 2 inches high, and 7 X 2 inches deep. Weight is 17 pounds.

11. Must be serviceable to the component level.



e Veras, K9OCO Elmac AF-68 Transmitter



Elmac Twins Interconnect Diagram
W4PQW, May 2006

Notes:
1. Install 12V, 4PDT relay on left side near pi-net output.
2. Add RCA female connector on rear panel.
3. Add 2-term. strip on rear panel
4. Break rcvr output xfmr secondary gnd connection. Connect output wire to original green wire going to rcvr plug, pin 8.

12. Must be attractive in appearance and sell for $200 in 1960.

The man that designed this equipment had quite an order to deliver but deliver it he did. The receiver is unusually stable with smooth tuning. The dial calibration and tracking are good and it has a full range RF gain control with plenty of good audio.

The transmitter is easy to zero beat with the received signal. It has easy and smooth tuning of the drive and PA tune and load. As for modulation quality, in nearly 60 years of Ham radio activity, I have never owned a better sounding transmitter.

If a person wanted to drive a small amplifier, something in the 600 watts output class, this would make a high-class AM station. Thirty-five watts from the AF68 should give about 200/250 watts linear output to the antenna. That would do the job quite well and sound good doing it.

With this type of performance, versatility, quality of construction, and ease of operation, it's no wonder that Multi-Products' line of ELMACs were so popular during the 1950s and 1960s. I remember that Elmac also produced a marine ship-to-shore AM, 2 to 3 MHZ transceiver that did quite well but never made the big time. This was probably because there was too much competition from the big names like Bendix, RCA, Raytheon, etc. The mobile Elmacs certainly held their place and made their contribution to the progress of Ham radio during the post-WWII days.

The Elmac power supplies for AC operation are very rare if they even exist. The manual shows pages of hook-up data. I am including a simplified hook-up diagram for using a universal or home-built power supply and a complete push-to-talk addition to the AF 67/68 transmitter. I hope you find as much enjoyment and satisfaction as I have experienced with this equipment, *if* there is an Elmac in your future.

ER

Direct Conversion: One More Time

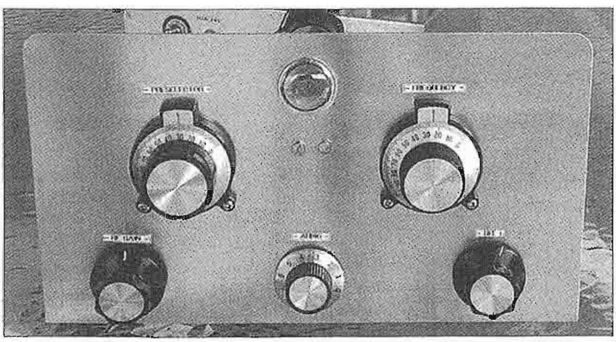
By Richard "Luke" Lucas, K4JEJ
6065 Felter Street
Jupiter, FL 33458
K4jej@adelphia.net

In these days of Bluetooth, Blackberries and iPod's, home brewing a tube-type receiver must seem pretty senseless to a lot of hams. Maybe it's one of those if-you-have-to-ask things. I consider myself among the fortunate few who remember and appreciate what our hobby was years ago, when home-brewing was a large part of it. Most of our newer hams got here too late to understand. Time marches on!

The early 70's were a unique time in our hobby and for electronics in general. It was the early years of the transistor and before integrated circuits would appear. We didn't know it then of course, but it would be the last chance we would get to enjoy the luxury of designing and building at a component level while remaining on the leading edge of the hobby. It was probably the last time that most of us could truly define and have near-complete knowledge of all the pieces, circuitry and parts it took to build the receiver or transmitter we were using.

Even the switch to solid state devices wasn't all that traumatic. You learned the personalities of bipolar transistors and then along came JFETs and MOSFETs. It was still the same game with different players and slightly different rules- until the IC showed up. Then for the first time you had to think about using silicon chips whose internal complexity was way beyond the understanding of the average ham, me included. It was hard to warm up to those things. The glory days of building stuff with individual components were over. We were supposed to think of these chips as building blocks and just how they did what they did was a mystery and proprietary information known only to the manufacturers. That's pretty scary, forbidden territory for a home brewer and about 180 degrees out of phase with anything we cared about.

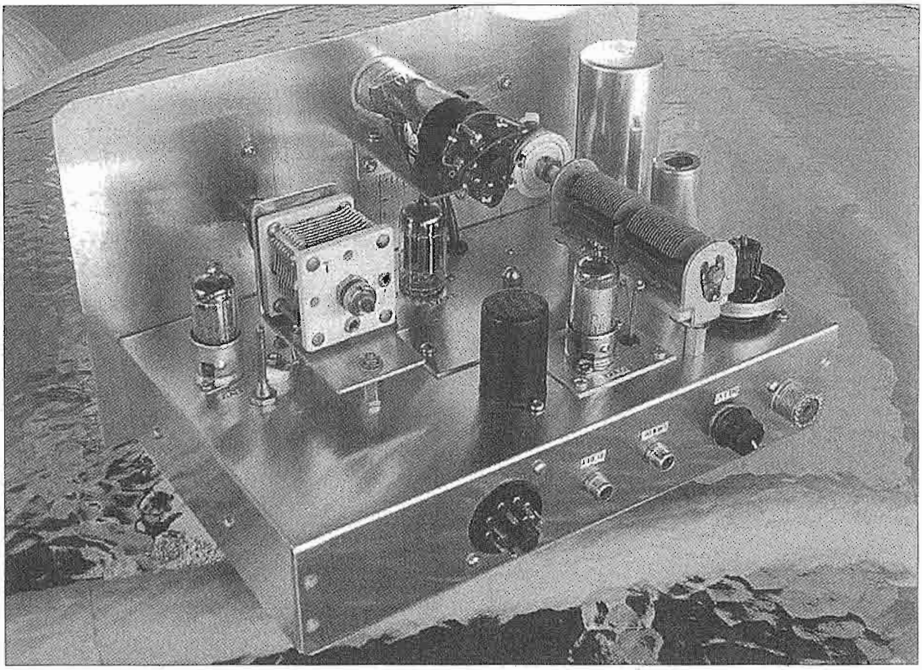
Most of us know about the explosion in electronics that took place for the next 30 years-I lived with it every day too. And I am aware of most of its benefits, like the word processor I'm using to write this article. But still it leaves a void that just can't be filled with microchips. Thankfully, there are a few of us left who still remember the art and carry it on. And thanks to the likes of Electric Radio for providing us with a means of sharing it. Good show, Barry & Ray.



Operation of a DC receiver is pretty simple. The RF gain is normally run wide open, as the AGC does most of the work. Tuning is done with the coarse "Frequency" control, then the RIT is used to fine-tune +/- 1 kc. The"magic eye" tube works like an S-meter and is fun to watch, too.

The Receiver

Speaking of the early '70s, the first reference to



There is plenty of room left for future experimenting. Adding one more tube and some crystals for filtering could turn it into a real superhet. Or a single-band, 1 tube converter could be added to cover another band.

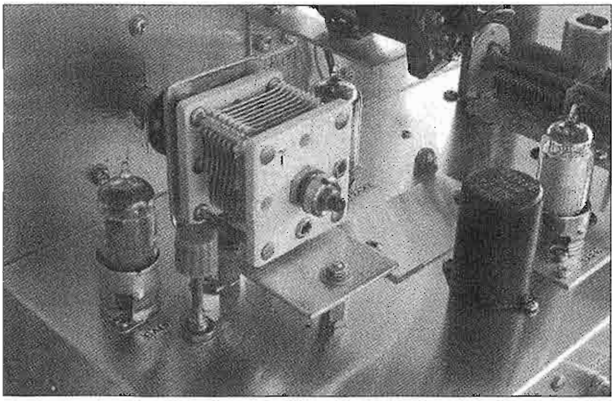
Direct Conversion (DC) receivers that I'm aware of was the early '70s Handbooks. It seemed like DC receivers made their appearance along with some of those new-fangled solid state devices. I know—I built a few of them, but I can't remember any tube-type DCs. The principles involved with direct conversion are still sound, and I've found that the results, especially for CW and SSB, are far better than a regenerative receiver of similar complexity.

