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ELECTRIC RADIO

celebrating a bygone era

Number 222 November 2007

Sharon (K6IRD) and Wayne (W6IRD) Spring

ELECTRIC RADIO

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

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

Regular contributors include:
Chuck Teeters (W4MEW), Jim Hanlon (W8KGI), Tom Marcellino (W3BYM), Gary Halverson (K6GLH), David Kuraner (K2DK), Bruce Vaughan (NR5Q), Bob Grinder (K7AK), Larry Will (W3LW), Dave Gordon-Smith (G3UUR), Dale Gagnon (KW1I)

Editor's Comments

"Honor Your Elmer" Contest

The Honor Your Elmer contest deadline has been extended to December 29, 2007 to give everyone a chance to enter!

2007 Electric Radio Heavy Metal Rally

The annual Heavy Metal Rally will be held this year on Saturday, December 29. The Heavy Metal Rally is a night for friendly AM QSOs, and is open to anyone using restored broadcast, military, homebrew, any commercial ham gear.

Suggested Frequencies: 1885 Kc east of Mississippi, 1915 Kc West; 3830 Kc, 3870-3890 Kc, nationwide, 7290 Kc.

Scoring: You get 1 point per contact on each different band. If you work the same station on both 80 and 160 it counts for two points. You get 1 additional point per contact if you are using all tube-type heavy metal. 1 point for each different state worked. 1 point for each letter or email received from hams or SWLs with positive comments about a station's signal or sound quality. So, if someone works 20 stations in 10 different states with a tube rig, the score is: 20 contacts + 10 states + 20 tube points = 50.

The winner should be running a rig weighing 250 pounds or running at least 250 watts. This includes big homebrew, military, and vintage commercial ham gear, and Class-E solid state rigs as long as they meet the qualifications. For example, some vintage Navy rigs weighed in at over 300 pounds, but only produced 100 watts of carrier—that's still Heavy Metal! (The "or" statement is intended as an illustration, and should not be misread as an intent to keep someone out.)

You can't win unless you're running a Heavy Metal rig—NO exceptions!

This is Heavy Metal night! Everyone is welcome to participate with smaller rigs, but the winner needs to be using Heavy Metal.

Completed logs should be sent by email to Ray@ERmag.com or by US mail to the Electric Radio address printed inside the rear cover. Please have your point totals calculated when you send in your log, and be sure to mention the equipment used during the rally. 73, Keep Those Filaments Lit! NØDMS

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Cover: **Wayne (W6IRD) and Sharon (K6IRD) Spring are well known for their contributions to ham radio and AM. They share the radio shack pictured, and Sharon is a frequent control operator for the Wednesday night West-Coast AMI net.**

The 1938 National Transmitters

Part 5, The "NC-600" National 600-Watt Transmitter

By Jim Hanlon, W8KGI
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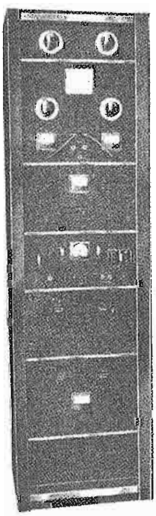
Sandia Park, NM 87047
w8kgi@arrl.net

The pinnacle of the 1938 National transmitter series is the 600-watt transmitter, also known as the NC-600. In this case, I have far more than just the physical and electrical design of the transmitter to tell you about. The particular transmitter pictured and described in this article started off as the personal property of none other than James Millen himself from the late 1930s until 1982. Professor Peter C. Patton (WØEWQ), an extraordinary collector of HROs and related receivers, acquired the transmit-



NATIONAL 600 WATT TRANSMITTER

The National 600 Watt Transmitter is a compact and efficient unit of flexible design. The standard design provides a plate input of 600 watts on 10, 20, 40 or 80 meters.

An NTE Exciter-Speech Amplifier (described on page 15) is used as speech amplifier and as exciter for the buffer and final amplifier unit immediately above it. A Pi Network antenna coupler at the top of the cabinet completes the RF units.

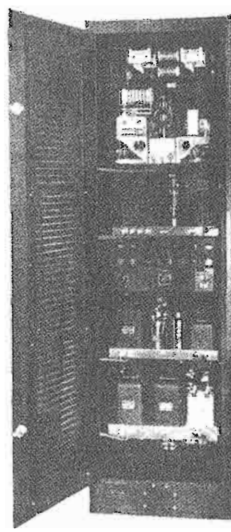
The buffer and final amplifier unit features a compact, open construction that results in short leads, symmetry of the push-pull circuit and complete accessibility. The final employs a pair of 100 TH's driven by a single 35T as buffer.

The modulator chassis is immediately above the Exciter-Speech Amplifier, which serves as driver for the Class B amplifier. A pair of zero-bias 203-Z tubes provide 300 watts of modulating power.

Power for the modulator stage is supplied by the power unit immediately below the NTE. This 1250 volt supply also provides power for the buffer.

The power supply at the bottom of the cabinet delivers 300 MA at 2000 Volts for the final.

All transformers and chokes are Thordarson CHT units, except those in the NTE, which are special units of National manufacture. **The National 600 Watt Transmitter**, as described, complete except for the microphone. **List $1,727.50**

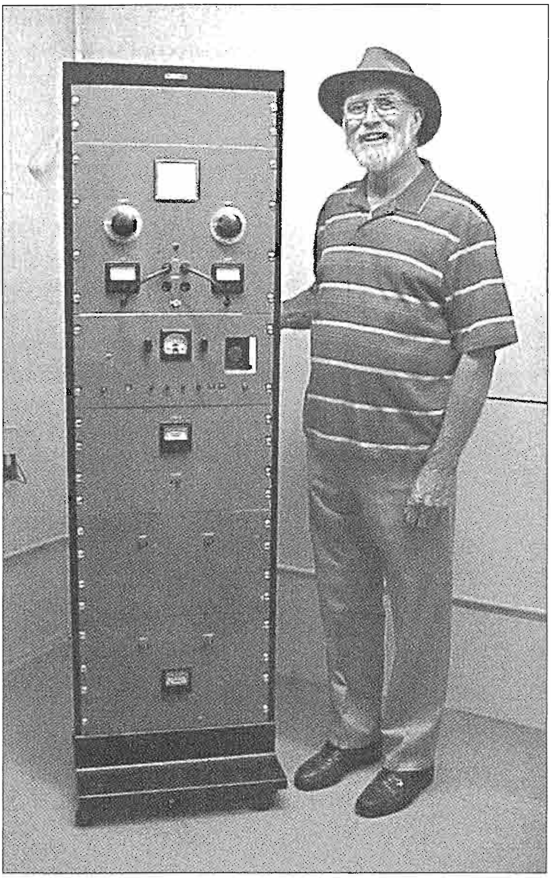


TRANSMITTER FOUNDATION UNITS

The individual units of the 600 Watt Transmitter described above are available as separate chassis. In the table below, the first column lists completely wired and tested units. The chassis listed in the second column are drilled, punched and formed, and ready for assembly. Panels, brackets, screws and small hardware are included.

UNIT	WIRED AND TESTED		FINISHED ASSEMBLY	
High Voltage Supply	NT 2000 PCW	$265.00	NT 2000 PC	$12.00
Medium Voltage Supply	NT 1200 PCW	$150.00	NT 1200 PC	$12.00
Class B Modulator	NT 300 PCW	$127.50	NT 300 PC	$12.00
Final Amplifier	NT 100 PCW	$245.00	NT 100 PC	$16.00
Pi Network Coupler	NT-APW	$55.00	NT-AP	$2.00
Relay Control Panel	NT-RPW	$45.00	———	

Figure 1: The transmitter and its "foundation units" were advertised in the 1942 edition of "Radio's Master Encyclopedia." The fully-assembled, enclosed-cabinet version carried a list price that would be at least $26,000 in today's dollars.



Mort Jones (W6KLG) and his restored NC-600 that was James Millen's personal transmitter until 1982, when it was sold to WØEWQ.

and I trust it will make this article itself more interesting to you, the reader.

The 600-watt transmitter was offered as a series of five "Foundation Units" that could be purchased separately and in kit form. These units combined with an NTE-B Exciter and Speech Amplifier all together comprise the 600-watt transmitter. See **Figure 1**.

The individual unit kits are the NT-100PC buffer and final RF amplifier, total "list price" including coils for 80 through 10 but less tubes $161.45 ($235 wired and tested), the NT-300PC Class-B modulator $72.25 less tubes ($110 w&t), the NT-1200PC power supply for the RF buffer and modulator stages $88.40 less tubes ($135 w&t), the NT-2000PC power supply for the RF-final amplifier $168.90 less tubes (but including a 0-3000 VDC voltmeter costing $45.50!, $210 w&t), and the NT-AP pi-section antenna coupler $28.30 ($58 w&t). The NTE-B exciter and audio speech amplifier was available "wired and tested" with tubes for an additional $215.00.

ter from Mr. Millen, and transported it from North Reading, Massachusetts to Minneapolis. Pete later sold it to Bill Smitherman, then in Texas, who moved it to North Carolina and became KD4AS. Bill advertised it in the Yellow Sheets for July 2, 1995, and it was acquired by its current owner, Morton Jones (W6KLG), and moved to San Diego. Mort has kindly supplied not only the pictures you see in this article but also copies of correspondence between Professor Patton and Mr. Millen. This treasure trove of information has made my writing job much more enjoyable and easier,

In addition, the National brochure, *The 600-Watt Transmitter,* by James Millen and Dana Bacon, described offering a National type RR relay rack for $65, and a Turner 30-BTS microphone for $25. The amateur could buy all of these units at the discounted "net price" which was of 60% of "list." So the complete NC-600 transmitter kit, less tubes, would have cost the amateur of 1938 a very healthy $437.58. While the National brochure describing the 600-Watt Transmitter lists each of these units as a complete kit of parts or as a fully-wired and tested unit, less only the tubes, Jim Millen in his letter of October 31, 1982, to Pete Patton describes the transmitter components somewhat differently.

"Back in the mid '30s before solid state circuitry and Japanese imports, the real reason for NC-600 was to try and find a way for the Ham in Wisconsin, etc., to obtain a 'factory made' adequately powered transmitter from his local dealer to match his HRO. By using a locally available Western Electric Relay Rack (through Graybar) and Thordarson Transformers, Eimac and Raytheon Power Tubes (through local Ham Dealers) we not only solved the transportation problem with less cost and effort than you just furnished, but enabled the local dealer to merely have to secure our light weight, easily shippable pre-wired chassis units. This, of course, also shifted the patent infringement problems from our shoulders to the local dealer who was immune from legal troubles."

So it would seem that most of the foundation units were probably purchased as punched and wired chassis-and-panel combinations from National and then completed by their individual owners using the National-supplied schematics and parts lists as a guide. One suspects that method could have resulted in considerable variation between the various owner-assembled units.

The NC-600 used the Thordarson C.H.T. line of transformers and chokes throughout. It was even described in a separate *Thordarson Transmitter Guide* document. But, as Mr. Millen wrote in a June 4, 1979, letter, *"Due to the death of Mr. Thordarson and the sale of his company, there were very few NC-600 transmitters made and sold (it was a cooperative deal with Thordarson). We probably did not make more than 100, if that many, of the complete transmitters and probably 400 or 500 of the exciters and final amplifiers."*

Figure 2, taken from the National brochure, shows the schematic of the NC-600. As you can see, the electrical circuit is very simple and straightforward and quite typical for equipment of the late 1930s. The power supplies are

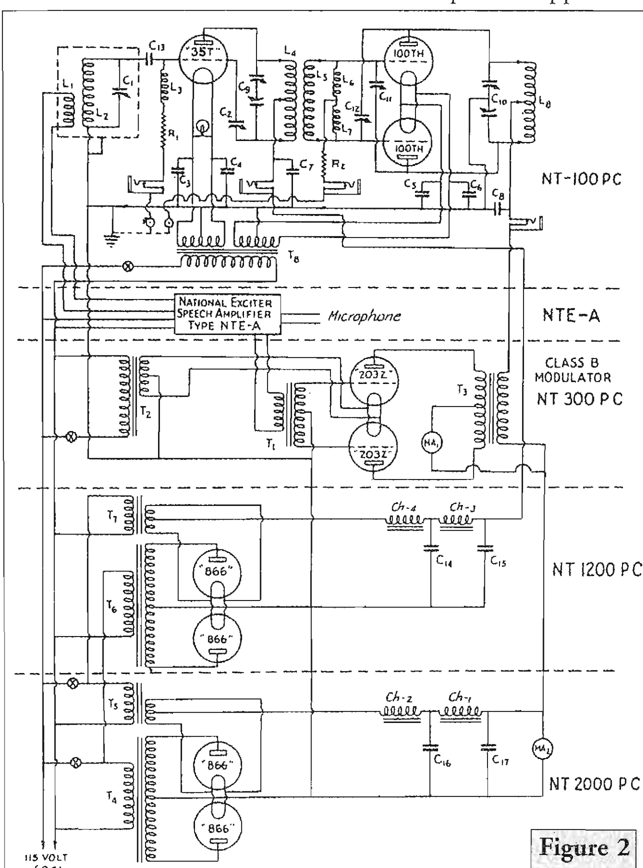
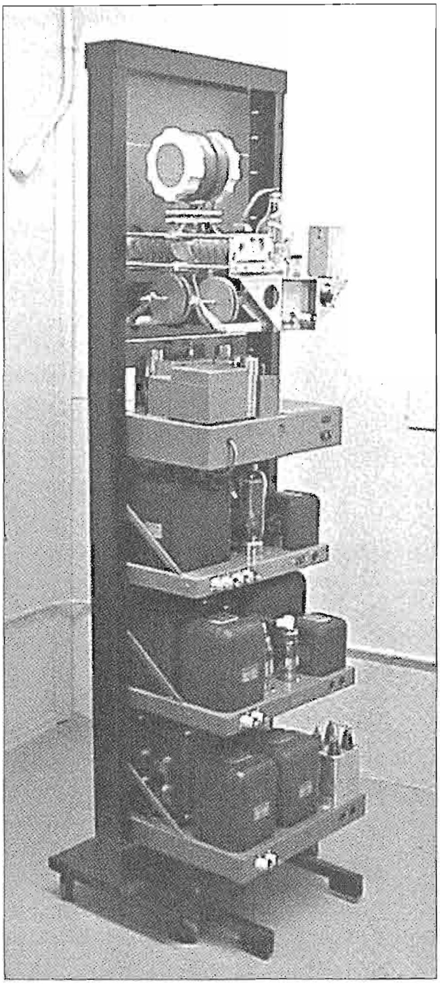


Figure 2



Rear View of the Restored NC-600 at W6KLG

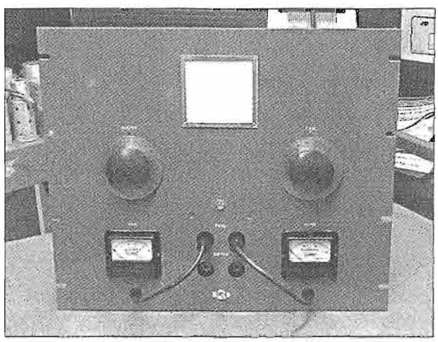
both conventional, full-wave rectifier arrangements using a pair of 866 mercury-vapor diodes and a two-section filter with a Thordarson swinging choke in the input. The modulator is equally conventional, using a pair of push-pull Taylor 203Z zero-bias triodes, transformer coupled to the audio output of the NTE exciter on the grid side and coupled via the Thordarson T11M77 modulation transformer to the plate feed of the RF-final amplifier on the plate side.

Other than ample top and bottom view pictures of these units, the National brochure only passes along the advice that *"In assembling units of this type it is desirable to mount and wire all the small parts before installing the chokes and power transformer, since the chassis is very awkward to handle after the bulky parts are mounted."* Certainly this is a far cry from the Heathkit assembly manuals of the '50s.

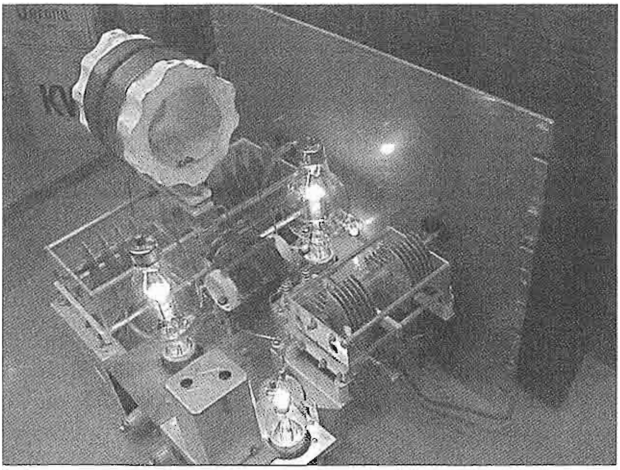
The most interesting story in the National 600-watt transmitter brochure is about the mechanical design of the RF stages. I'll turn the keyboard over to Millen and Bacon for a while for their description. You will probably want to refer to Mort's pictures, especially of the RF stage, while reading this description.

The 600-Watt Buffer-Amplifier

In most descriptions of RF amplifiers that appeared in the 1930s prior to this one, the authors generally stressed primarily the circuit details and then, possibly, to some extent, trick layouts making possible short leads. Mechanical and structural design, both of the piece of gear as a whole, as well as of such minor details as brackets, coil and condenser mountings, etc., had largely been ignored. Millen and Bacon, feeling that it really took no more time to do a good mechanical job in the first place rather than the more usual ragtag one, set out to illustrate and comment upon the mechanical rather than the electrical



Restored NT-100 RF Deck



After many hours of work, the 100TH PA tubes in the NT-100 RF deck are hot and ready to go.

proper pre-tuned input tank circuit unit for the particular band desired (assuming, of course, that the exciter output has been shifted to the proper band, as previously described) and the input and output plug-in coils of the final stage.

"Design and Construction Notes"

"The four main points kept in mind in arriving at the mechanical design were:

1. Efficient electrical layout (short leads, symmetrical arrangement of push-pull circuit components, etc.).
2. Compactness.
3. Economical use of component parts.
4. Freedom from likelihood of mechanical or electrical failure.

"Structurally, the transmitter is built around the central steel chassis or U-frame, under which is mounted the filament transformer and the 100TH sockets, and to the sides of which are attached the aluminum brackets carrying the relatively lightweight r.f. components, such as the two variable condensers, the neutralizing condensers, input tank circuit, and the buffer tube socket. This chassis unit is illustrated without wiring and without mounting of the front panel, in order to illustrate the simplicity and neatness of this type of construction.

"Perhaps at this time it may be well to point out some of the constructional details that contribute much to the neat final appearance of the complete unit. Most prominent in this connection are, of course, the aluminum brackets carrying the variable condensers; actually, it takes very little, if any, more labor on the part of the constructor to form-up the

design features of a moderate-power RF final amplifier recently designed for a 600-watt 'phone transmitter. Consequently, they used more than the customary number of photographic illustrations and devoted less space to circuit comments and description.

"The Circuit"

"The output from the exciter is ample to drive a high-mu triode of the 35T, 808, or RK-37 variety, consequently one of these triodes (35-T) is used for the buffer stage. In addition to the small size of the tube itself, it has the added advantage of requiring a relatively low value of neutralizing capacity (1.9 mmf.), making possible the use of the compact NC-800 type condenser, shown in the illustrations. The buffer stage in turn drives the final amplifier, employing a pair of 100TH high-mu triodes in push-pull.

"Coupling between the exciter unit and this amplifier unit is by means of a low-impedance link circuit with a pre-tuned plug-in tank circuit, mounted adjacent to the buffer tube on the amplifier chassis.

"Band Shifting"

"In shifting from one band to another, it is merely necessary to plug in the type of brackets shown from sheet aluminum in an ordinary vise, than it does to bend up strip stock in the more normal manner. The round holes cut in the two rear brackets add much to the appearance and little to the labor, as holes of this size are very easily cut in aluminum with an ordinary trepanning tool or fly-cutter. Just to illustrate another type of bracket construction that is quite easily made and equally neat in appearance, we used for the front condenser mounting a slightly different form of bracket, made from sheet aluminum and shown very clearly in the front view.

"In order to bring the control shafts of the two condensers in line with symmetrical panel arrangement of the dials and without having the bracket extend above the main chassis level, four GS-1 standoff insulators were used minus their regular bases, for mounting the interstage tuning condenser. This also permitted the frame of that particular condenser to be operated above ground electrically, which is considered quite safe practice in this instance inasmuch as the plate voltage used on the 35-T is only 1250, and not the 2000 of the final, and especially inasmuch as the metal shell of the Type '0' National dial, used for tuning this condenser, is unusually well insulated from the shaft by means of a large bakelite bushing molded as an integral part of the knob. The only precaution necessary is to have ample clearance in the hole provided in the front panel for passage of the condenser shaft.

"By mounting the filament transformer in the manner shown, not only is its relatively heavy weight supported by the strongest part of the chassis, but extremely short leads also results. The a.c. input to this transformer is through the special receptacle recessed in the side of the chassis. Such an arrangement makes it possible to remove the entire amplifier from the relay rack at any time merely by pulling a few plugs, inasmuch as the r.f. input circuit is also fed through the G.R. plug-type terminals.

"In addition to the symmetry of layout of the push-pull stage, which is so desirable for easy neutralization, the neutralizing condensers have also been mounted with a view to ease of access of adjustment for facilitating the original tuning of the transmitter. As can be seen from the photographs, the adjusting screws on all neutralizing condensers are readily accessible from the side of the transmitter. They are also placed so as to eliminate the necessity for mounting brackets.

"The two 100TH sockets on the main chassis are mounted underneath, with just part of their shells protruding, so as to eliminate the necessity for bushings and holes through the chassis in order to make connections to the socket terminals.

"The final r.f. tank coil is mounted by means of brackets designed especially for the purpose, upon the frame of the final tank tuning condenser. Such an arrangement, again, is neat in appearance, requires no special effort on the part of the constructor, provides a symmetrical push-pull circuit arrangement, and results in short leads.

"The terminal strip, located along side the AC filament transformer input socket, furnishes a convenient means of supplying the buffer and final amplifiers with fixed, in addition to the automatic, bias for CW use. The grounded ends of the jacks used for grid metering of the buffer and final tubes as shown in the circuit diagram are connected to the screw contacts of the terminal strip. One terminal is used as the bias connection for the buffer and the other as the bias connection for the final amplifier. For phone operation both terminals are connected together and to a ground lug secured to the chassis by the mounting screws of the terminal strip. For CW use the grounding and shorting lead is removed and the proper negative grid voltage is applied to the grids of the tubes by connecting the leads from the external bias supply to the screw contacts.

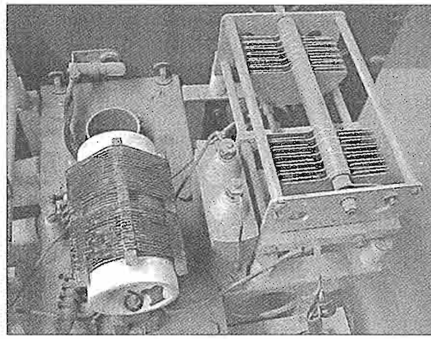
"For reasons of economy only two meters are employed; one is a grid milliammeter and the other is a plate milliammeter. By means of jacks and plugs, they may be used in either stage. Jacks are mounted on a bakelite sub-panel so as to eliminate danger of anyone's coming accidentally in contact with the mounting bushings, which, of course, in the case of the plate jacks, are at high voltage. The usual type round-shell 'phone plugs are amply long for easy insertion in jacks mounted some distance behind the panel in this manner.

"The chassis unit just described is mounted directly to the aluminum front panel. Aluminum, rather than Masonite or other such composition, is used for the front panel because of the strength required for carrying a relatively heavy unsupported chassis without warpage, as well as for its electrostatic shielding value."

Restoration

Jim Millen's NC-600 could not possibly have found a better destination than Mort Jones' shop. According to our mutual friend, Doc Khalsa, the owner of one of the NTEs featured in this series, and who has visited him, Mort has a long metalworking shop attached to his house with a very spacious area for working on radios. It is at the end of the metal shop section and before the two-room hamshack. Mort also has two other large outbuildings filled with radio stuff and a car or two. After keeping the NC-600 waiting for some TLC for ten years, he kindly postponed his work on restoring a 1962 Jaguar to put the finishing touches on the NC-600 units for these articles.

His most recent work on the modulator and the NTE exciter typify what he has done on all of the units. On the modulator, he disassembled it, sandblasted the chassis and repainted it. He painted the panel and filled in the etched lettering with white paint. Mort also over-sprayed the driver and modulation transformers in black satin. For the NTE, he disassembled it, sandblasted the parts needing it, stripped the old paint from the panel, and then sanded and painted the panel.



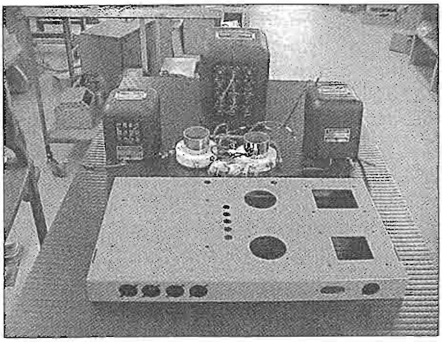
This is a closeup view of the NT-100 RF deck before restoration.

For the power supplies, Mort did a similar job of disassembling, cleaning, and repainting. He replaced the original 866 rectifiers with 3B28s, a gas-filled, direct plug-in replacement. The original oil-filled filter capacitors all checked out as good. He did have to repair the dropping resistors in the voltmeter circuit for the 2000-volt supply. And, both power supplies came up and worked just fine.

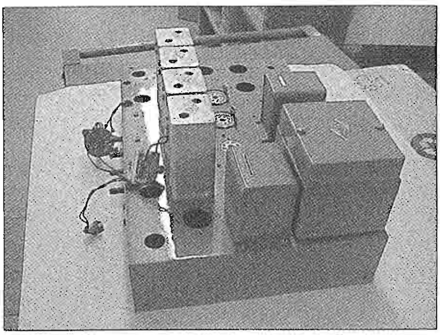
Mort sandblasted the rack, primed it and did some sanding, and then finish-painted it with a satin-black enamel.

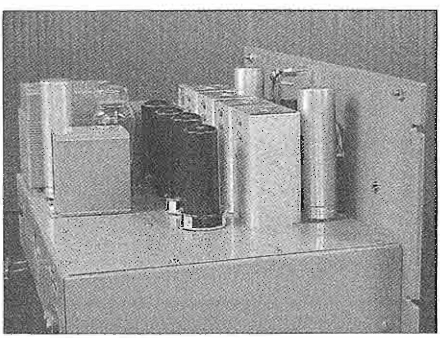
He restored the RF deck, disassembling some of the parts in order to clean a little deeper. He replaced the power switch and two RF chokes, stripped the paint from the front panel and repainted it.

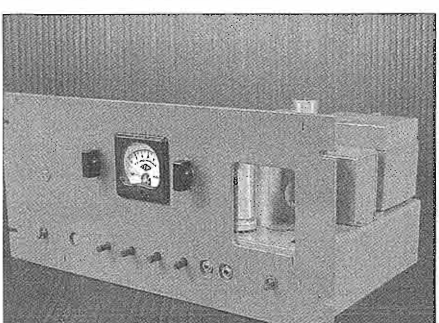
I'm including before-and-after pictures showing Mort's beautiful work. They are presented on several pages that

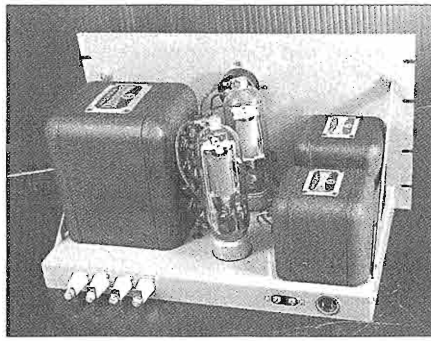


NT-300 Modulator Deck During Restoration





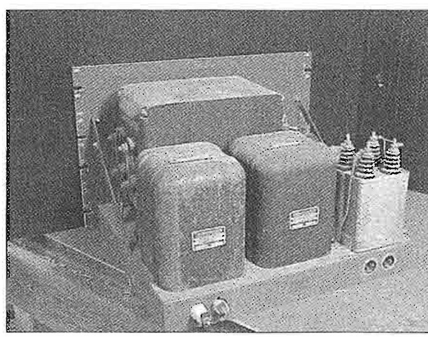


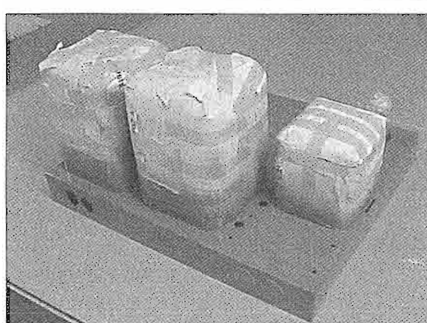


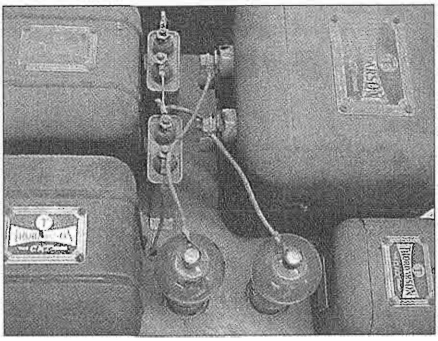
The restored modulator deck gleams like it did in 1938.

Left Column, 3 Lower Photos: The NTE exciter deck during restoration and the completed unit is below in tow photos. The NTE was covered in Part 1 of this series, ER #218.

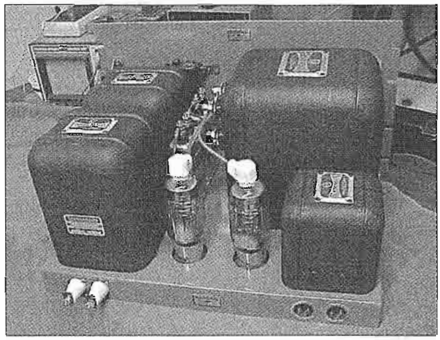
Below: The first photo is the NT-2000 high voltage supply before it was restored, and the photo below it was taken during refinishing operations.







The NT-1200 Medium Voltage Supply Before Restoration



The NT-1200 after restoration shows the same careful attention to detail.

follow, and give a representative sampling of Mort's work.

Mort has yet to power up his finished work, but it shows every sign of being able to come up on the air and put out a beautiful signal. I can hardly wait for it to be available, hopefully for the next AWA AM QSO Party. It would be an ideal Western Flagship Station for the contest. And a QSO between the James Millen transmitter at the AWA Museum in New York, under the call "W2AN," and Mort's James Millen transmitter signing "W1HRX," James Millen's former call, and now assigned to the James Millen Society, will be something I dream of listening in on.

Acknowledgments

I've had a lot of fun writing this series of articles. It would never have happened without a lot of help from three guys who had a big part in making it possible. Bill Fizette (W2DGB) certainly got me going by furnishing my NTX-30 and NSM pair along with a lot of information on how he restored his units and encouragement to get mine going. Bill also came through with a real, live NSA speech amplifier for that article and furnished pictures and a sidebar that made the article a whole lot better. Doc Khalsa (K7SO) was in it from the very start with the NTE exciter that he came up with on ebay. Doc also found Mort Jones (W6KLG) and his wonderful NC-600 and then visited Mort on one of his trips visiting family in California. Mort has also done a lot of work to get his NC-600 into showroom shape for this article. And all of these guys, Bill, Doc, and Mort have kindly read my manuscripts and helped to improve them both in content and writing style. Peter Patton also deserves thanks for rescuing Jim Millen's transmitter initially and for preserving their correspondence and allowing me to make use of it in this article. Lastly, our good editor, Ray Osterwald, has stretched his schedules and been highly cooperative with my efforts to get all of this ready for print.

So, I offer sincere thanks to all of you guys for your part in making all of this possible. It's been a lot of fun!

ER

RF Performance Testing of the R-390A/URR Receiver
Part 2, Testing and Understanding R-390A Performance

By Bill Feldmann, N6PY, SK

Part one described how a problem with intermodulation distortion in my R-390A was discovered and corrected. This second part will describe, in more detail, the test methods fixture used in the first part, along with the reasons for the R-390's outstanding RF performance. I'm going to present some equations to help explain and test receiver performance. I won't be going into great detail on the math involved, but there will be sufficient references given for readers wanting to better understand how these equations and concepts have been derived. Most of us are interested in the R-390A or other tube-type radios, so I'll mostly discuss the performance properties of these radio receivers.

Receiver Performance Terms

One of the most important things we need to know about a receiver is how weak a signal can it copy in the presence of very strong signals. This is best characterized by the receiver noise figure (NF) and intermodulation dynamic range (DR) values. A receiver's NF is the amount of noise, in decibels (dB), that has been added to a signal between its antenna input and audio output. It dictates the minimum detectable signal (MDS) it can receive. DR is the difference in dB between the MDS and the strength of the out-of-band signals that generate spurious signals ("spurs") in the receiver, that interfere with a weak signal near the MDS being copied. A receiver's NF and DR performance are directly affected by its RF/IF system performance, so our discussion will be confined to the RF through the last IF stages to show how they are tested.

MDS and IMD power levels are always given in decibels of power referenced to one milliwatt (dBm). Power in dBm is used instead of voltage because it's not dependent on a receiver's antenna-input impedance. Also, the nonlinear dB scale can easily express magnitudes as large as a billion units, 90 dB, with a resolution of 1 dB, or ¼ of a unit.[1]

For readers used to seeing 50-ohm receiver inputs expressed in microvolts or "S units," a 100-microvolt input would equal –73 dBm, or "S9" on Collins receivers calibrated for 6-dB-per-S unit. Therefore, 1000 µV would be –53dBm, "S9 +20 dB" on a Collins, and .01 µV is –153 dBm, way below an "S1" reading on the calibrated receiver.

From the tables in Part 1, a R-390 or R-390A in good condition is capable of copying CW MDS levels near .04 µV, showing how they are very sensitive receivers. Both of my receivers have the lowest MDS of any unmodified receiver I've tested.

Test Fixture Description

Figures 1A and 1B are schematics of the homebrew IMD test fixture used over the last 26 years. It's shown connected to my R-390A in Part 1, and was built as an experiment in 1980 using scrap material, so its appearance isn't very attractive. Critical parts of the fixture are enclosed and used coax wiring for best accuracy. It has the disadvantage of only working on 20 meters. Professional receiver testing is usually done using two signal generators capable of covering the receiver's complete frequency range, see reference 5. This fixture was a good compromise because 20 meters often has many strong signals capable of causing IMD spurs. It's good for MDS testing of double-conversion receivers because they usually don't have

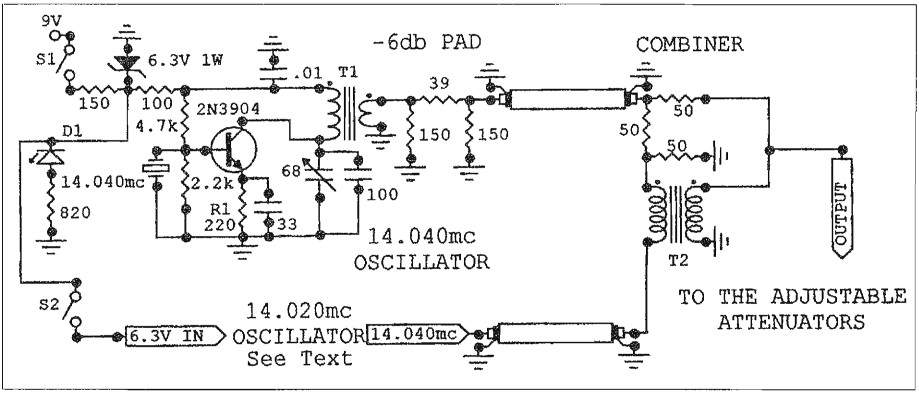


Figure 1A: Schematic of the IMD Test Fixture, Minus the Attenuators

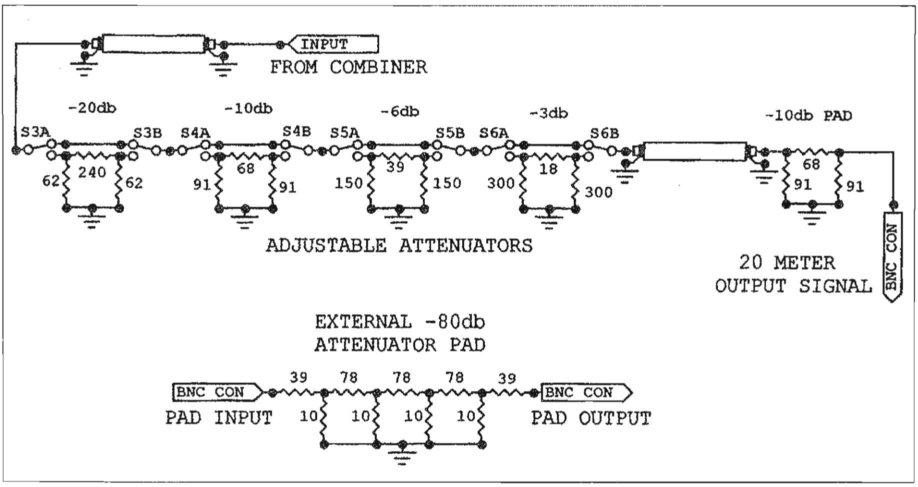


Figure 1B: Schematic of the Attenuators for the IMD Test Fixture

a great loss of MDS performance up to 10 meters. It's not good for testing older single-conversion receivers, like the SX-28, since their MDS performance drops rapidly above 20 meters.