The DC receiver shown here is more of a work in progress than what you could call a finished product, so it's subject to upgrades at any time. All of the normal good practices were followed, including well-filtered B+, balanced filament leads and regulated B+ for the VFO. The power supply is the same one I've used on several regens.

The Circuit

For those unfamiliar with the principle involved, a DC receiver is a superhet with its IF at audio frequencies. The heart of the receiver is the converter (mixer) tube with its input grid tuned to the frequency of choice, 80 Meters in my case. Then you feed the other grid with RF from the VFO, tuned to the same frequency, plus or minus a kc or so. This mix results in the detected audio from CW, SSB or even AM signals when they're zero-beat. Another way of looking at it is to call it a product detector with an RF input instead of the usual IF stage feeding it.

Originally I used 1/2 of a 6EA8 as a mixer but, I found the front end tuning was pulling the VFO frequency too much, so I switched to a real converter tube, a 6BE6. These tubes were designed to provide oscillator isolation and this one does its job nicely. The double-tuned 6BZ6 tuned RF stage adds a handy 10-15 db of gain; however the receiver will work OK without it, if a good, high and resonant



Above: The VFO tunes smoothly from 3.5 to about 3.95 Mc. The knob behind the tube is on the VFO coil slug. Although the mechanical rigidity could be a little better, the VFO is quite stable. The small black transformer is actually a miniature 4 Hy choke. Tuning it with a 4700 mmf condenser creates a nice 6 db peak at 800 cycles.

antenna is used. Adding the RF stage also adds another tuned circuit for better selectivity, and as a bonus, it provides a place to apply some AGC voltage. The 10-k pot is used as the RF gain control and is front-panel mounted.

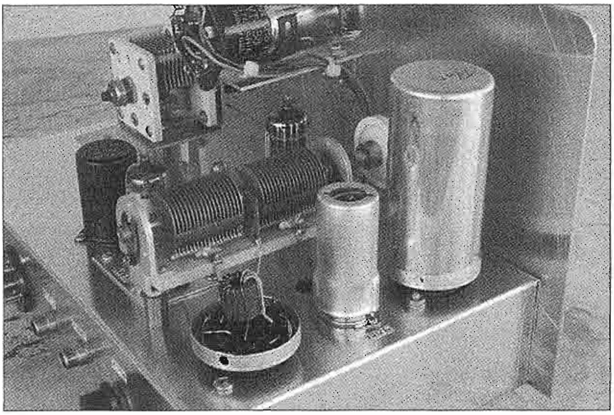
There is no trick circuitry here. The RF and converter stages are straight from the Handbook. The VFO uses a 6AU6 in a series-tuned Colpitts design. It supplies about 3.5 volts RMS volts of signal to the converter grid and also, enough RF to make my Oak Hills Digital Dial read out the tuned frequency. I included a small trimmer on the VFO cathode and brought it out as a front panel RIT control. It makes critical tuning far easier. The Main VFO tuning becomes a band-set control and the trimmer then works as an RIT with a range of about +/-1 kc from center.

Other configurations were tried. The 6BE6 could have been used as a self-excited mixer/oscillator, thus eliminating the separate VFO. I tried that but I was unable to build one that didn't have too much 60-cycle buzz on the audio. Some more work using the 6BE6 in a Hartley oscillator configuration might make sense. I notice that Drake built their mixers in their early receivers this way. Although it adds another tube, the separate VFO solves the problem and it is quite stable after a 10 minute warmup.

Taking to a tip from Ray Osterwald, I switched the converter tube to a 6BY6. The results were surprising. The 6BY6 has a bit more gain and is less microphonic than the 6BE6. It's also a lot less prone to intermod products. The 6BY6 wasn't designed as a mixer but it works well. Hallicrafters discovered that and used them in some of their later models. I didn't take any noise measurements, however the man-made and atmospheric noise is far above any tube noise at these frequencies.

Tunable hum was eliminated early-on with the addition of some .05-µF bypass caps across the power supply diodes and the power transformer secondary. To deal with the mixer tube microphonics, in my next design, assuming there is one, I will shock-mount the entire tube socket, thus isolating it from the rest of the world. This is another reason to add the tuned RF stage. It increases the RF input signal, thus lowering the need for more audio gain and all its unwanted by-products.

I thought I could get away with using unshielded, 1930s-style, air-wound plugin coils on 1–1/4" forms for the RF stage, one on either side of the 6BZ6. It looked good, but I found there was no way to make the amplifier not become an oscillator. Several frustrating hours were spent trying various schemes to stop or lessen the tendency for self oscillation. Bypassing the cathode resistor with a .01-µF capacitor is guaranteed to bring on trouble with a capital T. Eventually I



One of the coil shields in the view above has been removed to show the toroid winding. Originally 1-1/4" air wound coils were used, but the close proximity of input and output circuitry led to tons of instability.

went to plan B.

The 2 coils were rewound using a toroid cores. These toroids are virtually self-shielding and the change immediately made a major dent in the self-oscillation problems. The new coils are built into two-piece aluminum cans. A small compression trimmer was added across the antenna coil to provide better tracking of the two tuned circuits.

Probably one of the first things you notice after you've got the receiver working is how broad it is. Some selectivity is definitely needed, especially on the crowded CW bands. I was successful at rolling off the high end with the R/C network at the mixer audio output. Also, a nice 6-db bump at 800 cycles is created by using the small 4-Henry choke in the plate lead. It's parallel tuned with a .005 condenser. It adds some selectivity and makes for pleasant sounding CW when you tune it to the 800-cycle sweet spot.

Just one stage of a 12AX7 provides plenty of audio gain. I like to use an external powered speaker, which of course could be replaced with a built-in power amp stage. A 6AK6 with an appropriate output transformer would do the job nicely. The other half of the 12AX7, however, is there just to add a little *pizzaz*; read on!

A Little Bling

To this old guy, the sight of a working magic-eye tube brings back a ton of fond old radio memories. These tubes were used back in the '40s in higher end consumer shortwave radios and were usually wired into the AVC bus. The higher the AVC voltage, the more closed the eye became. Thus it became an S-meter of sorts. The addition of the magic eye brings a little fun to the receiver.

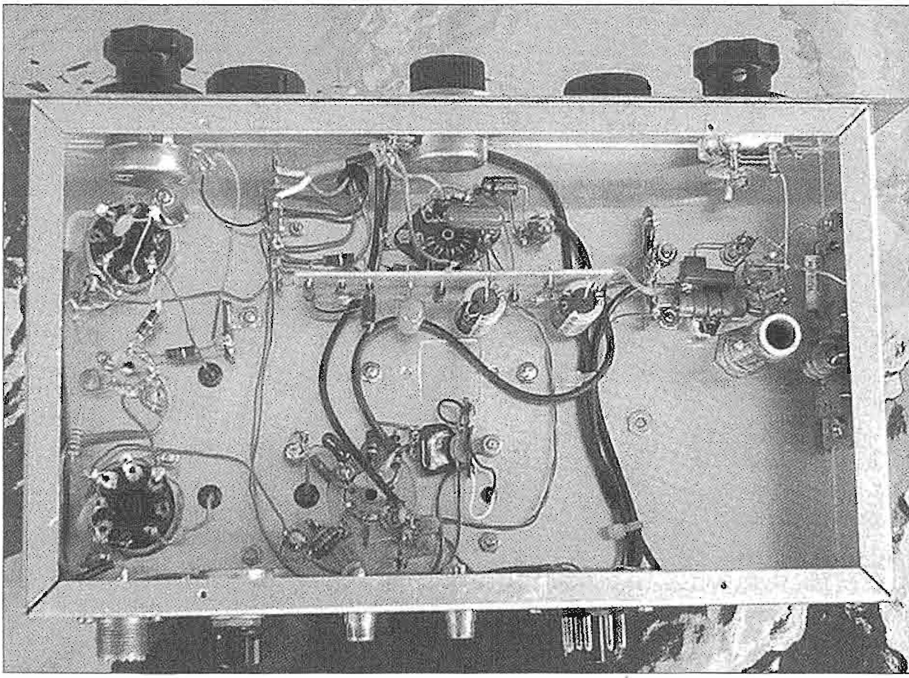
To create the necessary DC control voltage, I added the second stage of audio to feed only the fast-attack, slow release rectifier/filter. The way it's wired, the AGC voltage is independent of the volume control setting. The scheme produces about 5 VDC of audio-derived AGC voltage that feeds the 6BZ6 RF stage grid as well as the grid of the1626 magic eye tube.