On the left side of Figure1A is a 14.040-Mc crystal oscillator, identical to the low-harmonic and low-noise design suggested by Wes Hayward in Part 1, reference 1, of this article. A 9-volt battery, connected through S1 to a 6.3-volt Zener regulator, powers the oscillator and a 10-mA power-on indicator LED, D1. T1 is wound on an Amidon T50-2 toroid core with a 24-turn primary and 3-turn secondary. It's output goes through a 6-dB attenuator to the combiner, shown on the right. This oscillator is built on a small PC board and is enclosed in the box shown in the upper left-hand corner of **Figure 2** with its cover removed. A second identical oscillator and attenuator, using a 14.020-Mc crystal, is powered through S2, and is located inside the enclosure just below the first oscillator.

The –20 dB combiner is on the printed circuit board located on the left-internal wall of the fixture in Figure 2. T2 uses 10-bifilar turns on a T50-6 Amidon

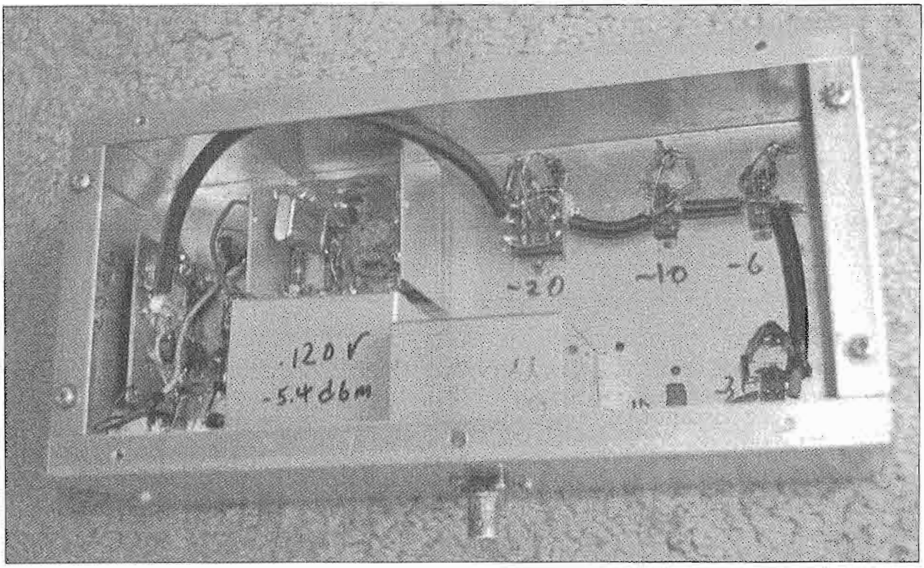


Figure 2: Inside the Homebrew IMD Test Fixture, Cover Removed

toroid core. Its output is connected to the attenuators shown in **Figure 1B** through a coax cable. They use 1%, ½-watt film resistors that are soldered to the terminals of DPDT slide switches, S3 through S6, for selecting attenuation. Resistors were paralleled to get non-standard values. The attenuator output goes through another length of coax to a –10 dB, enclosed-attenuator pad to the fixture's BNC-output connector, shown in the lower part of Figure 2. The pad isolates the adjustable attenuators from any 50-ohm mismatch. **Figure 1B** also has the schematic for a –80 dB attenuator pad that's used for MDS testing.

Test Fixture Calibration

The fixture was calibrated using a VTVM with an RF probe connected to the oscillator outputs at the combiner. Each oscillator's output was first peaked using the 68-pf trimmers, and then adjusted for a –5dBm output by selecting values of R1 near 220 ohms for a .12-VRMS reading on the VTVM. The combiner and output pad, together, have a total loss of –30dB, so adjusting each oscillator for –5dBm output gives a maximum fixture output of –35dBm. The oscillators and adjustable attenuators were later re-calibrated using a recently-calibrated HP3586 selective level meter but were found to be within 1dB of the output settings before re-calibration.

Using the Test Fixture

To test a receiver for MDS, the –80 dB pad is connected, S1 "on" and S2 "off," to power only the 14.040-Mc oscillator. The receiver's AGC is switched off, and using full RF gain, turn the BFO on, and the receiver is tuned for a signal at 14.040 Mc. Using headphones, the fixture's attenuators, S3 through S6, are set to produce an audio tone that is 3 dB above the receiver's idle noise. [Editor's Note: The 3-dB rise can be measured with a VTVM across the speaker terminal; the tone's audio voltage should be twice the idle-noise voltage, with volume set to produce ½ watt.] The MDS level is then calculated by adding the attenuator settings to –115 dBm. The cable to the receiver's input must be of good quality and be as short as possible when testing levels the high amplification of its 6AB7 1st-RF amplifier, its Req = 1.9k, even though it uses a noisy 6SK7 second-RF amplifier (Req = 11k), and a pentagrid mixer.

The TS-830S and FT-1000D have a low MDS due to good RF amplifier design, using modern FETs, where the FT-101B has a noisy dual-gate, FET-RF amplifier and a bipolar-transistor mixer.

Let's put some numbers for an R-390A into equation 2 to see how low an MDS we can expect from a R-390A. If we use a B = 1,000 cycles for CW selectivity, T = 290K for room temperature, NF = 6dB, and S/NdB = 3 dB for our test method, we get a value of −130 dBm. But, we measured a MDS of −145 dBm in the tables of Part 1. Suspecting something was wrong, the MDS testing procedure was repeated, not using headphones, because that's dependent on my hearing to detect the MDS audio signal. Using Wes Hayward's and the ARRL Lab's procedure of connecting a RMS Fluke multimeter across a 600-ohm resistor on the line-audio output of my R-390A, the line-output gain was set for a meter reading of 100 millivolts of the receiver's internal noise. I turned on the fixture and adjusted its attenuators for a meter reading of 140 mv, 3 dB over the 100-mv noise. The fixture's output was now −131 dBm, very close to the calculated value. But, listening in my headphones to the local audio output, I noticed how the tone was way above the noise. Using my hearing to set the tone 3 dB above the noise, the same −145 dBm level, "MDS3dB" as in Part 1, was obtained.

Human-Ear Audio Filters

After a lot of thought during a sleepless night, I saw the reason for this 14-dB difference. To explain it, let's do some backward reasoning. Suppose we connected an audio filter to the R-390A's audio output. For CW, let's use a filter bandwidth of 100 cycles, since some bandwidth is required for CW detection. Using equation 2 as before, but using B=100, we get a MDS of −145 dBm, and that's exactly the −145 dBm measured in Part 1. But, we used 1 kc of selectivity and didn't use an audio filter at the audio output in the tests of Part 1.

In my past experience, working for a company doing research into artificial hearing, I learned that we have nerve receptor sites in our ears for specific audio frequencies. We must have the ability to concentrate on the output from one site and compare the audio level at that site to random noise very close to the tone's frequency and not the total noise power over the IF bandwidth, as the meter method does. Therefore, we may have a narrow-band audio filter that's not in our radios, but in our hearing system! This also explains why there is very little change in MDS with IF bandwidth in the Part 1 tables.

Another interesting observation tended to confirm my theory. When listening to an audio tone, almost in the noise, if the BFO was adjusted to change the tone's frequency, it will really jump out of the noise at certain audio frequencies. I suspect the audio frequency is being tuned to the frequency of the more-sensitive nerve sites. I therefore feel my way of detecting the tone better reflects how we use a receiver for CW signals. My method does introduce some lack of precision since it's hard to resolve audio powers less than 3 dB by ear. But, my method has worked fine for evaluating worthwhile differences of many dB when comparing receiver performance and modifications. It also allows me to compare receivers of different bandwidth, since our hearing of single-frequency tones *may not be affected by wide-band noise*. For more precise MDS testing simulating hearing, the RMS-AC meter detection method could be used with an audio filter.

From the above MDS measurement examples and discussion I feel it's best to specify receiver sensitivity as noise figure (NF) because it's independent of bandwidth, hearing ability, and is easily measured. But, please don't jump to the conclusion that bandwidth isn't important. While receiver bandwidth may not be important for random noise, it's very important in the presence of QRM and man-made pulse noise. Also, don't think that the MDS signal levels we tested are power levels into the antenna. Everything we add before the receiver will add it's own NF.

One may wonder, why do we need a receiver with a MDS over −130 dBm, way below the usual QRN, even on 10 meters? This is because with a less-than-ideal antenna, like a short whip that degrades the S/N ratio of a very weak signal at the antenna input, a very sensitive receiver will have the capability to copy it where one with less sensitivity will not. High sensitivity also gives the versatility of trading a loss of unneeded sensitivity for much better IMD performance by just adding an input attenuator.

Strong-Signal Problems

As mentioned in Part 1, there are many strong-signal problems. Two common ones are blocking and cross modulation. A nearby strong signal may cause current to flow in the grid of a tube, changing its bias, and thereby lowering its gain. This gain-compression blocking will cause a decrease in sensitivity. Cross modulation happens when a strong signal, modulating an amplifier's gain, causes its modulation to be transferred to a weaker signal being copied. But, IMD spurs usually occur at much lower levels in tube amplifiers than in the others. So, testing for IMD is a good overall predictor of strong-signal performance.

When testing for IMD spurs, two closely-spaced signals are used because they won't be attenuated by the receiver's preselector system. But, the signals causing IMD won't necessarily be the same in strength, or even be CW signals. Signals of different modes, like SSB, can cause spurs that sound like "splatter." Very strong QRN-like, power-line noise signals can generate IMD products and yet more noise. A method using two equal CW signals is the most practical way to test and compare receiver susceptibility to IMD problems.

Let's look at equation 4 from reference 3, which is the general-transfer equation for any device, circuit, or electronic system, like a receiver, where "Y" is the output in power, current, or potential.

Equation 4:

$$Y = K1\left[f_x\right] + K2\left[f_x\right]^2 + K3\left[f_x\right]^3 + \ldots$$

K1 through K3 are constants that will be above "one" for circuits with gain, like amplifiers. For RF signals, the f_x terms are complicated functions of input, time and phase angles. If the transfer curve of output vs. input is plotted for a perfectly linear device, like an amplifier, using a ideal sharp-cutoff tube, the terms of the equation after the K1 $[f_x]$ term are zero. So, our transfer plot of Y vs. input or f_x will be a perfectly straight line. For an amplifier using an ideal remote-cutoff tube, like an amplifier with AGC control, the first two terms are not zero and our transfer curve will be a curved line having only second-order curvature.

But, it's impossible to build tubes that won't generate higher-order terms that will cause intermod spurs. If we have two signals, F1 and F2, presented to the input of an amplifier with the first three parts of equation 1 above zero, their second harmonics, $F1^2$ and $F2^2$, will be generated and mix with the original signals resulting in spurs at ($F1^2$ – F2) and ($F2^2$ –F1). If F1 and F2 are 20 kc apart, the spurs will be 20 kc above and below the original signals, at 14.000 Mc and 14.060 Mc using my fixture. In a device with even-order products, F1 and F2 and their harmonics can mix, producing even-order spurs. But, these spurs require very wide frequency spacing of F1 and F2 so are *not* of concern in a R-390A with peak-tuned RF and IF filters! They will be of *great* concern in many modern receivers using broad-band filtering.

Mixers tend to generate even stronger spurs than a Class-A RF amplifier because they are driven into very high curvature, or cutoff regions, of their transfer curves. Even with its high-RF amplification, the single-conversion SX-28 has relatively good IMD performance, see Table 1. This is because the 2nd mixer in a double conversion receiver can be very susceptible to IMD because of higher, amplified signal levels. Table 1 shows how overdriving of passive IF devices, like the later IF stages in a FT-101B, and when the R-390A's crystal filter is switched out for 8-kc selectivity, will generate IMD spurs. In Part 1, we reduced the gain at the filter input by the addition of a 3.3-k resistor that corrected the R-390A's IMD performance with no loss of sensitivity because of its very high RF/IF amplification, over 80 dB, between its antenna connector and filters.

The strength of a 3rd-order IMD spur increases at a rate of 3 dB for every 1 dB increase of IMD-causing input signals. But often, higher-order terms are usually present that produce odd-order spurs at higher increasing rates and different phase angles at the same frequency as the 3rd-order spurs. These spurs will affect the level of the spur 3rd-order spur being tested for by adding to or subtracting from it. The signal input vs. spur curve will not be a straight line and will deviate from the expected 3/1 slope, see reference 3.

3rd-Order Intercept

IP3 (3rd-order intercept) is often used to specify receiver IMD resistance. It's defined as the receiver input power level of one of two equal-strength signals causing a 3rd-order spur, where the spur's output will equal the output from the signal causing the spur. It's impossible to directly test for IP3 because the receiver would go into gain compression at such high power levels, so it must be calculated. It's calculated from the assumption that the IMD spur is only of 3rd order, increasing at exactly a 3/1 ratio of signal input. But, in real receivers this is almost never true and from the above discussion and examples in reference 3 and reference 4, IP3 cannot be accurately calculated. Because of this, I prefer to rate receivers IMD performance by DR or IMD signal-causing levels because they can be accurately tested for and verified using signal generators or my fixture.

I feel NF and DR are the best ways to specify receiver sensitivity and intermod-dynamic range because they can be verified by careful testing and are independent of receiver bandwidth. However, the accuracy of their tests are dependent upon bandwidth. Testing the NF of older receivers with wide, poor, shape-factor IF filtering can be done with good accuracy using the meter method of detection and a very flat, good shape-factor audio filter between the receiver's output and the RMS-AC meter. My fixture also can be used with the addition of a 0 to –3 dB adjustable attenuator with a resolution of at least ¼ dB.

Accurate DR testing could also be done using my fixture as suggested for NF testing. But, the MDS and IMD should be tested for at exactly the receiver's noise floor thereby removing inaccuracies caused by the fact the IMD spurs raise at near a 3/1 ratio faster than the MDS signal. This DR would be an improvement over using an inaccurate and unverifiable IP3 number.

I hope the above discussion will help explain the reasons for the excellent RF and IF performance of the R-390A. I hope this article has been as educational for you as is was for myself. For myself, writing and doing the research for it was very enjoyable but would have not been possible without the hard work and great articles of those listed in the table of references for both parts of this article.

References:

1. D. Smith, KF6DX, "In Search of New Receiver-Performance Paradigms," ARRL, QEX, Nov/Dec 2006

2. F. Terman, 1947, Radio Engineering, Third Edition McGraw-Hill, pg. 578.

3. U. Rohde, DJ2LR, "Theory of Intermodulation and Reciprocal Mixing," ARRL, QEX Nov/Dec 2002, pg 2, and QEX, Jan/Feb 2003, pg 21.

4. D. Smith, KF6DX, "Improved Dynamic Range Testing," ARRL, QEX Jul/Aug 2002 pg 46.

5. U. Rohde DJ2LR, "Receiver Measurements," ARRL, QEX Jul/Aug 2005 pg 3.

Footnotes:

1. Editor's note: Since it was introduced in 1929 by the Bell System as a transmission unit, the decibel is defined *only* as the log of a ratio of two units of power. It is not a unit of measurement, such as an "inch," because a power ratio does not have a dimension. When a transmission level in a system is expressed as power, it is not necessary to state an impedance. This power is called "0 dBm." When a level is expressed as a voltage, impedance is mandatory. A level expressed in dBm can appear across any impedance and will *always* be the power level. Voltages will vary to maintain this power level. Any other kind of a ratio (voltage, current, etc.) must first be converted to a power *ratio* and then into a specific power *level*. Engineers and technicians prefer using "dBm" because system levels may be directly compared, added and subtracted, etc.

The decibel is relative. If "10 dB" is mentioned, it means nothing in terms of absolute values. The dB has be be referenced to something to be absolute. For example, the "m" in dBm means the reference is one milliwatt. There are *many* reference units.

2. Editor's note: A term called "environmental degradation," expressed in dB, tells how much effective receiver sensitivity is reduced when connected to a real antenna. At HF, there is a tremendous amount of atmospheric and man-made noise present, even on 10 meters. For example, at midnight in a quiet location, during mid-winter, a 10-meter dipole will easily show –120 dBm across the antenna impedance, and -110 dBm at 20 meters. Under these conditions, the low MDS measured on the bench is not directly useable. However, a low MDS has other performance benefits besides ultimate sensitivity due to the nature of the noise and the way receivers and their human operators work. Noise and receiver sensitivity could be an entirely separate article.

3. Editor's Note: An often-overlooked noise source in RF amplifiers having the input and output circuits tuned to the same frequency is caused by feedback originating in the inner-electrode capacity between the tube elements, mostly plate-to-grid. This broad noise source was not taken into account in classic equivalent-noise calculations, but can be seen on modern spectrum analyzers, and is much higher than shot noise caused by current flow in the tube. Actually, most of the "hissing" noise in a receiver comes from this feedback-produced source and not from the RF tube's equivalent-resistance calculation. Receivers with a mixer as the first stage can be made much quieter *if* the input coils are properly designed.

4. Editor's Note: Gene Senti (WØROW), the 75A-4 designer, told me that a 6BA7 mixer was used because it has superior cross-modulation performance compared to triodes.

ER

The Mars MT-75 Thunderbird Mobile Transmitter

By Walt Evanyk, W8KSW
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Plano, Texas 75074
shaneford@aol.com

Most of us (especially us old timers) have had, or have seen, ham radio SWR and field-strength meters labeled "Mars." Pausan Company had a division called "Mars Amateur" that produced a line of products for amateurs. They supplied a hybrid phone patch, the Mars LE-2, and also had a line of miniature, clear-plastic panel meters that many of us used in our homebrew projects, along with a CW monitor, and both 50-ohm and 75-ohm low-pass filters.

While scouring the indoor flea market at Belton, Texas, I happened to find another great product from this company. It was a Mars MT-75 Thuderbird mobile transmitter. I paid $25.00, not even really knowing what it was or its operating condition. The XYL doesn't understand why I do these sorts of things, but I usually just look at the parts, and decide if I can, at least, use them. She says, "You have boxes of those funny items!"

The MT-75 is a small mobile transmitter, 7-½ x 5 x 4-½ inches. Their sales flyer listed its original cost at $59.95.

In this situation, I obtained a pristine miniature transmitter that is built for phone operation in the 75-and-40 meter ham bands. The original box, schemat-

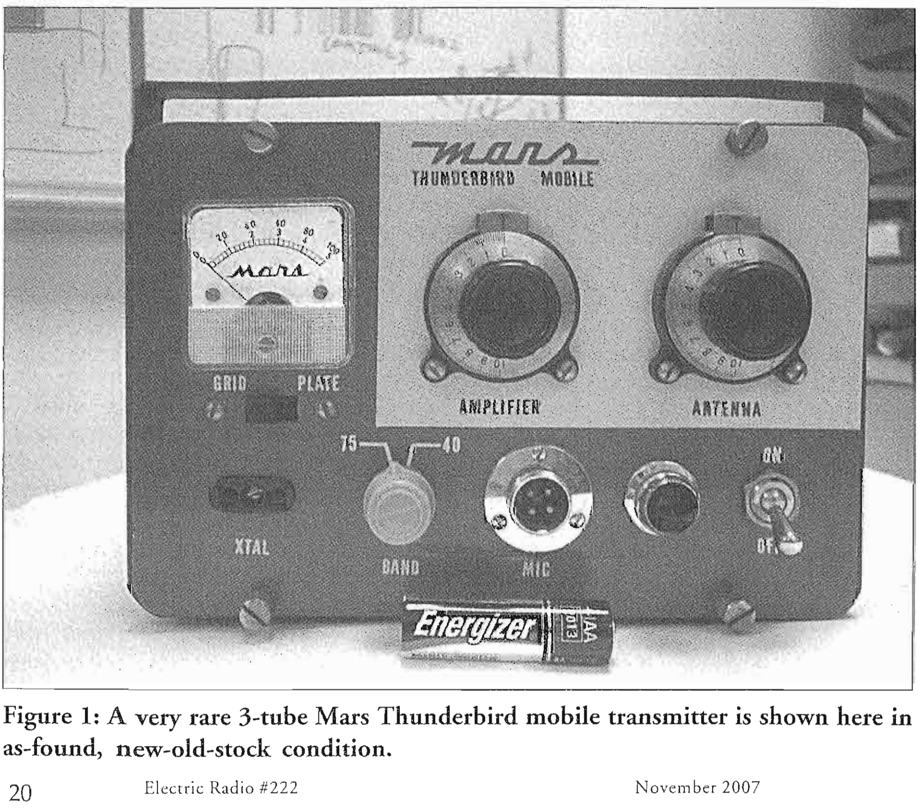


Figure 1: A very rare 3-tube Mars Thunderbird mobile transmitter is shown here in as-found, new-old-stock condition.

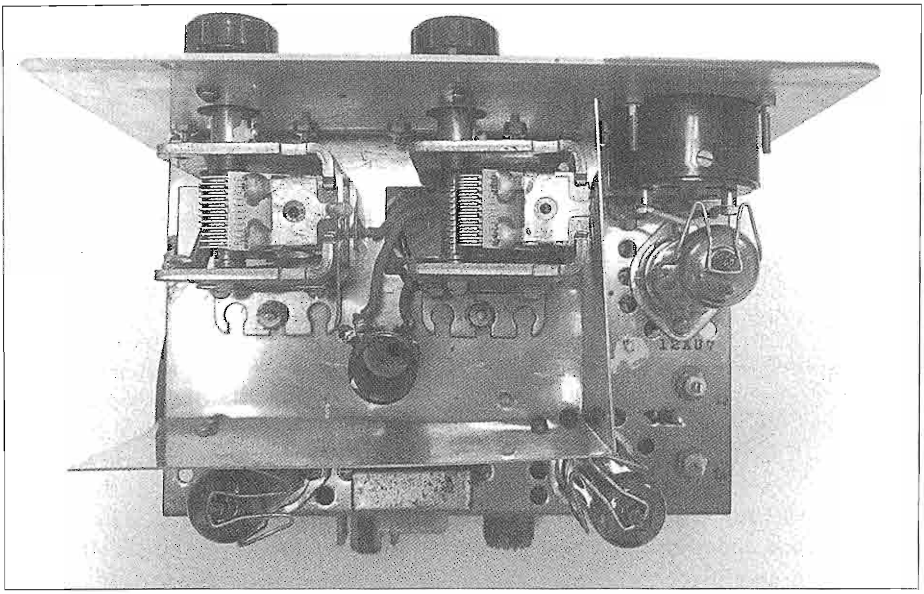


Figure 2: The top-chassis view of the Mars MT-75 shows how the copper chassis is still gleaming like the day it left the factory.

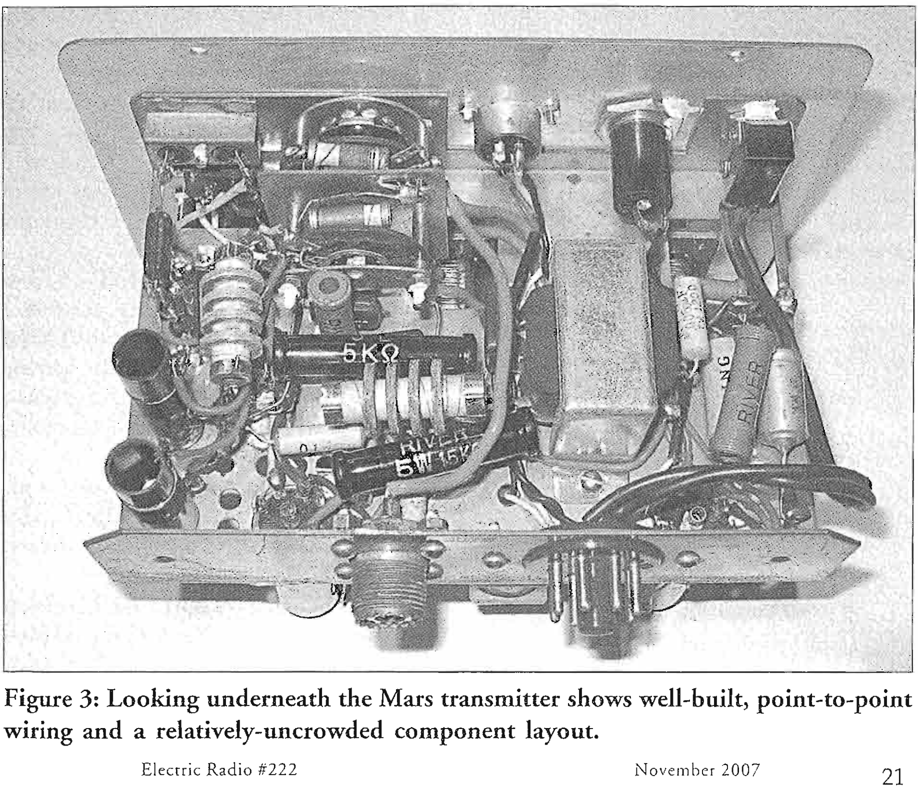


Figure 3: Looking underneath the Mars transmitter shows well-built, point-to-point wiring and a relatively-uncrowded component layout.

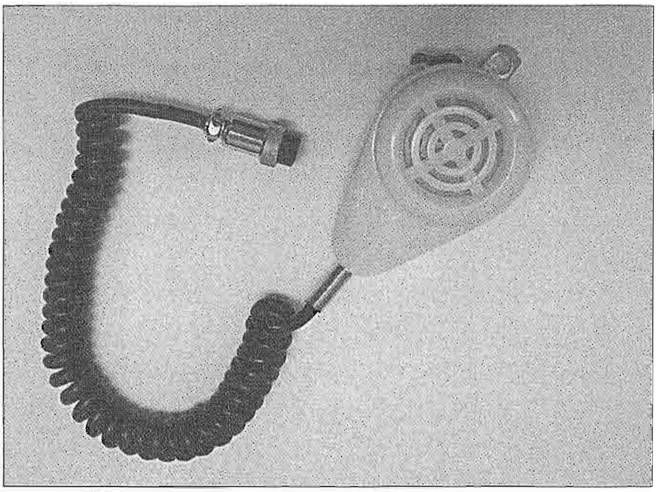


Figure 4: The mic supplied with the MT-75 was a single-button carbon style for higher-speech output into a single-tube speech amplifier.

ics, manual, microphone and power cord were included.

It is a very simple and delightful transmitter. The chassis is heavily copper plated and is still gleaming yellow. Above-and-below chassis views are shown in **Figures 2 and 3**.

It has 15-watts input power, and the transmit audio is outstanding. The signal it produces lives up to the flier's claim as being cleaner and huskier than most transmitters with three times the output.

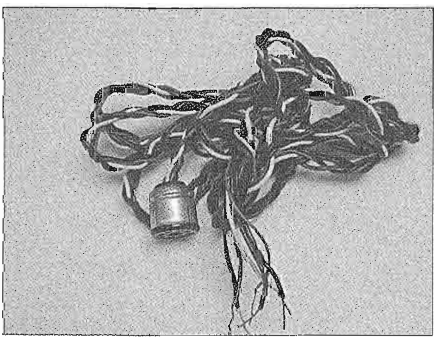


Figure 5: The original control-cable wiring had never been installed.

The grid-and-plate currents are metered, it is push-to-talk ready and has two 8-to-1, vernier-tuning knob assemblies for the amplifier and antenna. The transmitter is rock bound between 3000 to 5000 kHz and 4500 to 8500 kHz.

This one is wired for 12 VDC (can be made 6-VDC compatible). The external-power requirements are 300 VDC @ 150 mA, under load. The MT-75 came with its own single-button carbon mike. The mike looks like a standard communications-grade unit and is pictured in **Figure 4**.

The power supply interconnect cable assembly, **Figure 5**, had no indications of having ever been used.

I've been powering this one from an old Mallory vibrator-power supply, with the vibrator replaced with a solid-state swap. (This Mallory unit even has a tube rectifier and provisions for a regulator tube.)

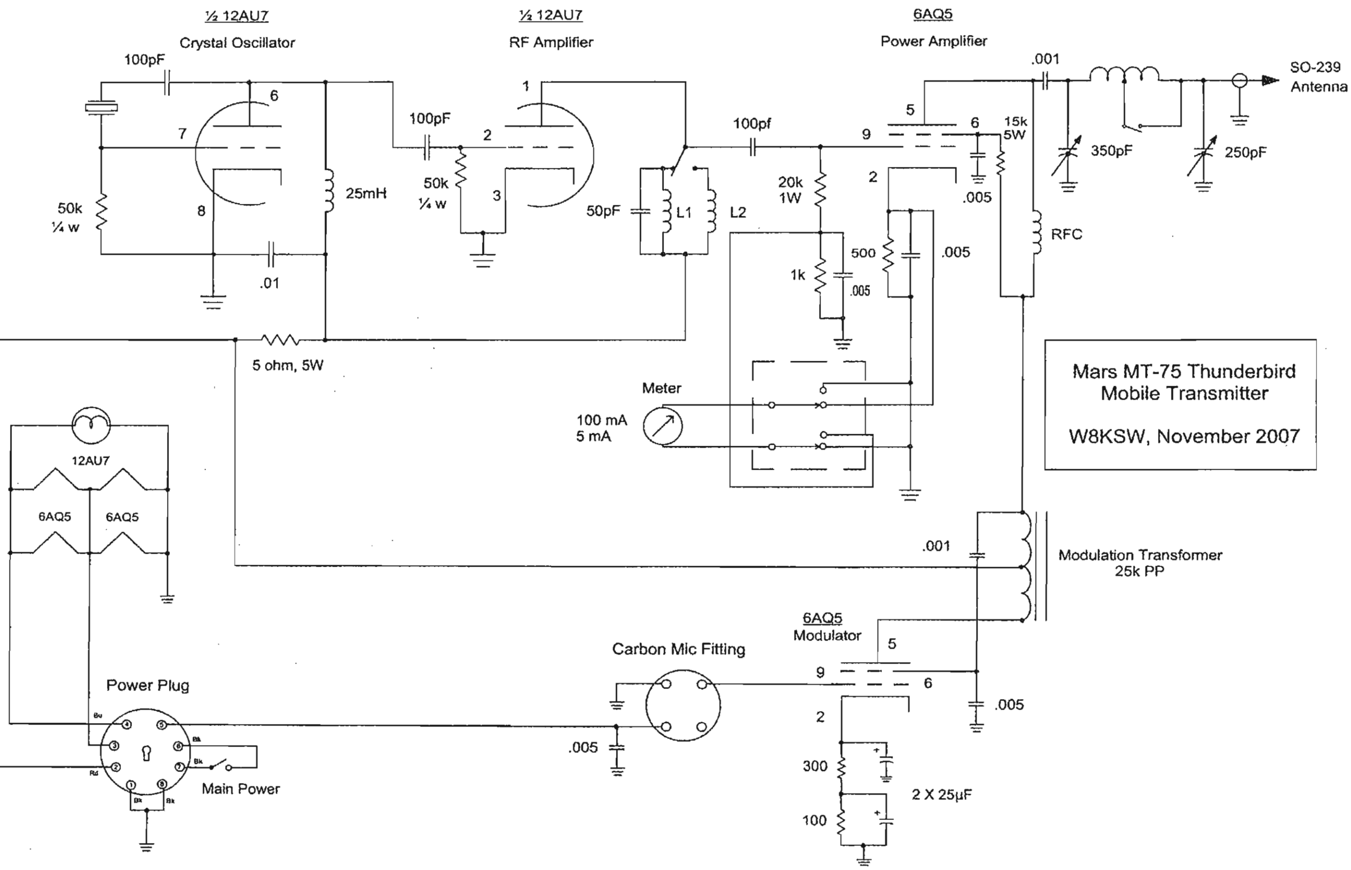
The audio reports of the MT-75 have been fantastic. I can tell why, because I listen to its modulation with an ICOM ICR1 monitor and I always use a scope (a tip I picked up from Tim, N5DWV), and a monitor receiver when transmitting with AM modulation.

The MT-75 uses a 12AU7 as an oscillator and buffer, a 6AQ5 as a final and a 6AQ5 as the modulator. That's correct, three tubes, all hollow state!

The schematic (**Figure 6**) has been redrawn since the original, being printed on actual rice paper, has turned color and is very fragile.

The secret of the great audio is partly

Figure 6


Mars MT-75 Thunderbird
Mobile Transmitter
W8KSW, November 2007
½ 12AU7
Crystal Oscillator
½ 12AU7
RF Amplifier
6AQ5
Power Amplifier
100pF
100pF
100pf
.001
SO-239
Antenna
50k
¼ w
25mH
.01
50k
¼ w
50pF
L1
L2
20k
1W
1k
.005
500
.005
.005
15k
5W
RFC
350pF
250pF
5 ohm, 5W
Meter
100 mA
5 mA
12AU7
6AQ5
6AQ5
.001
Modulation Transformer
25k PP
6AQ5
Modulator
Carbon Mic Fitting
Power Plug
Main Power
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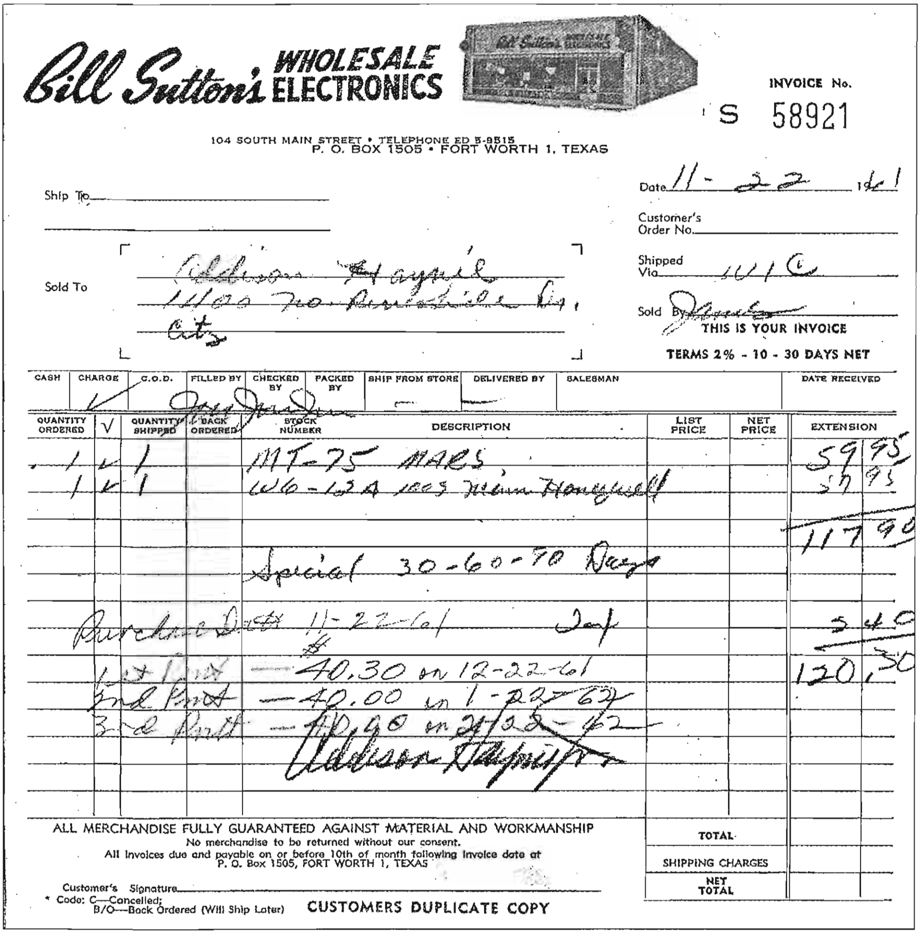
.005
300
100
2 X 25µF



Bill Sutton's WHOLESALE ELECTRONICS

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104 SOUTH MAIN STREET • TELEPHONE ED 5-8515
P. O. BOX 1505 • FORT WORTH 1, TEXAS

Date 11-22 1961

Ship To

Customer's Order No.