The inclusion of the 1626 as a tuning aid may be questionable, but it sure is fun to watch! Very strong signals will close or even over-lap the display while the weak ones just barely move it. There's not a whole lot of dynamic range, but with a little practice you can actually read a slow CW signal by watching the eye.

Results

The AGC is not the greatest, as it's applied to only one stage, but it does a nice job of limiting the audio on strong signals. Because it works on recovered audio, it follows the keying on CW and audio from SSB and even AM signals, with the RF gain turned down a little.

The results are worth it. The AGC and the stability of the VFO make operation a pleasure. After a brief warm-up, you can park it on any frequency and copy CW or SSB for quite a while without ever having to reach for any knobs. In a side-by-side



The coil sockets and RF stage are on the left side, audio and mixer tubes in the center and the VFO components are in the right front corner.

comparison with my Drake 2-B I heard little difference in the audio. It's a real kick listening to the Europeans coming through on the low end of 80 using the home-brewed DC receiver. The RF gain control can be run full-open except on very strong signals.

A Surprise Bonus

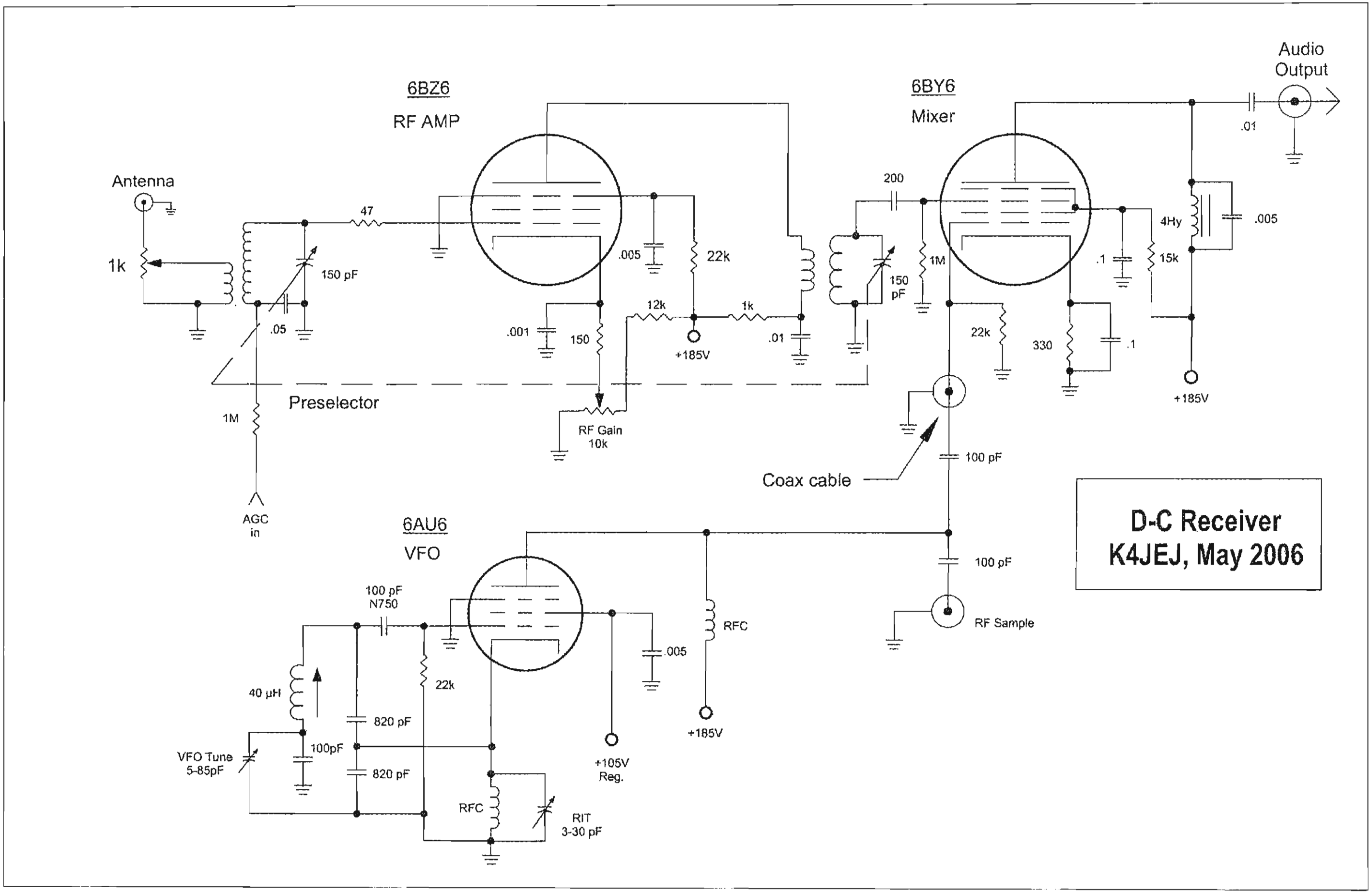
The RF input stage (preselector) actually tunes continuously from 3.5 Mc upward to slightly above 40 Meters. However, the VFO only covers the 80/75 Meter band. If the VFO did track with the RF preselector, the tuning rate would have been way too fast for even casual CW reception.