Sold To Addison Haynie, 1100 No. [illegible], City

Shipped Via [illegible]

Sold By [illegible]

THIS IS YOUR INVOICE

TERMS 2% - 10 - 30 DAYS NET

CASH	CHARGE	C.O.D.	FILLED BY	CHECKED BY	PACKED BY	SHIP FROM STORE	DELIVERED BY	SALESMAN	DATE RECEIVED
	✓								

QUANTITY ORDERED	√	QUANTITY SHIPPED	*BACK ORDERED	STOCK NUMBER	DESCRIPTION	LIST PRICE	NET PRICE	EXTENSION
1	✓	1		MT-75 MARS				59 95
1	✓	1		W6-13A 100.3 Minn Honeywell				57 95
								117 90
				Special 30-60-90 Days				
Purchase Date 11-22-61								2 40
1st Pmt — 40.30 on 12-22-61								120 30
2nd Pmt — 40.00 on 1-22-62								
3rd Pmt — 40.00 on 2-22-62								
Addison Haynie								

ALL MERCHANDISE FULLY GUARANTEED AGAINST MATERIAL AND WORKMANSHIP
No merchandise to be returned without our consent.
All invoices due and payable on or before 10th of month following invoice date at P. O. Box 1505, FORT WORTH 1, TEXAS

TOTAL

SHIPPING CHARGES

NET TOTAL

Customer's Signature

* Code: C—Cancelled; B/O—Back Ordered (Will Ship Later)

CUSTOMERS DUPLICATE COPY

Figure 7: The original sales receipt for the MT-75, from 46 years ago, November 1961, was found included in the box.

because of the high-level plate modulation. Note the simplicity illustrated in the schematic of the circuitry. One could very easily homebrew a copy to use as a driver. I have had excellent results driving Johnson Thunderbolt and Johnson Courier amplifiers.

The MT-75 also came with some personal history. Notice the enclosed invoice from 1961 that's shown in **Figure 7**. All the original documents were in an envelope that was mailed to a Ralph Samples (W5FFB) in Fort Worth, Texas, from Oklahoma City, OK, in 1989.

The original purchase was made in Fort Worth, Texas, by Addison Haynie on November 22, 1961, from Bill Sutton's Wholesale Electronics.

In continuing to research Mars and this rig, I recently have learned there was an "A" version offered (1962 or '63) that had the ability to tweak the oscillator from the front panel, as well as providing AM and CW operation. Perhaps I'll find one of these someday.

ER

US Army Engineer Communications in the 34th Engineer Group

Vietnam, 1967 to 1968, Part 1

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Preface

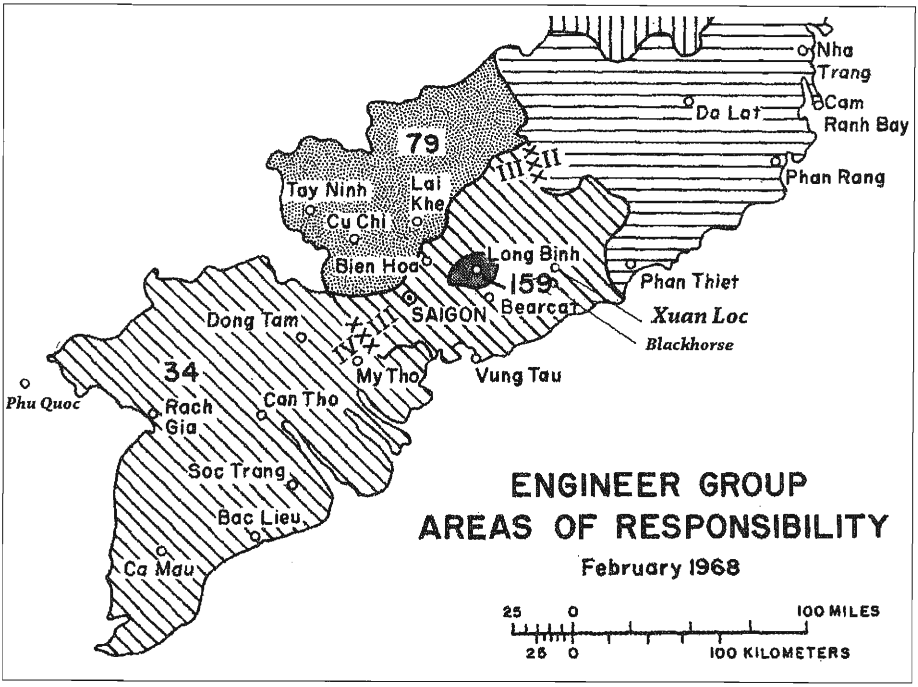
While searching through old documents here at W3LW, I came across a paper I had written on my Army unit communications experience shortly after returning from an assignment with the 34th Engineer Group (Construction) (34th) in the Republic of Vietnam (RVN) from September 1967 through September 1968. It occurred to me that with revisions, it might be of interest to those of us utilizing vintage US Army Signal Corps equipment even today. Originally written for a Signal Corps audience, but never published, it has been extensively modified here to provide much more detail on the utilization of the various types of tactical communication equipment utilized by our forces. This series will discuss many pieces of communications equipment now completely obsolete in the US Army yet many of these items are utilized today by amateurs interested in restoring and maintaining military communications gear. Included herein are various tactical HF and VHF/UHF FM radio systems, telephone and radioteletypewriter (RATT) gear, telephone and landline teletypewriter (TTY) equipment with radio wire integration (RWI, i.e. phone patch) and also some discussion on larger area multichannel line of site (LOS) VHF/UHF and microwave and tropospheric scatter (TROPO) radio relay systems used to tie various military units together in a theater of operations. A short section on the Military Affiliate Radio (MARS) system in Vung Tau is also included. I hope to present a written and visual "snapshot" of how we solved communications requirements in a field situation that often had supported elements at such distances and available frequencies that reliable communications with organic equipment were not always possible.

During my tour with the 34th, I was assigned first as the Group Public Works and Utilities Officer in the operations section (S3) for approximately 6 months. I then became the Group Signal Officer (SigO) when the then current SigO left to take over as the Executive Officer of one of the battalions. During this 12 month tour, I got involved in civil works projects (roads, bridges, airfields, buildings, water supply and the like), as well as communications and electrical power projects. Some event timing is from my recollections as well as from reference 1 and may not be exactly correct. The author invites corrections and updates.

Introduction

The conflict in the Republic of Vietnam provided an extensive test of then current U. S. Army Doctrine in all phases of Army operations. The unusual deployment of troops and supporting units and lack of "front lines" in the Vietnam Theater of Operations compared to previous engagements necessitated many variations and

34th Group Crest



modifications of then current standard Army doctrine. These variations were significant in the Army combat and construction Engineer units deployed throughout South Vietnam not only for construction equipment and methods, but also with regard to HF and all forms of communications.

The object of this article is to discuss some of the mission requirements, the communications equipment and means, and the communications problems encountered by the 34th within and without of the operational chain of command. While communications sometimes presented unique challenges, the civil engineering projects had their own issues with equipment maintenance, project scheduling, and supply. But that is a whole other subject that will not be explored here. The mission included a significant civilian works component and the area of operations (AOR) resulted in spreading of battalion and other unit elements over wide areas exceeding reliable communications distances. In this theater during this period, all units generally were assigned a primary frequency and one alternate for each radio system for a given period of time. These frequencies were assigned without regard to propagation conditions and sometimes without regard to intersystem interference. The requirements of the commander and his staff, all who were constantly traveling, and the means and equipment used to provide necessary communications support is also included.

The 34th was initially deployed to Xa Vung Tau (Village Vung Tau or Cap. St. Jacques) on the South China Sea in then Phuoc Tuy Province at the entrance to the Song Dong Ni (River Dong Ni) leading up to Saigon. The approximate HQ coordinates were 10-21-42.5N, 107-05-37E. The 34th arrived in Vietnam in March of 1968 from Fort Lewis, Washington and quickly came under the operational control of the 20th Engineer Brigade (BDE) headquarters at Bien Hoa about 25 km NNE of Saigon, an Army Corps level unit with a broad Engineer combat and construction mission and responsibility of supporting combat operations over a wide area of III and IV Corps in southern South Vietnam. The 34th was operating as a Modification of a Table of Orga-

UNIT	LOCATIONS	ARRIVED	DEPARTED	DISTANCE
20th Engr BDE	Bien Hoa			74 km
27th Combat Bn	Xuan Loc/Camp Eagle	1 Oct 1966	31 Jan 1972	65 km
31th Combat Bn	Vung Tau/Xuan Loc	24 March 1968	12 March 1972	65 km
36th Construction Bn	Vung Tau	1 Sep 1967	30 Apr 1972	0 km
69th Construction Bn	Vung Tau/Can Tho	2 May 1967	17 Nov 1971	0/140 km
86th Combat Bn	Blackhorse/My Tho	16 Oct 1966	15 Aug 1969	30/122 km
93rd Construction Bn	Bearcat/Dong Tam	21 Jun 1967	31 July 1971	30/80 km
156th Well Drilling Detachment (Det)	Phu Quoc Island			330 km
536th Port Const. Det	Vung Tau			0 km
544th Support Co	Vung Tau			0 km
573rd Float Bridge Co	Long Binh	24 Mar 1967	20 Dec 1968	75 km
617th Panel Bridge Co	Long Binh	4 Nov 1965	15 Jun 1970	75 km

Table I: Units of the 34th Engineer Group

Notes to Table I

- The 20th Engr Brigade was the higher Headquarters above the 34th Engr Gp.
- The 27th Bn was transferred to Camp Eagle under the 45th Engr Gp on 12 April 1968.
- The 31st Bn was only assigned to the 34th Group 24 March to 1 July 1968.
- The 69th Bn moved to Can Tho in Oct 1967.
- The 86th Bn joined the 34th Gp in Apr 1967 then transferred to My Tho in Mar 1968 and reassigned to the 45th Engineer Gp.
- The 93rd Bn Main was at Bearcat and approximately ½ the Bn relocated to Don Tam to assist in the construction of a new base camp for the 9th Infantry Division (ID). The 9th ID completed the division relocation in July 1968. The 93rd also constructed the Long Thanh North airfield which still exists today based on satellite images on Google Earth®.
- The 544th was a Port Construction Support Co with quarry operations, several asphalt plants, and large truck for hauling rock and asphalt.
- Distances refer to greatest airline distance to any portion of the unit used for HF communications.

nization and Equipment (MTOE) Army unit. The MTOE designation allowed some flexibility in organization and equipment selection to adjust to the operational situation, which made adapting to the needed communications challenges a bit easier. At the time of my arrival, the 34th had been "in country" for about 6 months and already consisted of a Headquarters and Headquarters Company, 5 Engineer battalions (Bn) and approximately 5 separate companies and detachments totaling about 4500 troops. The mixture included combat and construction battalions, a light equipment company, two portable bridge companies, a port construction detachment, and a construction support company, among others. A 6th Bn, the 31st, briefly joined the group raising the troop count to approximately 5500. As I remember, at one point, we had upwards of

7-10 separate attached companies and detachments.

Left over from the Korean era with some modifications with replacement equipment, the normally authorized communications gear for routine radio voice in the Engineer battalions and separate companies was both the AN/GRC-19(*) and the AN/GRC-46(*) and a few of the VHF FM VRC-12(*) family of radios. The Engineer battalion headquarters signal section also had the AN/GRC-46 for both voice and secure radioteletypewriter (RATT) communications with higher headquarters and with supported units as needed. The Group and Brigade HQ had the AN/GRC-46 and the Group did not have FM VHF equipment. This mix was chosen previously because these higher headquarters were relatively static, and from previous doctrine, employed landlines installed by Signal Corps units for both voice and teletypewriter (TTY) communications. This system was generally known as an "area" communications system operating much like a Bell System/AT&T telephone company in the 1950s and 1960s The 34th Group had authorized AN/GRC-46(*) radios that could be used by the Group staff during periods of "on the move". The radios could be outfitted for shelter use in ¾ and 5/4 ton vehicles as well as in a voice only configuration in the Ford supplied M151A1 "jeep".

34th Engineer Group Mission and AOR

The mission of the 34th and its assigned units in the Republic of Vietnam was to provide combat support, combat service support and construction support to US and Allied units within its AOR and to act as Infantry if necessary. This mission included support of Infantry, Mechanized Infantry, and Armored Calvary Divisions combat operations, Artillery batteries and fire support bases, land clearing, mine and booby trap sweeping, enemy weapons cache hunting and destruction, direct support to the Royal Australian Engineers on US Engineer doctrine and communications, and the design and construction of roads, ports, airfields, bridges, buildings of all types, quarries, wells, POL facilities, water supply, and sewage treatment plants. In addition, a significant effort was expended in support of Vietnamese Army and civilian projects. A special staff officer of the grade of Major was assigned to the operations section specifically for civilian works management. As shown in Figure 1, the 34th Gp area of operations during my tour included a portion of III Corps and nearly all of IV Corps. This later changed to mainly IV Corps by February 1969.

Initial Conditions for the 34TH

The arrival of the 34th was part of an expanded Army Engineer presence buildup and the area previously under the control of the 159th Engineer Group was being split between the 159th and the 34th. When the 34th arrived "in country" in March 1967, all operation facilities and troops were initially housed in a mixture of tents and permanent buildings, but the unit quickly established headquarters infrastructure construction and communications in standard field fixed fa-

Lieutenant Larry Will (W3LW) is on a mission with a helicopter crew.

cilities. At first virtually all hard copy (the Army term is RECORD) communications was via the message center or courier, while voice communications handled by common user telephone circuits. Theater of Operations common user circuits are not unlike the U.S. telephone system in structure but usually using operators to set up calls and operating on a smaller scale. At this point in time, the 39th Signal Bn, a unit of the US Army 1st Signal BDE, was expanding post communications in Vung Tau and the total troop density was relatively low so Class "A" common user circuits were relatively easy to obtain. Class "A" circuits allowed for long distance phone access while Class "C" phones only worked within the local exchange. The Army telephone TA-236/PT was used which essentially was a Western Electric 500 set. The 34th Engineer Group reported directly to the 20th Engineer Brigade in Bien Hoa roughly 74 km distant. As long distance service, which was provided by elements of the 1st Signal Brigade, improved around III Corps, the common user telephone became the natural medium for normal telephonic communications. Even 7 digital number dialing was begun in Vung Tau and Bien Hoa while I was "in country". The area message center, operated by elements of the 1st Signal BDE was a complete facility for the secure transmission of all RECORD traffic. Area message centers were standard in the Corps AOR because many Corps support units had little or no organic communications equipment. Messages were hand written on standard forms, delivered to the center where they were then sent by TTY on the Signal Corps long distance infrastructure to any user anywhere in the world. I'll cover some of the radio long lines equipment used in the area system in Part III.

As shown in TABLE I, the 34th Engr Gp had units all over the southern half of South Vietnam. The 36th Engineer Bn (CONST) arrived in Vung Tau on 1 September 1967 and the 69th, replaced by the 36th Construction Bn, relocated to Can Tho about 102 km distant along the Song Mekong (Mekong River) in the delta. The 86th Bn relocated to Blackhorse, home of the 11th Armored Calvary Regiment (ACR, the BLACKHORSE Regiment), and assigned to provide support to the 11th (Figure 2) among other duties. The 93rd Bn was assigned direct support of the 9th Infantry Division at Bearcat adjacent to Bien Hoa.

In the first 6-8 months of the 34th deployment, the 34TH Gp HF AM voice and RATT equipment was not really needed as the units were making do with common user circuits and courier service. Prior to my taking over as the 34th Group Signal Officer (SigO), an AN-GRC-46(*) HF AM/RATT net was established to connect each Bn Headquarters with the 34th Group and also to connect the 34th with the 20th BDE HQ primarily to handle classified RECORD traffic by radio rather than by the area message center.

As the troop buildup continued, the 34th became one of three groups assigned to the 20th Engineer BDE. This configuration with only slight modifications continued until February 1969 when the 34th Headquarters, supporting a shift in the unit area of responsibilities, relocated to Bin Thuy adjacent to Can Tho along the Song Mekong in IV Corps. The 20th is still in existence, redesignated as an Army Corps Airborne Engineer Brigade and headquartered at Fort Bragg, NC.

As the tactical situation evolved, some of the battalions were split and elements spread over large areas with organic and attached units sometimes 75 to 140 km from battalion headquarters. The separate companies for the most part reported to group headquarters for operational orders but were sometimes attached to local supported units for rations and quarters. Many of the Army camps had consolidated field mess facilities. [Next month, part 2 continues with radio communications systems.]

ER

Those Pesky 70-Volt Audio Transformers

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Introduction

You have probably seen boxes of them at the ham flea market, both loose and attached to ceiling speakers, and you might even have several of them in your junk box. I am talking about those transformers with 4, 8, and 16-ohm marked terminals on one side and power levels like 1, 2, and 5-watts printed on the other side. Since there is virtually no information on the primary impedance, most of us simply throw these in a box and forget about them. What if I told you that they were actually very useful audio-multimatch transformers, well suited to handing vintage and military receiver output impedance matching?

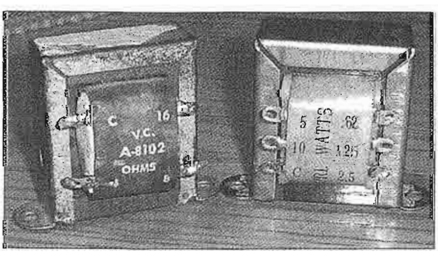
70-Volt Sound Systems

The ceiling speakers which are required in building sound systems, including music and intercom systems, must be easy to install and adjust and they must be inexpensive; oh, and I almost forgot, they must have musical sound quality! On first principles, this could be accomplished with a simple series-or-parallel speaker system.

Consider a 20-speaker parallel system with 8-ohm speakers and the need to deliver 2 watts to each one. The combined load would be 8 ohms/20, or an impedance of 0.4 ohms. Theoretically, you would need only 40-watts RMS to drive them. Unfortunately, real-world losses would wreck your plans, even if you used good speaker wire. The impedance mismatch of the amplifier, and the I^2R heating of the speaker wire, would create a situation where the amplifier would croak or the power loss would be unmanageable. The last speaker in the chain could well be starved completely. An elaborate series-parallel system might help to raise the overall impedance, but this would be expensive to wire and it would also be difficult to individually adjust each speaker's level. The solution to these problems, called distributed voltage, was engineered in the 1920s, and it is still used today.

The trick was to develop a distributed-power system using a high-audio voltage and to utilize multiple transformers to reduce the output to each load. This is how the power grid works. The interesting thing about this method is that you only need to maintain the voltage roughly at a set level and you can keep adding loads as long as you keep sourcing enough power to maintain the buss voltage. For sound systems, this voltage can be anything from 25-to-200 volts, but the most common-modern standard turns out to be 100-volts peak, or 70.7 VRMS.

We could design an amplifier with a direct output that produces an RMS voltage output of 70V into 8 ohms. This would be quite an amplifier since E^2/R = 612 watts. Crown would love to sell you a nice amplifier like this! We could engineer a more modest 25-to-50 watt amplifier with a higher-impedance, 70.7-



Two Pesky 70-Volt Audio Transformers

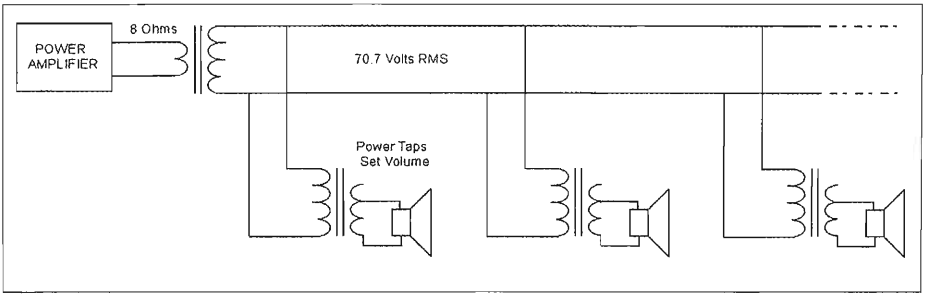


Figure 1: 70-Volt Audio Distribution System

volt output or winding.

Consider a 25-watt amplifier, which delivers 70.7 volts into its load at full output. What is the impedance of that load? Using ohm's law, $R=E^2/P$, so, $(70.7)^2 / 25 = 200$ ohms. Stated another way, a 200-ohm resistor with 70.7 volts across it dissipates 25 watts. Today's amplifiers, whether tube or solid state, are generally designed with 4-or-8 ohm loads in mind, not 100 or 200 ohms.

To get the high impedance (and voltage), sound-system installers almost always use a step-up transformer. Basically this transformer steps 8 ohms up to around 200 ohms. The higher-Z winding services the distributed wiring. These types of transformers handle all of the power of the system, so for our 25-watt amplifier, we would need a transformer rated to at least 25 watts. Next, we would run a modest speaker wire (#18-2 is overkill!) all around the ceiling of the building. We could then hang smaller step-down transformers and speakers off this higher-voltage distributed line.

Bye-Bye Monster Wire

You'll notice that **Figure 1** shows taps on the transformers that are associated with each speaker. These taps are used to set the amount of power going to each load. This allows you to adjust some speakers to be louder than others. Having a single output and using external rheostats or L-pads is far less reliable and would waste audio power.

Most of these systems limit the amount of signal to any individual speaker to no more than 5 watts. To simplify the installation process, the transformers are set to provide roughly what is printed on the side of the transformer, from 650 mW to 5-or-10 watts, when you are connected to a 70-volt system. Notice that they allow you to select or mix 4, 8, or 16-ohm speakers by design, another cost-reduction innovation.

As you would with any distribution system, you will need to figure out how many loads you have and then divide that into the wattage of your amplifier–you should not exceed that load, otherwise, you will overload the amplifier, which causes distortion. Of course, there is some loss associated with the transformers and wiring but it is generally less than 10%; far less than if you tried to do it with a low-voltage system. Depending on the amplifier's power, with a high-voltage system like this, you could hang 25 or more speakers in parallel on a single-amplifier's output. You could even drive a speaker that is 1000 feet away with #24 wire, with a resistance of, say, 100 ohms, and still incur virtually no loss with this method.

Calculating the Input Impedance

These small 70-volt speaker transformers are rated in power. We can use good old Ohm's law to calculate roughly what the input impedance would be when the transformer is properly terminated.

Given: $P = E^2 / R$ and thus $R = E^2 / P$, and if E = 70.7 V, calculate the input impedance for each tap load rating when the transformer is properly terminated.

For a common Radio Shack Part, 32-1031, this produces the following:

Watts	Impedance (Ohms)
0.625	8000
1.25	4000
2.5	2000
5	1000
10	500

How Are They Rated?

These transformers can take a fair amount of high voltage since they routinely handle of 70.7 VRMS, or 100-volts peak of audio at frequencies from 100 Hz to 10 kHz. I would not push them much beyond normal receiver voltages of perhaps 250 volts. I have not found any actual DC rating. One of the big advantages of a voltage-distributed sound system is that you do not have to figure out the impedances closely to achieve a low-loss system, as long as the audio voltage is high enough.

Power ratings are published: Most of the small units are rated to 8-or-10 watts. The Radio Shack #32-1031, for instance, handles up to 10 watts for 4, 8, or 16-ohm loads.

Hammond lists some specs on their higher-end, 117-series transformers: frequency response, 100 Hz to 9 kHz (1 dB reference @1 kHz); insertion loss, less than 2 dB; distortion, less than 1.25% @ 100 Hz at maximum power.

Stancor Model A-8102 speaker-matching transformer: 70.7-volt line primary impedance 625, 1250, 5000, 10000 ohms to 4, 8, or 16-ohm voice coil. Power steps of 0.5, 1, 2, 4, or 8 watts. Approx. size: 2 x 1-5/8 x 1-½ inches.

Audio Output Transformer?

Did you know that the transformer is the most efficient machine ever conceived? When properly designed, transformers can exceed 99% efficiency. I say this because I thought that these transformers would make pretty nice audio output and modulation transformers, based on my calculations.

On first glance, these look exactly like the typical All-American Five, Class 1-to-2 watt, audio-output transformer. I wondered if they could be used in that role, as a replacement in a 6AQ5 or 50L6 amplifier driving a small speaker. After discussing this with NE1S, Larry Szendrei, at the 2007 AWA convention in Rochester in August, I decided that some investigation was in order. Larry said that these transformers might not be designed to handle DC current since they are only used to send AC to the various speakers in the distribution system. One hint that Larry was onto something was that these transformers are rated at 8, or even 10 watts, and physically the iron seems too small to handle that kind of power in a conventional Class-A amplifier circuit.

In technical terms, what Larry was trying to explain was that with these transformers, the permissible saturation-flux density of the core could be reached with a constant-DC current alone, flowing through the primary windings. We could easily exceed the transformer's design-operating flux. With the unexpected (not designed for) DC current, there would be no flux-density headroom left for audio signals. Likely, the peak AC would drive the transformer into saturation (exceeding "Bsat" saturation-flux density) causing losses, distortion, and so on. This is the same effect that happens with modulation transformers. The old remedy of a "modified-Heising" lashup relieves the

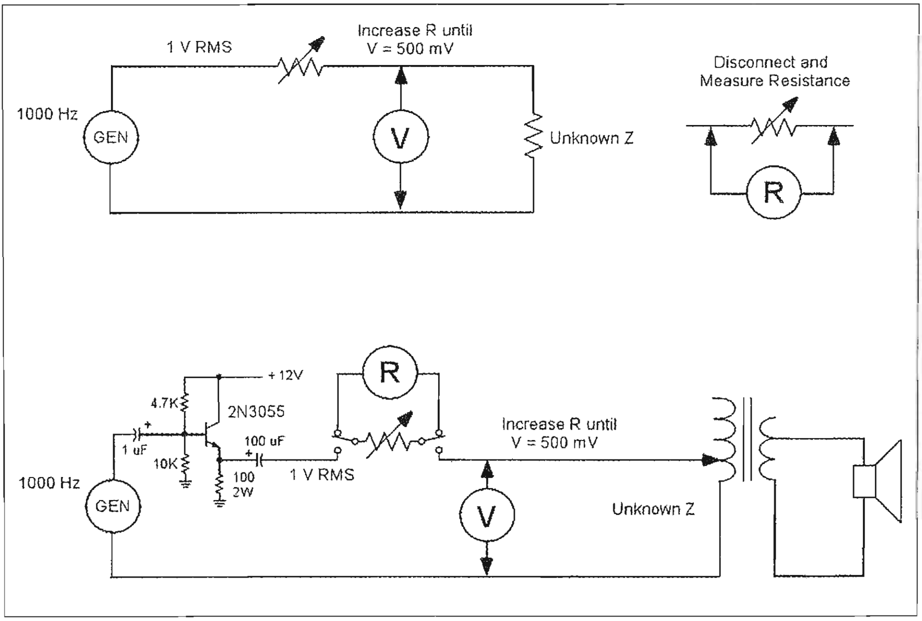


Figure 2: Substitution Method of Measuring Unknown Z and the Generator Helper

mod iron of DC-current flux saturation, thus reducing distortion and allowing higher-power operation.

Of course, I could also describe this as little magnet men being commanded to stand at attention and then being told suddenly to also jump up and down–but they can't because they are glued to the floor.

Making Measurements

The calculations shown above are probably close enough to estimate loaded impedance, but I wanted to actually measure a couple of transformers to see if we can use them in replacement service or in homebrew projects. Measuring the DC resistance of the windings is somewhat useful, but it does not give us the impedance numbers that we need. We need a way to measure the reflected AC impedance of a properly terminated transformer at audio frequencies.

Lacking a AC bridge, I made some measurements using a straightforward approach called the resistance-substitution method, see **Figure 2**. The idea is to put a variable resistance in series with the unknown load and increase it until the AC-voltage drop equals exactly one half of what you are applying. Once it equals exactly ½ of the AC voltage of the generator, remove the variable resistor and measure its DC resistance with an ohmmeter. I used a series-connected, 15-k potentiometer. Since the generator itself has a significant output impedance (usually between 10 and 600 ohms depending on the generator), I made sure to measure the generator's output voltage under load to remove the impedance of the generator from the measurement. This proved tedious because of loading. The HP generator was just not up to the task because its output impedance was a bit high. After checking around the shack for another generator, I found a solid-state Heathkit 5218. This generator was no better.

Generator Helper

This is where you need a shop amplifier. Driving a simple 10-watt utility amplifier with a single 6L6 or a pair of 6V6s, or a small solid-state amplifier, would be the easy solution. Not having one of these loose, I thought of an old circuit, the emitter-follower amplifier. I cobbled together an interesting circuit made of an old 2N3055 on a heatsink, three resistors and two capacitors, and a 1-amp, 12-VDC wall wart. This contraption, when attached to either audio-generator output, gave me a solid, low-impedance output at 1000 Hz–problem solved. I eventually came up with the nifty switch idea that allowed me to easily check the measurement resistance out of circuit.

Test Results

I had two typical small transformers to test. The Stancor A-8102 was marked 0.5, 1, 2, 4, and 8 watts, and the Radio Shack 32-1031 was labeled 0.625, 1.25, 2.5, 5, and 10 watts. My test loads were a small, 5-inch, 8-ohm speaker, a larger 8-inch, 8-ohm speaker and a noninductive, 8-ohm load. My test frequency was 1000 Hertz. I attached the loads to all three outputs, 4 ohms, 8 ohms, and 16 ohms and read the reflected impedance on all taps. The testing revealed only slight variations between the speakers and the resistive loads. This produced 6 sets of data, but I will only present two cases, one for each transformer with the resistive load. This is hardly a deep investigation, but the results are shown in **Tables 1 and 2**.

I performed some testing with high voltage on the Stancor transformer, on the primary side, using the highest impedance tap (500 mW). I connected a 0-to-350 VDC supply to the common terminal and attached an 18-k load in series with the 0.5-watt terminal and returned the connection to minus. At 350 VDC, I got a voltage drop on the windings of 10 volts and a current of just under 20 mA. There was no leakage detected to the core or to the secondary.

I also wanted to know how the unit would work as an audio choke. I measured the unterminated impedance of the lowest power (highest L) winding using the substitution method at several

Primary Power Tap (W)	Primary Z with 8 Ohm Speaker Connected to 4 Ohm Sec Tap	Primary Z with 8 Ohm Speaker Connected to 8 Ohm Sec Tap	Primary Z with 8 Ohm Speaker Connected to 16 Ohm Sec Tap
0.625	14.1 K	8800	5200
1.25	7700	4750	2600
2.5	3900	2450	1350
5	2000	1200	700
10	1100	706	360

Table 1: Transformer 1, Radio Shack 32-1031

Primary Power Tap (W)	Primary Z with 8 Ohm Speaker Connected to 4 Ohm Sec Tap	Primary Z with 8 Ohm Speaker Connected to 8 Ohm Sec Tap	Primary Z with 8 Ohm Speaker Connected to 16 Ohm Sec Tap
0.5	14.0 K	7430	3980
1	7200	4500	2210
2	3800	2350	1280
4	1900	1100	672
8	950	600	348

Table 2: Transformer 2, Stancor A-8102

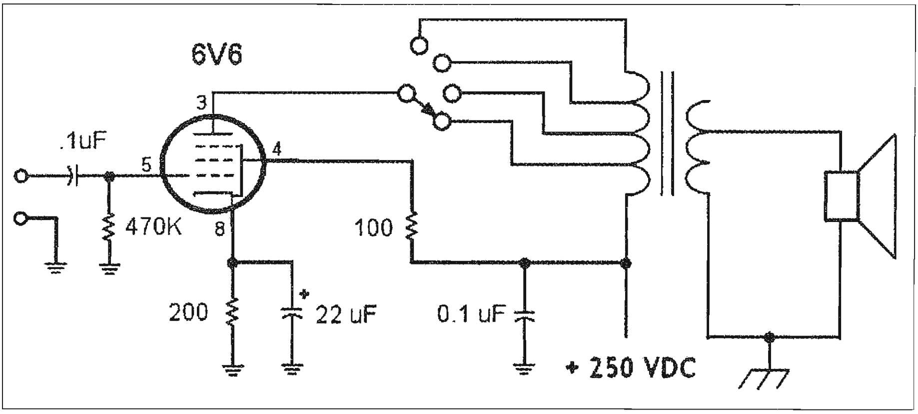


Figure 5: Transformer Audio-Test Amplifier

frequencies. What I found was that as unterminated chokes they have around 1 Henry of inductance, which is not so great for audio plate-choke service.

Audio Output Test

I told you that I did not have a 6V6-class bench amplifier, but it turns out that I had to build most of one anyway, just for this article, drawn in **Figure 5**. We know that these units have no trouble with high-voltage audio, but what happens when we introduce some standing DC bias, such as that required in a Class-A stage like a single-ended 6V6? I set the amplifier up per the RCA manual for a 45-mA resting current with 250 V. I actually hit 45 mA at 230V with the cathode resistor that I chose—close enough. Trying all of the taps, I determined that the best output in 8 ohms was with the 0.65-watt primary tap and 8-ohm secondary tap. The output voltage was 1-volt RMS into 8 ohms for a magnificent power of 125 mW before distortion.

Now, I substituted several ordinary audio-output transformers from various radios, all in the 1-to-3 watt class. Under the same bias conditions and voltage, the worst-case transformer delivered 1.8 watts to the speaker! So what can we use these little devils for?

Project: Military Receiver Multimatch Speaker

By inserting one of these transformers along with a rotary switch into an old speaker box, a useful multimatch speaker is created, see **Figure 6**. This little speaker can handle just about any impedance you are likely to encounter with military sets. With a single-pole switch, you can handle several impedances, from 14k down to 500 ohms, for receivers like the R-390A/URR. If you use a switch with more poles, you can get additional values by utilizing the unused speaker taps in autotransformer fashion, adding 4, 8, and 16-ohm inputs. When hooked up to a BC-654, which has separate taps for a 600-ohm speaker and 2000-ohm phones, I was able to get identical sound out of the speaker by selecting the correct tap.

Project: AM Modulation

These transformers are suitable for low-level modulator service, as long as the DC current is kept low. Conceivably, you could use a small, solid-state amplifier or cathode follower to drive the low-Z side and use the primary side to grid, and screen or suppressor modulation of a tube.

Conclusion

Those pesky 70-volt audio transformers are useful for all kinds of

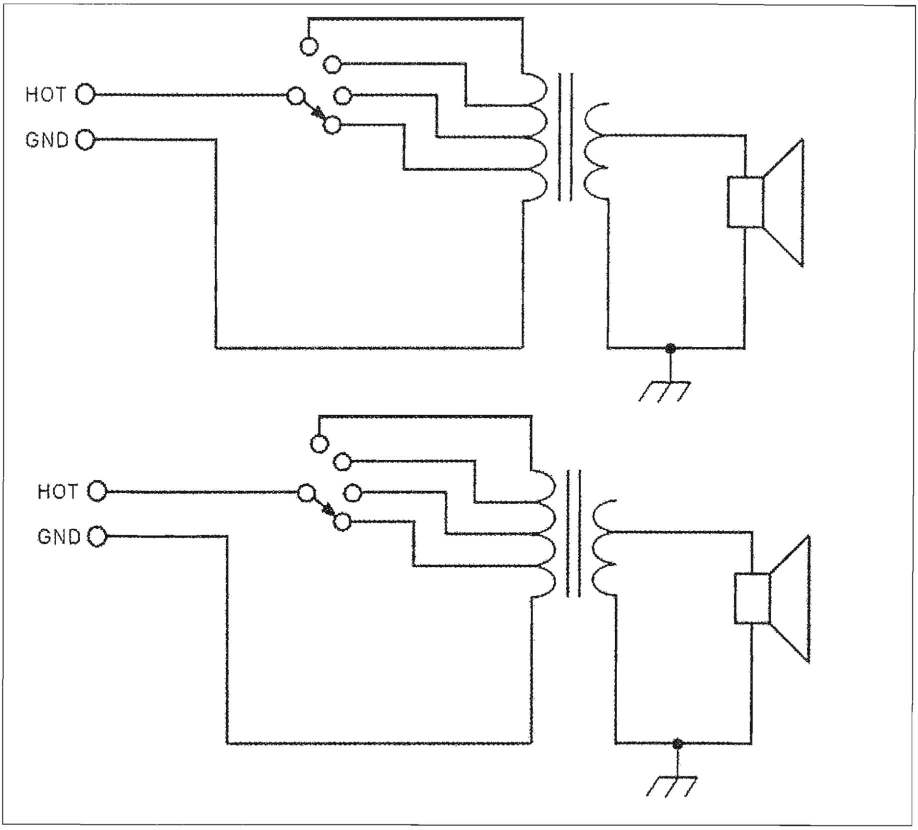


Figure 6: Above, Basic Multimatch Speaker Setup and Below, Universal Multimatch Speaker

audio impedance, interstage, headphone and speaker matching duties, from that contest-grade crystal radio to the military receiver in your GRC-9 or in an R-390A speaker. I have to note that these transformers were rediscovered many years ago by several hams that have contributed greatly to the R-390 knowledge base including A.J. Carmody (W2LE), Chuck Rippel (WA4HHG), and Rick Smedberg (WA8YLZ).

Unfortunately, it is also apparent that these units, although able to handle high voltage, are definitely not suitable for audio output replacement duty in receivers using 6AQ5, 6V6, 6AK6, 50L6 and 50C5-type stages.