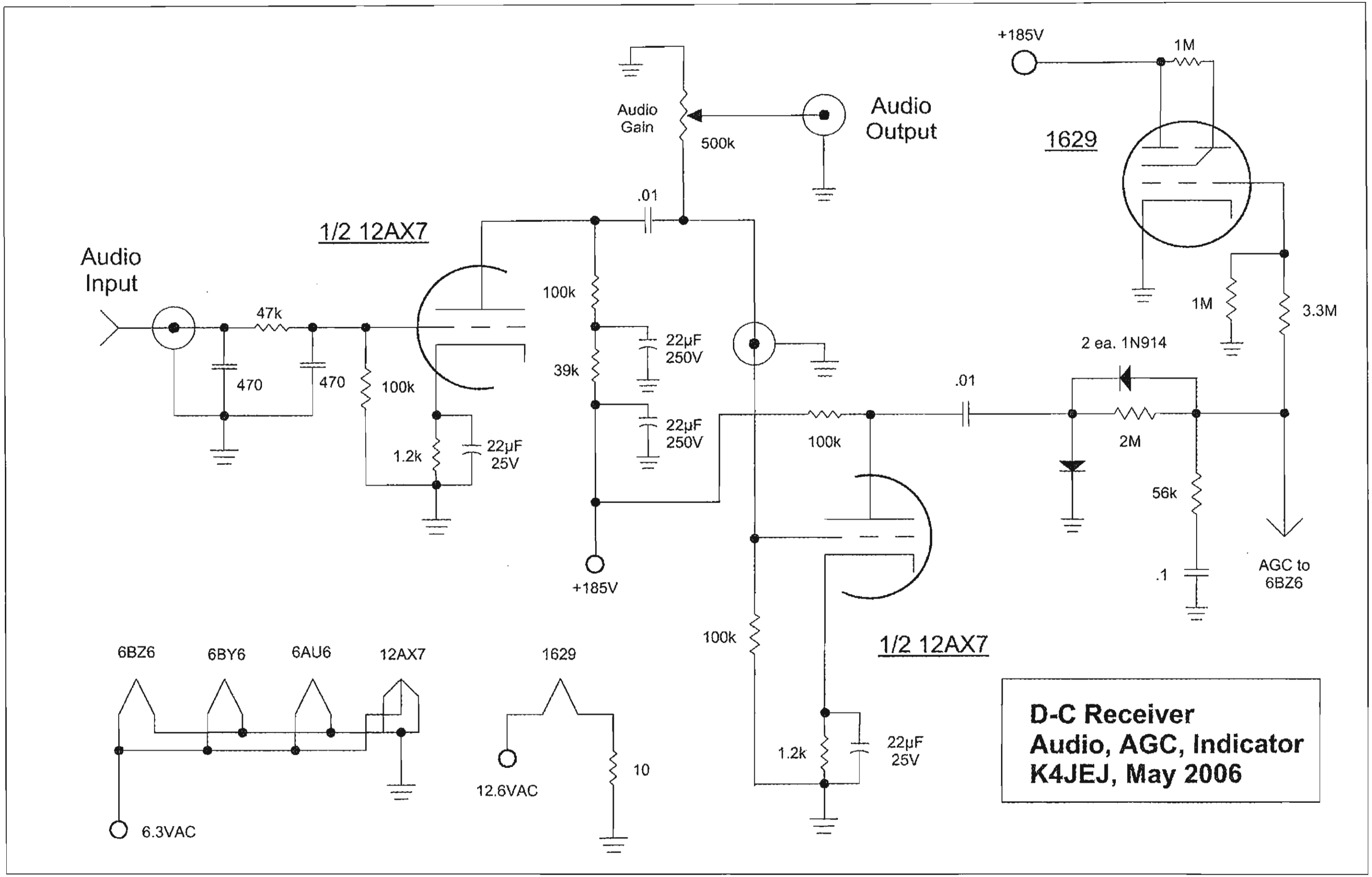
The unexpected surprise came when I discovered that the 40-meter band can be covered just by tuning the preselector to 40 meters. It seems that the output from the 6AU6 VFO contains some second harmonic (40 meter) RF along with its fundamental 80-meter output. This makes it possible to tune both the 80 and 40 meter bands without any band switching. Simply swinging the preselector tuning up to 40 meters is all that's required. I'd like to take the credit for this, but in reality it was discovered strictly by accident. The tuning rate is doubled of course, but after you get used to that, you've got a usable 2-band receiver with no band switching or coil changing needed.

Construction

The chassis is a Hammond 10 X 6 X 2 and the front panel is .04" aluminum. I replaced the tiny little knobs on the imported dials with some I can get a grip on. As can be seen in the photos, there is plenty of space for everything. Also visible on the chassis are a couple of aluminum patches I used to cover up changes as the project progressed; a necessary by-product of home brewing, I suppose.

Lately I've taken to making small PC


6BZ6
RF AMP
6BY6
Mixer
Audio Output
.01
Antenna
47
1k
150 pF
.05
.005
22k
12k
1k
.001
150
+185V
.01
200
1M
150 pF
4Hy
.005
.1
15k
22k
330
.1
+185V
Preselector
1M
RF Gain 10k
AGC in
100 pF
Coax cable
6AU6
VFO
100 pF
RF Sample
100 pF N750
RFC
.005
40 µH
22k
820 pF
100pF
VFO Tune 5-85pF
820 pF
+185V
+105V Reg.
RFC
RIT 3-30 pF
D-C Receiver
K4JEJ, May 2006


Audio Input
47k
470
470
100k
1/2 12AX7
1.2k
22µF 25V
100k
39k
22µF 250V
22µF 250V
+185V
.01
Audio Gain
500k
Audio Output
100k
1/2 12AX7
100k
1.2k
22µF 25V
.01
2 ea. 1N914
2M
56k
.1
+185V
1M
1629
1M
3.3M
AGC to 6BZ6
6BZ6
6BY6
6AU6
12AX7
6.3VAC
1629
12.6VAC
10
D-C Receiver
Audio, AGC, Indicator
K4JEJ, May 2006

boards when several components need to be soldered in one small space. This modular approach seems to make for a better job than point-to-point wiring. I put all the audio related parts on the vertically-mounted board in the center of the chassis. The VFO components are in a corner on their own PC board.

Mounting brackets and spacers were added to the air variables, as needed. Getting them to line up with the dials was made easier with the help of some flexible couplings. In case you haven't noticed, these things are becoming very scarce and expensive.[1]

A couple of well-placed brackets on the front panel and more shielding would help the mechanical stability of the VFO.

All the power enters through the rear-mounted octal socket. The audio and RF frequency sample are on the rear-mounted RCA connectors. I also included a seldom-used input RF attenuator at the antenna terminal.

Parts

Almost everything came from my junkbox. Specialty items like the 4-Hy choke and air variable caps were just lucky finds. One rule of hamfests I have learned is that most of the stuff we homebrewers are looking for is usually found under the tables, not on top. The parts are usually in old boxes whose next destination is the closest dumpster. Our job is to rescue them from that terrible fate.

The Tough Spots

My biggest challenge was with the RF stage. It loves to turn itself into a tuned RF detector and with the slightest provocation, it will start demodulating strong, nearby BC stations instead of the CW you're looking for, especially on 40 Meters. No doubt a new design is needed that would eliminate the plug-in coils and shorten all the leads to provide better isolation between input and output. Some fiddling with the RF gain control and the preselector is required for optimum listening.

So far, I haven't mentioned the one down side to a DC receiver. By design, it's a double sideband receiver and not the single-signal quality you get from a true superhet. So you hear stations on both sides of zero beat. At first it sounds a little odd, but on the positive side, this one shortcoming can be used to your advantage. If another station comes on near the one you're listening to, simply tune to the other side. This works well so long as the band is not too crowded.

What could really help the selectivity is an audio Q-multiplier, like the old Select-O-Ject, remember those? It would be easy to add a modern, op-amp style audio filter, a filter that works with those IC's that I mentioned earlier. That would sharpen up the selectivity but it still wouldn't eliminate the opposite sideband.

Rewards

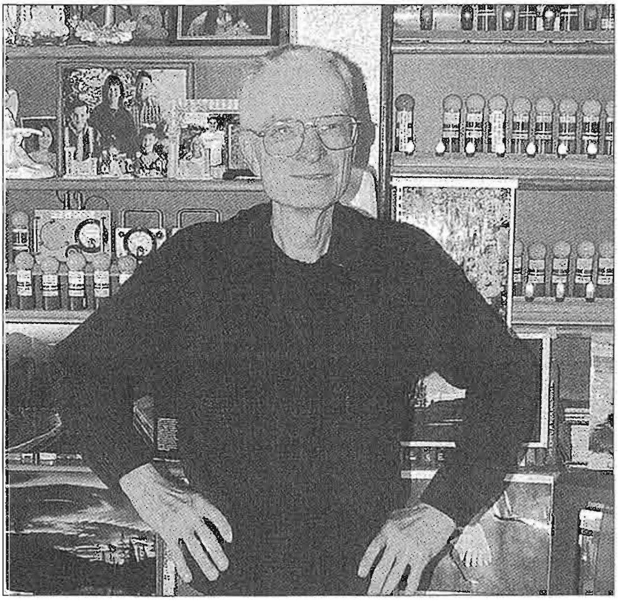
Few projects are more satisfying than building a working receiver. It has that instant gratification feel, in that you immediately get to hear the results of your efforts. Building a receiver also eliminates depending on signal reports and the opinions of others for your next step.

That magic that you hear coming out of the speaker can't be duplicated. I find that success puts me in the mood to go a little further each time. Speaking of which, it wouldn't take a whole lot of effort to turn this thing into a simple superhet—a 1750 kc IF maybe—and on it goes.