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ER

A 50C5 Transmitter

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Modesto, CA 95356

The transmitter presented here was inspired by a March 1968 *Electronics Illustrated* magazine article by the late W5LET. The article was "A Bare Bones Transmitter" and it was "bare bones" indeed. The W5LET transmitter used a pair of rectifier diodes and a couple of capacitors to achieve 300 volts directly from the line cord. The transmitter was a simple-keyed oscillator using a 50C5 tube and built on a flat board with nails used for terminal-tie points.

In 1968, I was only eleven years old but I was fascinated with the article. It would be several years before I received my ham license and the article was to lay dormant in my mind for several decades. Fast forward to the year 2006 and I am a longtime, licensed ham-radio operator and I find myself longing for the simplicity of early amateur transmitters. Playing around on the Internet one day, I did a search for "50C5 transmitter" and much to my surprise I found a number of references to the W5LET article.

I was fascinated with what I read. Evidently, there were quite a number of people who built the transmitter as described in the article and for some it was what got them started in the hobby. Today, people are still building the transmitter. Great job W5LET!

I had no choice but to build the transmitter myself, decades after reading the original article at the public library. It worked right off the bat but it had an awful chirp. There was no way I would put that signal on the air. I tried all sorts of methods to stabilize the beast, but nothing was completely successful. I finally came to the conclusion that the 50C5 was just not suited to run as a keyed oscillator. I suspect that my problems may have been do to the use of tiny, cheap crystals as compared to the large FT-243 crystals used by W5LET, and that I had used a different, tighter, output coupling circuit. I will give him the benefit of the doubt and assume that his original transmitter sounded reasonably OK.

I took a step back and looked at the project from a new perspective. I would keep the breadboard construction and the 50C5 tube. It would still be powered directly from the line without a transformer, but I would use a pair of 35W4 tubes for rectifiers in the voltage-doubler circuit and add an oscillator tube. The transmitter was redesigned, and evolved away from the original W5LET design and became a design of its own.

I experimented with 12AT7A and 12AU7A tubes in various oscillator configurations and was almost happy with the results but they never fully satisfied my desires. I needed an oscillator tube that would be very stable, have enough power to drive the 50C5, and have a low-voltage heater that runs at .15 amps so that all of the heaters could be wired in series and powered directly off the line voltage.

I pulled my old RCA receiving tube manual off the self, went through it page-by-page, and wrote down all of the tube types that might work. My first choice was the 6BH6. The tube is a sharp-cutoff pentode with a 6.3-volt, 150-mA heater that was designed for use in AC/DC receivers. It has a controlled-heater warmup, just like the other tubes in my

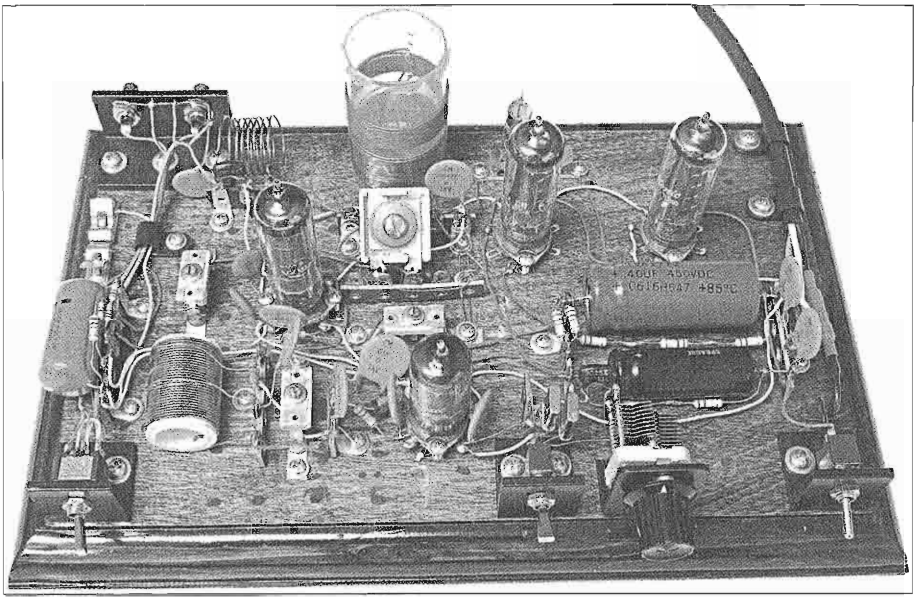


Figure 1: The transmitter is built in the traditional manner, on an open breadboard. Wood finishing and safety are discussed in the text.

circuit. The heaters would all heat up evenly, a much-desired feature for series-wired filaments. Now, I just had to buy one of the tubes and give it a try. I went to eBay and soon had several 6BH6 tubes on the way.

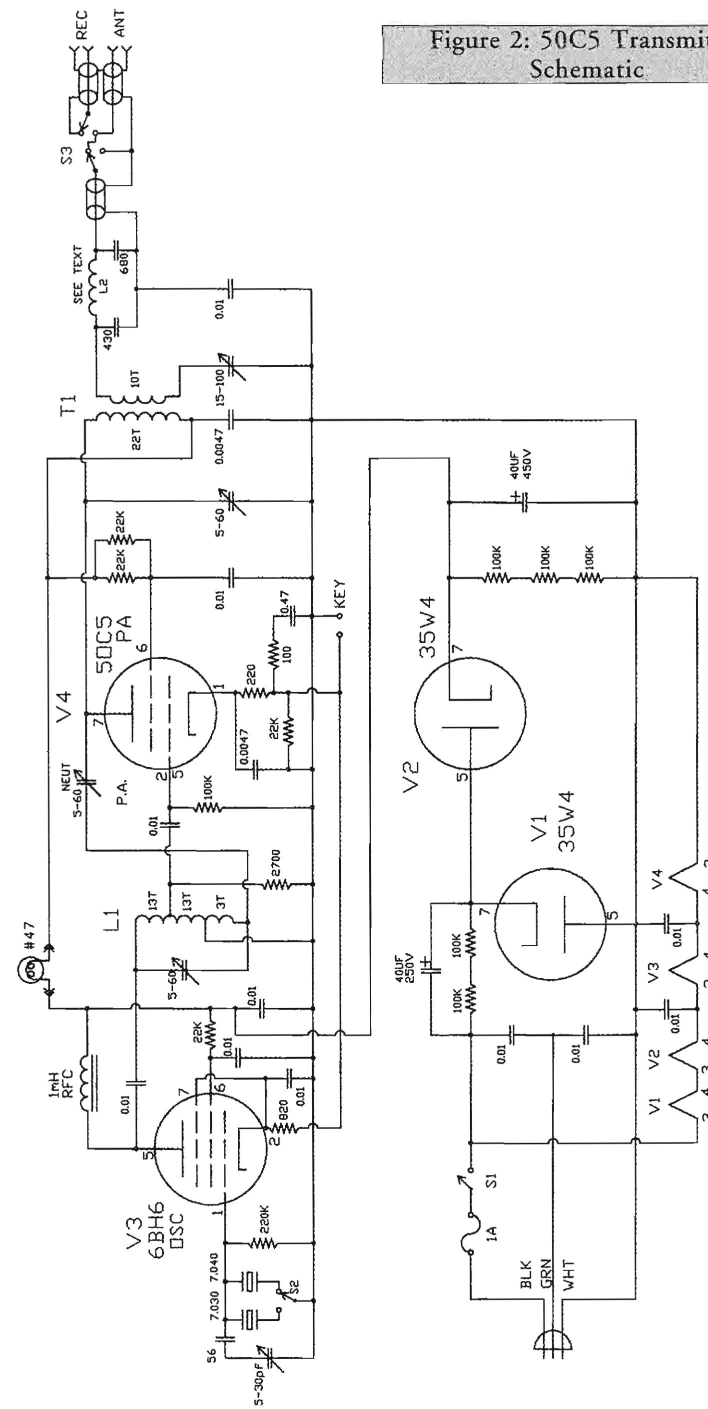
The 6BH6 tube turned out to be ideal for my oscillator. After some experimenting with component values, I had a stable, keyed oscillator with enough drive for the 50C5. The oscillator is not sensitive to voltage changes so no VR tube is required. This tube works so well as an oscillator that I intend to use it as my first choice in future projects.

The power supply uses a pair of 35W4 rectifier tubes as a voltage doubler and supplies about 250 volts (key down) to the oscillator and PA tube. Solid-state rectifiers could easily be employed here, but I wanted to use tube rectifiers for the sake of nostalgia. The voltage doubler is a half-wave design, so the low side of the power supply output is at the same potential as the line-neutral wire. The same components could be wired up as a full-wave voltage doubler, but the low side of the power supply would be at a high voltage compared to neutral and ground. This would create additional hazards as well as difficulty in interfacing a key safely.

The first numerals of the tube types used indicate the filament voltage of the tubes. If we add up all of the filament voltages (35+35+50+6) we get a total of 126 volts. This means that if we wire all the heaters in series we can operate them directly from the line voltage, as is done in this transmitter.

The oscillator circuit is very straight forward. This is a simple, tuned-grid, tuned-plate oscillator, the crystal being the grid-tuning element. The value of oscillator-cathode resistor was found experimentally to provide good keying characteristics. The plate-tank circuit inductor is 29 turns of number 22 magnet wire, wound on a 1-¼ inch length of 7/8-inch, outside-diameter PVC pipe.

Figure 2: 50C5 Transmitter Schematic



The inductor is operated at DC-ground potential.

The power-amplifier tube's grid is driven from a tap point on the oscillator's plate inductor. The position of the tap was just a guess, but since the transmitter performance was better than expected no further experiments with the tap position were tried. The purpose of the 2700-ohm resistor is to reduce the Q of the tank circuit, and is essential for stable operation of the power amplifier. The inductor has 3 turns on the "other side" of ground, which is used to neutralize the power amplifier by adjustment of the neutralizing capacitor.

The power amplifier is grid-leak biased by the 100-k grid resistor, and self biased by a 220-ohm cathode resistor. The self bias is not necessary for operation of the amplifier, but it provides protection for the tube during fault conditions, tune up, and during stability checks, as described later. The power amplifier plate-and-screen voltages pass through the number-47 lamp. The lamp is used as a plate-current indicator and is mounted by leads soldered to it's base that are inserted into fahnestock clips. The fahnestock clips allow for easy removal of operating voltages from the power amplifier to facilitate neutralization adjustments. A milliampere meter can be inserted in the fahnestock clips in place of the lamp for accurate measurements of current.

The power amplifier is transformer coupled to the antenna. The transformer windings are wound on a pill bottle with an outside diameter of 1.3 inches and spaced with a 3/8-inch gap between windings. The primary of the transformer is 22 turns of #22 enamel wire close wound, parallel resonated by a compression trimmer, the "Plate Tuning" control. The secondary of the transformer is 10 turns of #24 red telephone wire, series connected with a larger compression trimmer, the "Loading" control.

Before sending the signal on to the antenna, it goes through a PI filter, comprised of L2 and the 430 and 680-pf capacitors. Inductor L2 is made by winding 8 turns of number 22 enamel wire around a 35W4 tube (remove the tube after winding) and spacing it about an inch long. The values for two capacitors in the PI network were junk box values; I was shooting for 500 pf each. The addition of the low-pass filter cleaned up the harmonics and improved the power output of the transmitter.

The construction was done on an 8 x 12-inch piece of ¾-inch plywood. I used a router to put a fancy edge on the wood, which reduced the working area on top to 7 x 11 inches. The plywood is what is called "paint grade" that has a much nicer surface than shop plywood. I sanded and stained the wood. I followed that with several coats of clear lacquer.

Components are mounted to the tube-socket terminals and to terminal trips. The terminal strips and tube sockets are mounted to the plywood using number 4 sheet-metal screws and flat washers. The switches and jacks are mounted using 1 x 1 x 1/8-inch, aluminum-angle stock.

A transmitter like this requires a discussion on safety. Since this is powered directly off of the line voltage, without the isolation of a transformer, there are additional hazards. The line cord *must be* a three-conductor cord. The cord I used was a standard computer cord with the female end cut off. The black wire is hot and has 120 volts relative to ground. The white wire is neutral and may have a volt or two in relation to ground, depending what loads are running on the house circuit. The green wire is a safety ground which is at ground potential.

In this transmitter, the black wire

from the line cord is soldered directly to a one-amp fuse. The fuse and wire are covered with heat-shrink tubing so that there is no exposure of the unfused, 120-volt line. If this transmitter is connected directly to a telegraph key, the low side of the key is connected directly to the neutral circuit of the electrical supply. This may be deemed, by some, to violate electrical-safety rules. Being cathode keyed, the hot side of the key has about 45 volts with this transmitter. If something goes wrong in the transmitter circuit, a *much greater voltage*, as much as 300 volts, could be placed on the hot side of the key. In the old days these things were taken in stride but today we are all much more concerned about safety, as we should be.

It is imperative that the line cord is correctly wired and that it is plugged into a correctly-wired socket, otherwise the low side of the key could have 120 volts AC on it! An isolation transformer could be used to isolate the transmitter from the line and that would increase safety. The use of a step-down isolation transformer would allow our friends across the pond to use the transmitter as described without any further modifications.

The power supply produces in excess of 300 volts, so the open-breadboard construction has ***lethal voltages*** exposed. An enclosure, Plexiglas for example, could be fabricated to cover the guts of the transmitter and eliminate the potential of accidental contact with high-voltage points. With some minor redesign, the transmitter could be built in a conventional aluminum chassis. Lastly, an open circuit like this must be kept out of reach of children and even curious adults.

The initial tune-up is done by removing the #47 lamp, turning on the power, and allowing the tubes to warm up. While tapping on the key, adjust the oscillator-plate circuit for highest output along with good keying. Once the oscillator is working properly, an oscilloscope, or other sensitive indicator, is placed on the output along with a dummy load. The PA plate tune-and-load capacitors are adjusted for maximum indication, then the neutralization capacitor is adjusted for minimum feed through.

The next step is to disconnect the line voltage and discharge the power supply capacitors. The #47 lamp is inserted in the fahnestock clips and the transmitter is powered up. Using brief key-down times, the plate tune-and-load controls are adjusted for maximum output. If the keying has any chirp, it may be necessary to adjust the oscillator circuit.

It is a good idea to go back to the neutralizing-adjustment procedure once more to make sure it is as good as possible. I was able to reduce the feed-through power to zero, as indicated on an oscilloscope.

The final check is done with all voltages applied, but without a crystal. While watching the output on an oscilloscope, tap the key and look for any waveforms to pop up. If any signals are observed on the oscilloscope then further work should be done to make sure the rig is stable.

As can be seen, there has been considerable attention given to the purity of the signal in all respects. I wanted at transmitter that was completely useable and not just a novelty to use a few times and put on a shelf. The final product is a transmitter that has clean, chirp-free keying and a clean RF signal free of excessive harmonics and spurious emissions.

The RF output was checked using a spectrum analyzer. The second harmonic was 58-dB below carrier and the seventh harmonic was at -68 dB. No other spurious or harmonic energy was visible. These measurements were made after tuning the rig as described above, without touching up for the spectrum analyzer.

I used the transmitter on the air with no other instruments to tune other than the #47 bulb and a wattmeter. After a number of QSOs, I decided to do some actual measurements of the operating parameters, and the results are listed below:

PA Plate Voltage.......... 253 volts
PA Plate Current.......... 44.6 mA
PA Plate Input Power... 11.3 watts
Power Output............. 8 watts
PA Plate Dissipation..... 3.6 watts
Plate Efficiency............. 71%
PA Screen Voltage........ 162 volts
PA Screen Current........ 8.4 mA
PA Screen Input........... 1.36 watts

I was quite surprised to see that the plate-and-screen dissipations were within the maximum specifications for the tube. It appears that this rig could be run key down indefinitely. That being said, it might be interesting to hook up a modulation transformer in place of the #47 lamp and see how well it works in the AM mode.

While writing this article, I noticed that I neglected to bypass the filaments. I put in the two bypass capacitors on the PA tube, as shown on the schematic. The capacitors are soldered directly between the tube-socket lugs and the tube-socket metal ring which is used as the ground for the screen-and-cathode bypass capacitors as well.

The transmitter worked well before the addition of the filament-bypass capacitors, but there was significant interaction between the oscillator and PA tube despite the neutralization. After the filament was bypassed, all interactions between the stages were eliminated.

The variable capacitor in the crystal circuit is used to vary the operating frequency over a range of about 3 kHz. Two crystals yield 6 kHz of the band to operate on and provides many more opportunities to answer CQs than without the variable. The fixed capacitor was chosen to limit the range to where the keying is good.

Using the rig on the air is pretty simple. I use this transmitter with a vintage Heathkit SB-300 receiver. To transmit, flip the T/R switch to transmit then send a couple of "V" or "R" signals while adjusting the receiver gain for a nice side-tone level.

My first contact was far from spectacular. I called CQ and then heard a station that pegged my S meter as he tuned up. He came back with a QTH of "Modesto, CA." That's where I live, but he was not only in the same town but almost the same neighborhood. It turned out to be a nice opportunity to meet a local ham in person.

Subsequent QSOs were more impressive, with distances in hundreds, and then over a thousand miles. I find it quite rewarding to work distances like that with some parts mounted on a board and with a signal that I can be proud of. One of the most enjoyable contacts was working a station using a homebrew 6AG7/807 transmitter; working homebrew to homebrew is the way it should be, in my opinion.

The original W5LET transmitter put out about one watt. This redesign pushes my power meter to 8 watts! The 50C5 tube seems to be quite an excellent RF amplifier. Other tubes to consider for rectifiers and PA would be the octal-based versions such as the 35L6, 35Z5 and 50L6.

The use of direct-line power for the filaments and B+ supply is an interesting way to build small-and-simple circuits. I hope this will inspire others to build this or similar transmitters. I would love to hear from anyone that builds a transmitter inspired by mine. The next step is to build a companion T/R switch and receiver of similar style. These are in the works. ER

International Band Plan Hurts AM

By Paul Courson, WA3VJB
P.O. Box 73
West Friendship, MD 21794

American radio hobbyists will be unable to support an international system of voluntary band coordination if they intend to run AM on HF, according to the details of a plan taking effect in January that uses a bandwidth scheme to suggest where all activities are placed.

The International Amateur Radio Union (IARU), meeting in Brazil in September, approved a voluntary band plan that fails to acknowledge the widespread popularity of AM in Region 2, an area that includes Canada and the United States.

Although such band plans answer to government regulations in each of the three IARU regions, it has been a tradition that the amateur community strives to implement voluntary plans to forestall the chance for additional mandatory restrictions.