[1]Shaft couplers are available from Small Parts, Inc. 1-800-220-4242, www.smallparts.com

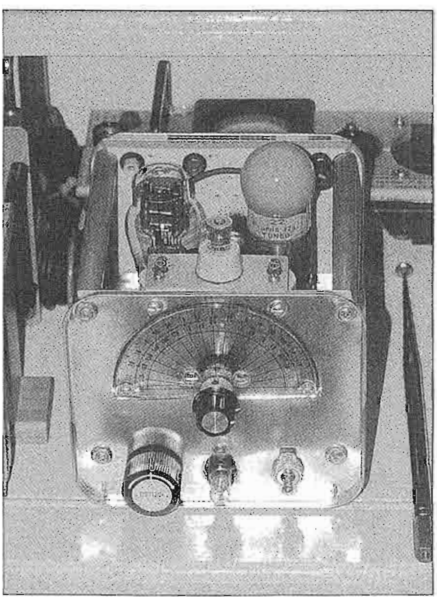
ER

PHOTOS

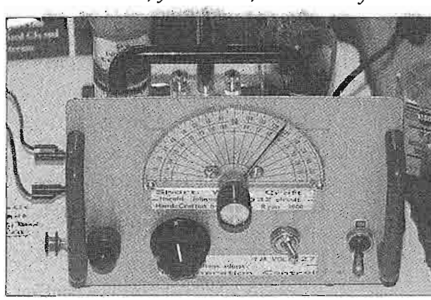


Left: Bob Ryan of Hemet, California is a longtime ER reader and a master builder of regerative receivers. Behind Bob, on the shelves, are many of the unique, illuminated, hand-wound coil sets he has built, and two of his receivers are visable to the left. Bob has corresponded with many ER writers over the years. On the lower left is one of Bob's regen sets. It has a plug-in coil to the right rear, and uses a protractor for a dial scale. Notice the attractive panel layout and the acryllic materials on the front panel. Below right is another receiver based on an article from a 1932 issue of Radio Craft.

(Photos courtesy Dave Ishmael, WA6VVL)



Facing page, lower right: Coy Johnson (K5BCN) is on the air from Waskom, Texas with classic American equipment from Heath, Hammarlund, Hallicrafters, Johnson, and many more.



Above: Dick Geordan (W6SGJ/7) operates great vintage stations from Vancouver, WA. Here are 2 of Dick's AM stations, which are an Eico 720/730 combo and a Heath DX-60A/HG-10/HR-10 combo. The DX-60A and HG-10 his originals from the 1960's, and he restored and added the HR-10 about two years ago. More exapmles of Dick's equipment will be featured in an upcoming Photo column.

CLASSIFIEDS

Advertising Information

Subscribers receive 1 free 20-word ad per month. **Extra words are 20 cents.** Here is how to count the words in your ad: "For Sale" or "Wanted" and your contact information counts as 7 words. Hyphenated words count as 2 words. **Please count the words in your ad as described above, and if you are over 20 words, send payment for the extra words at .20 each.** Note: Not all readers use e-mail, so it is a good idea to include phone numbers. Non-subscribers: $3.00 minimum for each ad up to 20 words. Each additional word is 25 cents. E-mail ads are fine.

Please call or write for display rates.

VINTAGE EQUIPMENT ONLY!

ER
PO Box 242
Bailey, Colorado 80421-0242

Telephone: 720-924-0171
FAX (call first): 303-838-3665
Ray@ERmag.com

Deadline for the June 2006 issue: Saturday, May 27!

SERVICE FOR SALE: Repair and restoration on all vintage equipment; over 50 years of experience. Barney Wooters, W5KSO, 8303 E. Mansfield Ave., Denver, CO 80237. 303-770-5314

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

FOR SALE: Hallicrafters SX-88 receiver, excellent condition, $6000 OBO. Call Charlie, 571-332-8704.

FOR SALE: Hallicrafters SX-28A rcvr and HT-9 xmtr with complete and extra coils. Both work. PU only. Don Hudson, 97 Southwood Dr, New Cannan, CT 06840 203-966-2859

FOR SALE: RCA Radiotron Designer's Handbook, 4th Edition, 1482 pgs, $39 + shpg. Henry Mohr, 1005 W. Wyoming, Allentown, PA 18103-3131

SERVICE FOR SALE: COMPLETE SERVICE JOHNSON "TURBO" RANGER, Valiant, Viking 500, Viking II, include panel and cabinet refinish. Hammarlund 180(A), National 300, 303, R390(A), Collins. Powdercoating. http://w4pnt.8k.com Patty & Dee's Marina: 534 W. Main St. Waynesboro, Va. 22980 540-249-3161 Cell: 540-480-7179 w4pnt@highspeedlink.net

FOR SALE: Johnson Thundebolt amp, new caps, spare finals, checked out, $600. Swan 500CX, VFO, AC, $300. Utica 650 & VFO, probably not working, complete, vy nice condx, $50. Drake copy TV6B transverter, in Drake cabinet & Drake front panel, needs PS, $75. Prices FOB Houston. Items guaranteed. Don, K5AAD, 713-042-9747

FOR SALE: Galena crystal radios and parts to make your own, also tubes and radio parts. Len Gardner, 458 Two Mile Creek Rd, Tonawanda, NY 14150, radiolen@att.net

FOR SALE: *"Unique Radio Parts", LLC.* www.wa9tgt.com (Replacement parts for "Drake" radio equipment)

FOR SALE: Hallicrafters HA-2/HA-6 transverter package, companion power supply, interconnect cables and manuals vgc, $475/swap. Collins 75S-3 exc w/ manul/cord, $600/swap. Gary, K6GLH, 209-286-0931 or ghal@ix.netcom.com.

FOR SALE: Globe Champion 300 electrically and cosmetically restored, new tubes, with audio and power supply mods. Frank KBØW/6 916-635-4442 fdellechaie@sbcglobal.net

FOR SALE: INTRAC 2000 test set by Motorola Model C 1570 C new with all cables and manual. $1000 plus shipping. John Snow W9MHS 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Make offer: 1 radio tower 97 feet high base 12 feet, ladder all way to top with platform heavy duty. Need sell at once. Frank Bridges Maple Street Brevard, NC 828-885-2470

FOR SALE: Johnson Messenger CB mn 242-128 commonly known as "whiteface" because of it's bright chrome plated look. 5 channel NIB and NOS. Complete. $125 ALSO a Johnson CB or QRP transceiver test monitor. Nice condition. Operates from a 9 volt battery. Untested. If you buy the CB I'll test this for you on it. $50. n7iok@juno.com or 520-323-1120.

FOR SALE: 1955 maintenance handbook for ARC-3, ARC-36, ARC-49. $20 + shipping. Jerry Miles, WA4KJK, 3349 Percy Priest Dr., Nashville, TN 37214. 615-889-4398

FOR SALE: B&K 666/606 Dyna Jet tube tester with manual exc cond $65 plus shipping. John Snow W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Standard Signal Generator Model 801A by Measurements Edison Electronics 6 ranges 25 rnhz to 470 Mhz as new $100 plus shipping. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: B&K 600 Dyna-Quick: tube tester with manual and one adapter exc cond $65 plus shipping. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Receiving tubes, many types NIB and tested pulls. $2 each, some higher, plus shipping. Cliff, N6ZU, 209-477-1235

FOR SALE: Tubes, transformers, receivers, cabinets, test equipment, misc. Two-stamp large SASE brings list. WA7HDL, 167 Highway 93 South, Salmon, ID 83467.

FOR SALE: Very rare Hallicrafters HA-2 & HA-6 transverters w/ PM-26 power supply and manuals excellent $300. Bob, W1RMB 508–222–5553

FOR SALE OR TRADE: Collins S-Line 32S1, 75S1, 312B4, 516F2 . Looking for late model HF. Don 540-882-4718. KC1AT@yahoo.com

FOR SALE: Two new in box 5894A/AX9903 transmitting tubes each list at $55 both for $75. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: RCA Red books Vol 1 1923-1937 & Vol II 1938-1942 $65 each. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Galaxy 5 station control. Kellogg power supply. Collins ashtray. Bill Coolahan, 1450 Miami Dr. NE, Cedar Rapids IA 52402, 1-319-393-8075

FOR SALE: Tube manuals RCA RC-11 1933 $20; RCA RC-12 1934 $15; RCA RC-15 1947 $15; RCA RC-20 1960 $15; RCA RC-24 1965 $10; RCA RC-27 1970 $10; RCA RC-30 1975 $10. John Snow W9MHS 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Two EIMAC 8560 AS transmitting tubes new in box each list at $125 each, both for $200. John Snow, W9MHS, 1910 Remington Ct., Andover, KS 67002 316-733-1856

FOR SALE: Radio tower, 97 feet high, base at top 12 feet, make offer. Frank, W4CPK, 104 Maple St., Brevard, NC 28712. fbridges@citcom.net

FOR SALE: Murch 2000B transmatch $200. RF Power Components transmatch, $250. G276 VLF LTV demodulator $150. CU-52 multicoupler $100. SP820 speaker $80. Ward Rehkopf, 1417 E. Bradley, Shawnee, OK 74804, 405-275-5677 or radiohound2@yahoo.com

FOR SALE: Harvey-Wells T90 & P.S. $150. Hammarlund two-tone gray 9" X 9" speaker, good condition. $45. Richard Cohen, 813-962-2460

FOR SALE: Telephone Filters, suppress >1MHz interference, plug in, 1/$7, 2/$11, 3/$14, 4/$16.75, shipped U.S. Brian Harris WA5UEK 3521 Teakwood Lane, Plano TX 75075 brian.k.harris@philips.com 214-763-5977

FOR SALE: Military whip antennas, Sears Silvertone batter set $45, Cathedral project radio $40. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777, 989-595-6483

FOR SALE OR TRADE: Complete QST 1915 to now, $6000, price and shipping negotiable. K8CCV, 330-427-2303

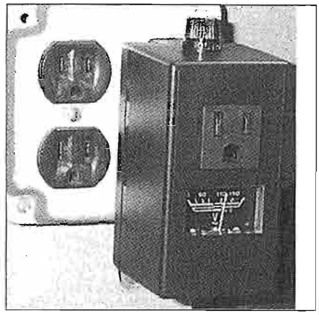
FOR SALE: Naval Receivers RAK, RAL, RAO, RBA, RBB, RBC, RBL, RBM. Some checked, pwr splys available. $75-$450 depending on condx. Many other types. Carl Bloom, carl.bloom@prodigy.net 714-639-1679

FOR SALE: Hammarlund HQ-170, clean, all orig. $200. Books: Radio Operating-Questions & Answers 415 pgs by Nilson &Hornung, 1920 to 1940 7th ed. HB $15. Military-Principles & Practice of Radio Servicing, 1944. PB, no dog ears. $5. Bernie Samek, 113 Old Palmer RD. Brimfield, MA. 01010, 413-245-7174, bernies@samnet.net

ZIM ELECTRONICS INRUSH CURRENT LIMITERS

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

Model AB-1M (With Voltmeter) $34.95
NEW! Model AB-300M **300 watts (2.5 amps x 120 VAC) with meter $39.95**
Model AB-1 (With Pilot Light) $29.95
Shipping, each limiter $5.45
(4 or more limiters are shipped free for US orders. Overseas customers please ask for shipping quotes.)



Model AB1-M

The Inrush Limiter provides a gentle, slow startup for your valuable vintage radio equipment. They also reduce the line voltage closer to original design values due to the voltage drop across the limiter element. Both models come with a full money-back guarantee.

Electric Radio Store
720-924-0171

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

FOR SALE: DRAKE TR-7/TR-7A/R-7/R-7A Service kit. Includes 13 Extender Boards and Digital Jumper Card. $63.85 includes postage. See http://pweb.amerion.com/~w7avk, Bob, W7AVK, 807 Westshore J28, Moses Lake, WA 98837, w7avk@arrl.net, 509-766-7277.

SERVICE FOR SALE: Let's get that old radio of yours working again! Antique Radio Repair - All Makes- Also Transistor Radio Repair. Tom Senne, N5KCL, 937-865-5213

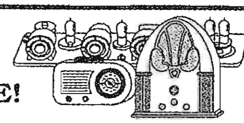
http://tomsradiorepair.bizland.com

FOR SALE/TRADE: 387 original manuals: Drake, Swan, Johnson, Hallicrafters, National, Hammarlund, Collins, WRL, Heathkit, others. NI4Q, FOB 690098, Orlando, F1 32869 407-351-5536 ni4q@juno.com

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

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

FREE SAMPLE!



ANTIQUE RADIO CLASSIFIED

Antique Radio's Largest Monthly Magazine – 5000 Subscribers!
Classifieds - Ads for Parts & Services
Articles - Auction Prices
Meet & Flea Market Info.
Radios, Ham Equip., Telegraph, Hi-Fi
TV, Books, Art Deco, 40s & 50s Radios
Free 20-word ad each month.

U.S. Rates: 6-Month Trial: $19.95
1-Year: $39.49 ($57.95 by 1st Class)
A.R.C., P.O. Box 802-E20
Carlisle, MA 01741
Web: www.antiqueradio.com
Email: arc@antiqueradio.com
Toll Free: (866) 371-0512; Fax: (978) 371-7129

HALLICRAFTERS SERVICE MANUALS: Ham, SWL, CB, Consumer, Military. Need your model number. Write or email. Ardco Electronics, PO Box 24, Palos Park IL, 60464, WA9GOB@aol.com, 708-361-9012 www.Ardcoelectronics.com

DRAKE INFO FOR SALE: Drake C-Line Service Information. Hi-Res Color photos of boards and chassis with parts identified. CD also includes Hi-Res scans of R-4C and T-4XC manuals, various version schematics and more. Garey Barrell, K4OAH@mindspring.com, 4126 Howell Ferry Rd, Duluth, GA 30096. 404-641-2717

HALLICRAFTERS PARTS: Hallicrafters SX101/101A reproduction main tuning knob. Includes silver inlay and set screws. $35.00 Mike Langston KL7CD, 1933 Diamond Ridge Drive, Carrollton, Texas 75010, mlangston@hcpriceco.com 972-392-5336

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

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

FOR SALE: QRP transmitter kits. Step-by-step instructions. Wood model, up to 5 watts 40/80M $15. "Tunatin" one watt 40M $10. You furnish crystal and power. Robert Larson, 1325 Ridgeway, Medford, OR 97504 W7LNG@arrl.net

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

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

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

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

FOR SALE: Tubes tested good globe 224 $6, 226 $8, 227 $9. Write or e-mail: tubes@qwestnet for price lists or see www.fathauer.com. Slightly weak tubes guaranteed to work in early radios 1/2 regular price. George H. Fathauer & Assoc., 1Z3 N. Centennial Way, Ste. 105, Mesa, AZ 85201. 480-968-7686 or toll free 877-307-1414

BOOK FOR SALE: Heath Nostalgia, 124 page book contains history, pictures, many stories by longtime Heath employees. (See ER Bookstore) Terry Perdue, 18617 65th Ct., NE, Kenmore, WA 98028

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

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

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

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

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

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

FOR SALE: Collection of 13 B&W plug in coils 10-80 meters JEL, JVL, JCL, BVL, BCL, TVK types. 3 Bud OES 10, 80, 160. New, most in original boxes, as lot only $150 + shipping. Richard Cohen 813-962-2460

FOR SALE: National HRO 5T. This radio is a 1946 rack mounted table top receiver with coils A, B, C and D and rack. It is part of my collection that I am selling because I will be living in Florida full time and I don't have room for everything. I serviced and recapped the receiver several years ago and I recently realigned it including the plug in coils both general coverage and ham bands according to the manual. This is an excellent receiver. $250. plus shipping from Lancaster, PA. Dan W4BN. 239-498-9021. W4IUV@aol.com.

FOR SALE: Check my eBay store: RadioWorld-OnLine and my website www.radioworld-online.com. Carl Blomstran, PO. Box 890473, Houston, TX 77289 281-660-4571

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

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

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

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

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

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

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

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

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

WANTED: Hallicrafters SX-73/R-274D

junker with good main tuning capacitor. Tom, W4PG, wtw@rti.org, 919-382-3409.

WANTED: RBL-5 or RBL-3 receiver, good condition, please contact Mike, VE7MMH, at: mike46@shaw.ca

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

WANTED: The large connector and curved hood from the front of the BC-312 or 342 receiver, or just the hood. Trade or cash ok. Contact: Frank, WA6RBQ at wa6rbq@aol.com or 541-479-7935 in Grants Pass, OR

WANTED: Hallicrafters R45/ARR7 receiver, even non working but complete and good cosmetics. Francesco Sartorello, francesco.sartorello@virgilio.it

WANTED: Entire metal case or back and bottom for BC125 or junker radio. Robert Hawworth, 112 Tilford Rd, Somerdale, NJ 08083, 856-783-4175

WANTED: CR-91A cabinet, audio gain knob, and manual. Would also like to purchase an AR-88. Ward Rehkopf, 1417 E. Bradley, Shawnee, OK 74804, 405-275-5677 or radiohound2@yahoo.com

WANTED: Altec Lansing horns: 811B, 511B. Drivers 808-8A, 806-8A. Ron, 262-673-9211, karenson87@yahoo.com

FOR SALE: Swan 350 $100. Carter, WD4AYS, 434-979-7383, celliott14@earthlink.net.

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

WANTED: Globe model UM-1 plate modulator and/or Globe model SM-1 screen modulator in good working condition. Alan W. Fremmer, KB2HEI, 550-H Grand Street, New York, NY 10002, 212-777-3630, awfremmer@aol.com

"Your audio is clean, full, undistorted and much louder"

HIGH PERFORMANCE AUDIO PROCESSOR INSTALLED IN THE BASE OF YOUR D-104 MICROPHONE FOR $89.00

www.k7dyy.com/processor.htm

WANTED: Service for my Hallicrafters transmitters. Will deliver/pickup within 4 hours drive of Savannah, GA. Bob, W4WTO, 912-663-4311. armco1@bellsouth.net

WANTED: Radio magazine, November 1939 and all after March 1942. Bill, w6fa@caltech.edu or 626-836-2065.

WANTED: Clean Gonset G76 with power supply/speaker and working R390A. Frank, KBØW/6, 916-635-4442 fdellechaie@sbcglobal.net

Hallicrafters Logo Tie Tac/Pin

This three color logo tie tac/pin will "dress up" any tie or lapel.

$7.50 including shipping!

Send check or money order to:

Ardco Electronics
PO Box 24
Palos Park, IL 60464

WANTED: National NC-183DTS speaker, NFM-83-50 adaptor and SOJ-3 Selectojet. Contact Ric at C6ANI@arrl.net

WANTED: SX115 and HT-32B. Ward Rehkopf, 1417 E. Bradley, Shawnee, OK 74804, 405-275-5677 or radiohound2@yahoo.com

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

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

WANTED: Navy WW2 shipboard receivers and transmitters. Need equipment, manuals and general operating information. Receivers of the type RAK, RAL, RBA, RBB, RBC, RLS etc, Transmitters of the type TBA, TBK & TBM (with modulators), TDE TBS etc. Equipment is for the restoration of Radio facilities aboard the **USS Alabama (BB-60)**, now part of the Battleship Memorial Park, Mobile, Alabama. I was a Radio Technician aboard the Alabama in WW2 and would like to hear from other WW2 RTs and Radio Operators concerning radio operating and maintenance procedures aboard other Navy WW2 ships. Please call Stan Bryn, AC5TW, at 1-800-984-9814 week days between 0800-1100 MST. Or email intor@zianet.com.

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

WANTED: Collins 310B-3, basket case OK, 70E-8A PTO per 1948. Chicago CMS-2, pair of Taylor T-21. Jerry, W8GED, CO, 303-979-2323.

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

WANTED: Tektronix **Type 570** curve tracer, any condition. Ron, AA2QQ, 718-824-6922

WANTED: INTECH COM 6000 Service Manuals: COM3648, COM1000, COM1005 HF SSB Marine radio. Wes, K5APL, 870-773-7424 k5apl@cableone.net

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

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

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

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

WANTED: Hammarlund ED-4 transmitter. Any condition or information. Bob Mattson, W2AMI 16 Carly Drive Highland NY 12528. 895-691-6247

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

The Caps Are Back!

By popular request, we are offering another run of the popular Electric Radio baseball caps. These new caps are a nice 5-panel all-cotton style with an adjustable rear headband and a 3-inch front brim. The background color is light tan, and the ER logo is embroidered in 3 colors, not printed. These hats will hold up for a long time.

$19.95, including priority shipping.

ER Store
PO Box 242
Bailey, CO 80421
720-924-0171
Or on-line: www.ermag.com

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

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

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

QUARTER CENTURY WIRELESS ASSOCIATION, INC

Licensed at least 25 years ago ?
And licensed now ?
Then you should belong to the

Quarter Century Wireless Association

For information write :
Dept. R
P.O. Box 3247
Framingham, MA 01705-3247
http://www.qcwa.org

WANTED: WW II German, Japanese, Italian, French equipment, tubes, manuals and parts. Bob Graham, 2105 NW 30th, Oklahoma City, OK 73112. 405-525-3376, bglcc@aol.com

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

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

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

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

WANTED: Incarcerated ham seeks

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

WANTED: Commercial or kit-built 1930s and 40s transmitters. Doc, K7SO, 505-920-5528 or doc@cybermesa.com

WANTED: Hallicrafters SX115, SX88, Collins 75A-1, AM broadcast transmitter in New England area, Heath DX100B. Will pay good price for good equipment. w1txjohn@aol.com, 802-775-7632 Eves.

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

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

WANTED: TCS & TBY Navy radios. Ken Kolthoff, K8AXH, PO Box 215, Craig, MO 64437. Work #913-577-8422.

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

WANTED: Harvey-Wells Odds-'N-Ends: Speakers, phones, mikes, manuals, supplies, prototypes, military, aircraft. Kelley, W8GFG, 219-365-4730, 9010 Marquette St., St. John, IN 46373

WANTED: Collins R-389 LF receivers, parts, documentation, anecdotes, antidotes. W5OR Don Reaves, PO Box 241455, Little Rock AR, 72223 501-868-1287, w5or@militaryradio.com or www.r-389.com

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

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

WANTED: Scott Special Communications rcvr. EA4JL, please call Kurt Keller, CT, 203-431-9740,

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

WANTED: Book: Alternating Current Machines by Puchstein, A.F, Lloyd, T.C., John Wiley and Sons, NY 1942. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 after 6 PM Eastern Time.

WANTED: JB-49 Junction Box, BC-731 Control Box, DY-17 Dynamotor. Rick

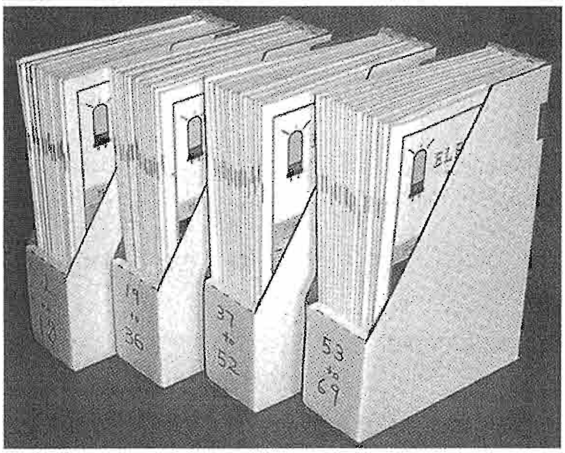
Brashear, K5IZ, rickbras@airmail.net or 214-742-1800

WANTED: KWS-1 RF section in any condition, or a complete KWS-1 for TLC restoration. Also HT33, prefer operating unit; Gary, K2PVC, gschonwald@earthlink.net 917-359-8826.

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

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

WANTED: Power change switch (S103) as used in a Collins 20V2. Dewey Angerhofer, PO Box 540, Edgemont, SD 57735 605-662-7692



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

---

WANTED: WWII Navy GP-7 transmitter in any condition, with or without tuning units or tubes, etc. Ted Bracco, WØNZW, braccot@hotmail.com A.C. 717-857-6404 X306

WANTED: Radio magazine, November 1939 and all after March 1942. Bill, w6fa@caltech.edu or 626-836-2065.

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

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

WANTED: Would like to buy back RME-99 from the person who bought it from the would-be Ham I gave it to. Hank, 570-654-2347

WANTED: Bandspread vernier with pinch drive model C-50618 for the NC-190 receiver. Spencer Cromwell, 2150 Ridgebrook Dr., West Linn, OR 97068. 503-329-4737. K6VRS@ARRL.NET

NOTICE: Expert HRO-500 alignment done with modern test equipment (HP, TEK, etc.) 650-529-9180 www.nortrex.net or nortrex@bigplanet.com

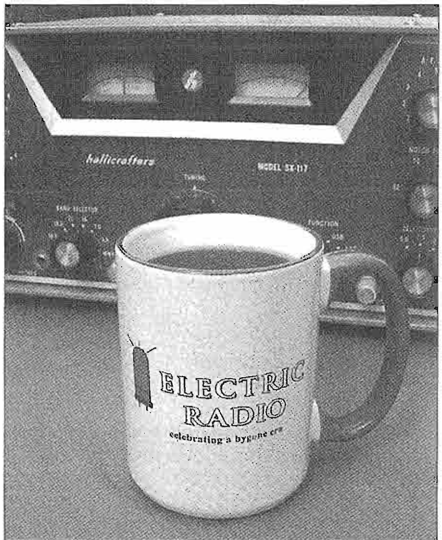
---

KDØZS optoisolator package per "New Valiant" article is $18.00 postpaid.

Fairchild 1N4938 switching diodes are still available in packs of 20 for $10.

See Ordering Info to the Right ☞

Don't forget to say you "Saw It In Electric Radio" when contacting advertisers! It helps Electric Radio and it helps the advertiser.



Electric Radio Coffee Mugs!

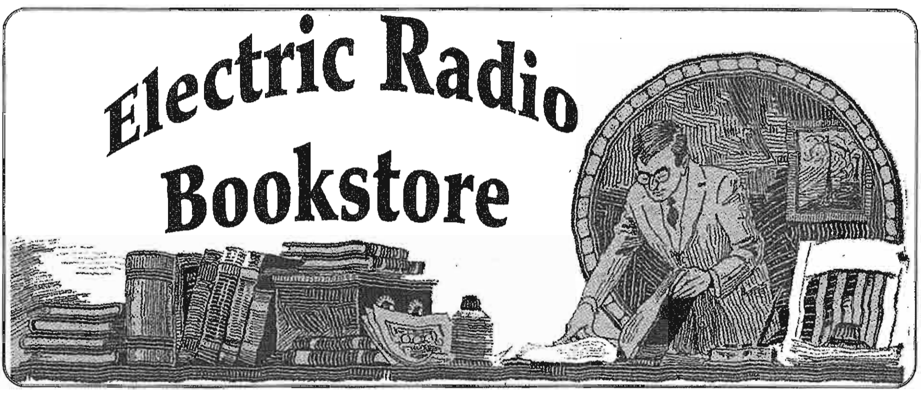
A new item in the Electric Radio Store is this nice 15-oz white ceramic mug with the ER logo in 3 colors and a maroon-red handle and rim. This large mug is perfect for those long roundtable QSOs and holds a lot of coffee!

$13.99, including priority shipping within the US.

ER Store
PO Box 242
Bailey, CO 80421
720-924-0171
Or on-line: www.ermag.com

Electric Radio T-Shirts

The front displays the logo from the cover of ER (the tube logo, Electric Radio, and "celebrating a bygone era"). The back has "Real Radios Glow in the Dark" (used with the permission of Classic Radio). The T-shirts are 100% cotton and come in Small, Large, X-Large, XX-Large. The color is slightly lighter than the cover of ER. $15.50 delivered, $16.50 for XXL.



— BACK ISSUES —

All Electric Radio back issues are either from the original press run or are lithographic reprints from the original negatives on archival quality, acid-free paper. Shipping prices are for delivery by media mail within the USA. Overseas, please inquire for shipping quotes.

- Single issues: **$3.85** postpaid
- 1-year sets (or any 12 issues) **$38.00 per year + $2.00 S&H**
- **Special deal on any four years (or any 48 issues): $100.00 + $4.00 S&H**
- Buy **the entire run** of Electric Radio from #1 for **$375.00 + $8.00 S&H,** at least a 50% discount over single issues.
- For a postpaid 29-page **printed back issue index**, please send $2. Foreign orders please inquire for shipping rates.

— COMPENDIUMS —

All the Collins compendiums are packaged in nice 3-ring binders

Collins 75A-4 Modification Compendium: All the factory modification bulletins from Collins Radio Co., and all the articles printed in CQ, Ham Radio, QST and ER over the last 45 years, now 92 pages, $20.00 plus $5.00 S&H.

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

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

— BOOKS —

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

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

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

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

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

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

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


K9EID
the Classic Microphone
for classic radios
Dual Impedance for vintage rigs
switchable 600 ohms or 30 K ohms
*Two dynamic elements
Heil PROLINE broadcast element
Heil HC 5 communications element
*40 Hz. -18 kHz PROLINE response
300 Hz.- 6 kHz HC 5 response
Soft touch PTT button on back panel
Comes to you mounted on our CB-1
replica of RCA stainless trim base
Shown here on our PL2T boom
*Complete with your own call letters
HEIL SOUND
www.heilsound.com
(618) 257-3000


RADIO DAZE
VINTAGE RADIO
& ELECTRONICS
• Books • Capacitors Of All Kinds • Chassis-Aluminum/Steel • Chokes
• Custom Cloth-Covered Solid/Stranded Wire • Dial Belts & Cord
• Dial Lamps & Sockets • Diodes • Enclosures • Fuses & Fuseholders
• Grillecloth • Hardware • Kits • Knobs • Potentiometers
• Power Cord & Plugs • Refinishing Supplies • Reproduction Glass Dials
• Resistors • Service Supplies • Sockets • Technical Data • Tools
• Transformers - Classic Audio, Power, Filament, Isolation, etc.
• Vacuum Tubes - One of the largest inventories of NOS tubes
Radio Daze, LLC · 7620 Omnitech Place · Victor, New York 14564
(585) 742-2020 · Fax: (585) 742-2099 · Toll Free Fax: (800) 456-6494
e-mail: info@radiodaze.com · Web Site: www.radiodaze.com

Subscription Information

Published Monthly

Rates within the US:

1st Class Rate: $42 (mailed in envelope)

Periodicals Rate: $32

Rates outside the US, by airmail only:

Canada : US $48

All other countries: US $60

Electric Radio
PO Box 242
Bailey, Colorado 80421-0242
720-924-0171
Office Hours: 9:00 AM to 5:00 PM MT, Monday to Saturday

Subscriptions and renewals may now be purchased online at WWW.ERMAG.COM

Visa, Mastercard and American Express

FAX: 303-838-3665

email: Ray@ERmag.com **or** 1editor2@indra.com

The Electric Radio mailing date is posted monthly at www.ermag.com

Electric Radio
PO Box 242
Bailey CO
80421-0242

PERIODICAL

TO:

Postmaster: Return entire magazine for address changes, do not destroy.