Conversely, favorable voluntary plans are often promoted as a template for revisions to government regulations. The IARU website touting the new plan covering North America says "it is suggested that Member Societies, in coordination with the authorities, incorporate it in their regulations and promote it widely with their amateur communities."

ARRL Fails To Represent AM

AMers were left out of the September deliberations in Brazil, which were led by paid staff from the ARRL, the club that represents U.S. licensees at the IARU. In the earliest versions of the plan approved by the full IARU, bandwidth would be limited to 2.7 kc throughout most of the HF voice allocations in Region 2.

"The original bandplan as posted had no 40m or 20m AM listed at all, except for the 7275 kHz "AM calling frequency" (@ 2700- bandwidth?)," said veteran AMer Don Chester (K4KYV), who is among those following the IARU plan.

The IARU concept of using bandwidth to coordinate modes and activities on HF is similar to the ARRL's failed petition to the FCC, which the group withdrew from the agency at a time of heavy opposition from both its subscribers and the greater amateur community.

League officials, apparently misunderstanding the message from their constituents, have threatened to again submit such a petition in the future, but none would confirm that the IARU scheme is an effort to lay groundwork for proposed U.S. regulation.

Two sources within the IARU have confirmed that the suggestion of using bandwidth in the Region 2 scheme came directly from the League's Paul Rinaldo, 76, a paid staffer who is determined to use the U.S. regulatory system to force acceptance of digital communications, a category that has not become popular in the amateur service.

Meantime, there was no known input, justification, nor documented basis for failing to fully provide for the rising presence of AM on HF in keeping with the plan's recognition of other popular modes and activities.

Rinaldo's suggestion to use a 2700-Hz bandwidth in the plan came from his expressed concern during the deliberations that "some people are running wider than that," according to Mexico's Region 2 representative, explaining the source of the bandwidth specification and why it became part of the plan.

Anti-AM Bias Detected

Rinaldo, in the 1980s, was the editor of the ARRL Handbook and made a decision to purge material related to vacuum-tube construction and AM operation. He said, at the time, it was a "space saving" measure to make room for other articles.

Rinaldo most recently has served as a behind-the-scenes regulatory lobbyist for the League, representing the club at unpublished meetings with the National Telecommunications and Information Administration and the FCC, including those linked with the club's failed bandwidth petition earlier this year.

He acknowledged this fall that AM has been a "sore point" in his activities, according to a longtime AMer who discussed the matter with him at a local club meeting.

Rinaldo's boss, League staff CEO Dave Sumner, and ARRL's elected vice-President Rick Roderick, both denied that the IARU plan will constrain AM activities in the U.S. Yet neither man would explain why AM is not supported by the voluntary plan. Repeated calls to Rinaldo's office have not been returned, and League President Joel Harrison has not followed through on a request for an interview expressed through Roderick.

Non-league IARU Staff Receptive

In an effort to clean up the mess left behind in Brazil by League staffers, several individuals have directly contacted IARU officials to express their concern that the AM community will not be able to support the voluntary plan for Region 2.

As a result, some revisions had taken place within a couple of weeks, but the overall plan remains unfriendly to AM activity on HF.

Don–K4KYV–notes the plan fails to acknowledge or provide for AM on 160m, "the basic restrictive bandwidth limitations are still there, and there is still no AM listed for 17, 15, or 12m."

"Looks like correspondence with the IARU people did at least grab their attention and they have acknowledged by tossing us some crumbs," Don said, in an Internet posting to the website www.amfone.net, noting a revised version that "now includes 40M from 7100 to 7300, and 20M from 14285 to 14300."

No League officials have been willing to publicly endorse the revisions, nor apologize for their failure to support AM alongside other modes noted in the Region 2 discussions.

Canada's Region 2 Director has given assurances they will revise the plan before it is implemented to appropriately include full carrier, DSB AM.

Ideally, we should urge that the numerical bandwidths be removed because there is no means provided to operators to check whether they comply. Vague specifications may generate unwarranted complaints since it will be one operator's word against another.

Conclusion

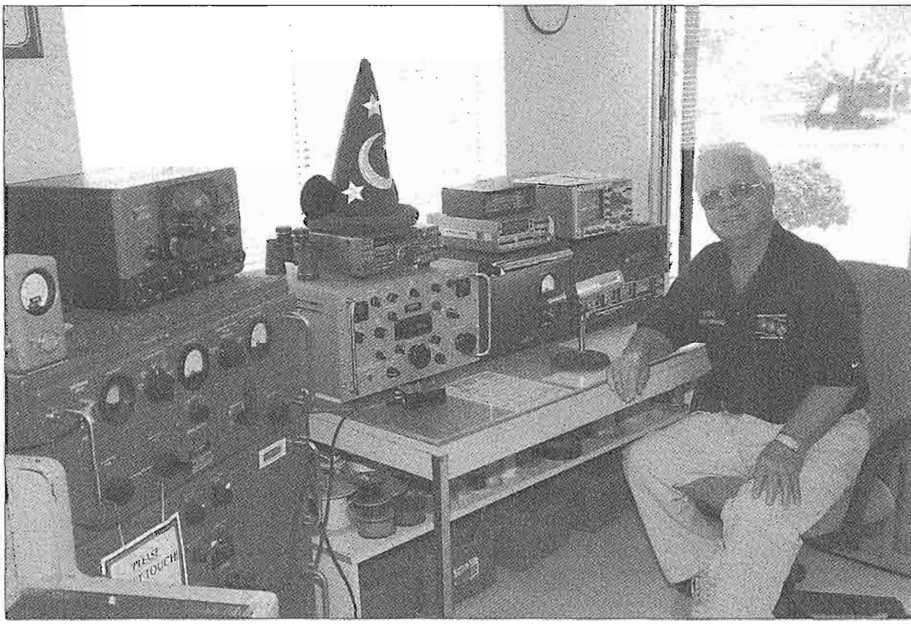
AMers have a long-standing history of voluntarily coordinating their activities to minimize friction with incompatible modes. Exclusion of this group by the ARRL is unconscionable, and should be an impediment to Rinaldo's reported candidacy to replace IARU president Larry Price upon retirement.

[Editor's note: Paul will have some follow-up material next month.]

ER

PHOTOS

Editor's Note: "Thank You" to everyone who has recently sent in photos, and please keep "those cards and letters" coming in so I can run the photo column on a regular basis!



The Best in the West

By Ron Weaver, W6OM
13691 Solitaire
Irvine, CA. 92620
W6om@cox.net

In every locale and endeavor in life there exists one person who continually demonstrates the qualities and commitment to their area of interest which inspires us all and serves to motivate everyone who comes in contact with them.

In Southern California we have "*two,*" a husband and wife team, who serve the hobby in a variety of ways through touching the lives of all who come in contact with them in a positive way. Wayne (W6IRD) and his beautiful wife Sharon (K6IRD) are considered "The Best in the West" by all who know them or come in contact with them.

Wayne and Sharon cover the gambit of amateur radio activities from accomplished DXers to volunteering once a month as net control operators of the West Coast AMI 3870 meeting of AM

vintage stations around the southwest.

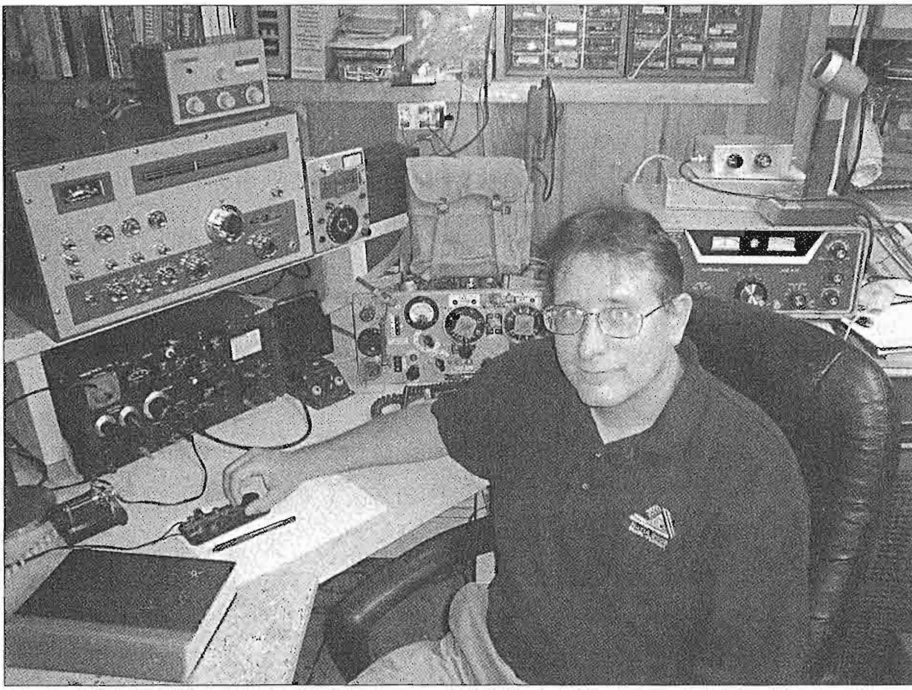
Wayne's well equipped shop in Orange, California serves as a local gathering place for AMers, DXers, and new hams needing guidance or repair of their boat anchors, while at the same time he is well know around the world for his Collins repair business. Sharon serves as the Vice President of the Southern California DX Club and is also affectionately known as the "First Lady" of AM radio with her cheerful greetings and patience understanding under the most difficult propagation conditions.

While having lunch with them recently I had the opportunity to go a little deeper and find out their individual views and reasons for giving back to the amateur radio community. After forty years of marriage to Wayne, Sharon finally got the bug and obtained her license two years ago. She received the same call suffix as Wayne. Sharon loves busting pile ups and working new countries and once you meet her on the air or in person you have a friend for life.

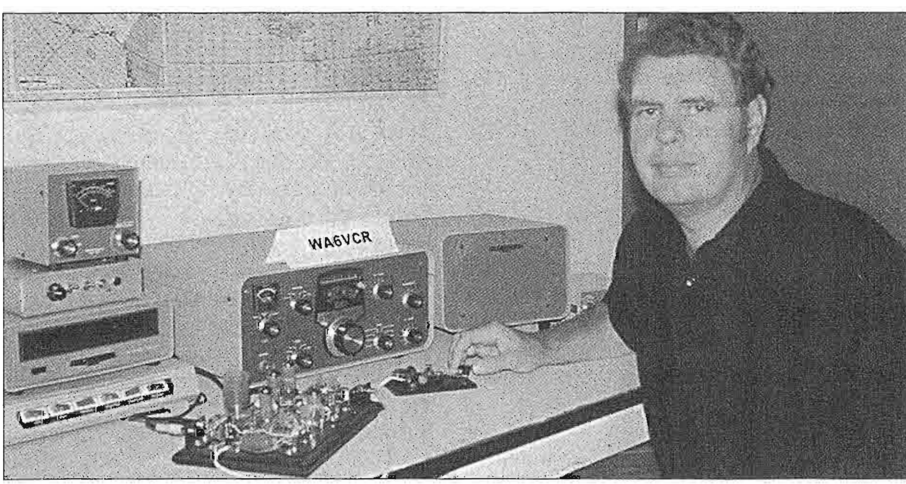
Wayne has a passion for fixing anything which comes through his door and his shop is always full of Collins, Johnson Vikings, and other gear in some stage of repair. Wayne has a deep sense of the importance in continuing the amateur radio tradition through helping new comers and old timers any time he can. For this writer, Wayne continues to be my Elmer, and through his unique blend of humor he always brings me around to see how to fix things on my own.

Together, Wayne and Sharon are an example of why many of us became amateur radio operators and why they continue to keep the spirit alive.

Wayne (W6IRD) and Sharon (K6IRD) are "The Best of the West."



Mike Murphy (WU2D) is the author of this month's article about working with 70-volt line transformers. Here is Mike in his shack that has a great mix of surplus and commercially-built equipment.



Steve Minshall (WA6VCR) is at the key of his 50C5 transmitter that he wrote up for this edition of ER, and his SB-300 is doing the receive job, as he discussed in his article.

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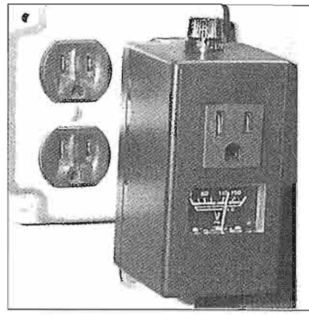

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SERVICE FOR SALE: Repair, upgrade, performance modification of tube comm. & test equip. Accepting most military, all Collins & Drake, & better efforts from others. Laboratory performance documentation on request. Work guaranteed. Chuck Felton, KDØZS,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

FOR SALE: Radio parts and hardware. Some are 60 years young! Free flyer, USA only. 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

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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

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

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

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

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

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WANTED: ART-13 power supply or components, particularly 400 volt 400 ma transformer. Contact Mike at 604-988-0112 or mike46@shaw.ca

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

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WANTED: Non working, dead 4-1000 transmitter tube, or similar, for my home display. Johnny Umphress, 1415 Moore Terrace, Arlington, TX 76010 jgumphress@yahoo.com

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WANTED: FT-154-Q mount for BC-348-Q. Evening fone 806-794-3031 or email ketner@arisbeassociates.com.

WANTED: Working 4 kc mechanical filter for the R-390A. Phil, w1gee@yahoo.com

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WANTED: Hand cranked generator GN-45 and/or cable for attaching to a BC-654A (SCR284 trans/rcvr). Bob Hall, 229 Ave B, Redondo Beach, CA 90277

WANTED: COLLINS 51J-2, 51J-3 or 51J-4. Vern, W9STB, 715-892-0238, telegrapher@hotmail.com

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WANTED: National 1-10 or 1-10A RF section, or complete parts unit. Ivan, WA6SWA, 703-237-9511, ihxxv@cox.net

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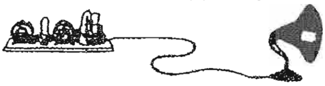

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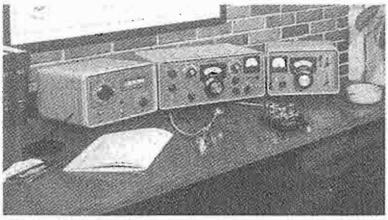

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WANTED: Will pay $59-$75 for good case for the following Hickok tube testers, 800 series; 500 series; 700 series. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

WANTED: May 1945 CQ Magazine. Lynn Stolz, N8AJ, 614-885-5428, n8aj@yahoo.com

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WANTED: Barker Williamson "80 JCL Coil" for my Globe King 400. Thanks! Brian, WØNW, sparkee@scinternet.net

WANTED: Black wrinkle spkr for HRO-5, reasonable, with emblem. Jim, K7BTB, in AZ, 928-635-2117, jeldgl@aol.com

WANTED: SB230 Heathkit amp with defective 8873 tube or Dentron MLA1200 with defective 8875. Bill Smitherman, KD4AF, 336-699-8699

WANTED: HRO 50 or 60 parts unit. Also need nickel PW dial assy. Bob, 516-754-1763

WANTED: Cases for HICKOK Models 600A, 800A, 532, 533, 539, & 752. Will pay good money for good or better cases. John Snow 1910 Remington Ct., Andover, KS 67002 316-733-1856

WANTED: Manual for Dumont model 245 oscillograph, and looking for model 241 scope. Steve Bartkowski, 1-708-863-3090

WANTED: I am looking for a Grebe CR-18 receiver in good to excellent condition. Will pay any reasonable price, and most unreasonable ones! Bruce, W1UJR, w1ujr@arrl.net

WANTED: DX-100 complete or parts rig for restoration. Chuck Milton, W4MIL, 58 Barrington Dr., Palm Coast, FL 32137 386-446-8571

WANTED: Dead or Alive! Harvey Wells APS-90 power supply for T-90 transmitter. K1MD, Richard San Antonio, san.antonio@cox.net or 401-732-4026

WANTED: Someone with a collection of Short Wave Craft, Radio Craft from the 1930s to collaborate on a series of articles on a substantial collection of original items from that time period. Please call Chuck, WØIUH, 320-277-3242

WANTED: James Millen plug in oscillator coils for Millen 90881 linear amplifier, Millen parts #s 43011, 43015, 43021, 43041 and 43081. Gary K2PVC; gschonwald @earthlink.net917-359-8826

WANTED: Technical Materiel Corp (TMC) power supplies PS4 (low voltage and bias) and PS5 (high voltage) for the TMC PAL 1K kilowatt linear amplifier, also known as the RFD or RFA. Gary K2PVC; gschonwald@earthlink.net917-359-8826

WANTED: Squires-Sanders SS-1R and SS-1V. Bob, WØYVA. 703-450-7049; robert@isquare.com

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WANTED: Hallicrafters HT33 with salvageable power supply. The RF section is not required to be useable, need a power supply to contribute to one that is. Gary Schonwald K2PVC. gschonwald@earthlink.netphone: 917-359-8826

WANTED: Technical Materiel Corp rack mounted antenna tuner and RF /SWR meters to be used with the 350-watt or 1000-watt TMC linear amplifiers. Will consider other TMC transmitting equipment and accessories for collection and on-air use. Gary Schonwald K2PVC. gschonwald@earthlink.net phone: 917-359-8826

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

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

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

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

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

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: PRESS WIRELESS, NY: Photos, information wanted on Hicksville, Baldwin, Little Neck, Centereach, Northville facilities. George Flanagan, 42 Cygnet Dr., Smithtown, NY 11787 w2krm@optonline.net 631-360-9011

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

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: 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

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: 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: 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, 1-708-863-3090

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

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

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

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

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, 203-431-6850, kkeller1@comcast.net

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

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

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: 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

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: HBR Receiver! HBR-11 HBR-14 etc. any condition–dead or alive, unfinished considered Jeff, KEØMT, ke0mt@aol.com

WANTED: Back in the early/mid '30s a monthly magazine such as Radio Craft had an article where a pair of type-30 battery powered triodes were used in a receiver breadboard layout where most of the parts were home made so 'poor kids' could afford to fab one. Holes were drilled in the board for the tube pins and paper clips were used to make contact. The variable capacitors and grid capacitor were 'vertical book style', one tuning and one regeneration, made from pieces of flattened tin plate from cans, resistors were made by rubbing graphite on the breadboard using lead from a pencil, the audio coupling transformer was wound on a group of nails, the plug-in-coils wound on pieces of a broom handle, RF Choke scramblewound on a wood dowel, etc. Would love either magazine or copy of pages! Byron Lott, W6VIB, 925-294-8766, 4787 Mulqueeney Common, Livermore CA 94550, BDLott@cs.com

WANTED: Need test set I-135 "G" or "F" will trade WWII I-135 "E" or will purchase, also have BC-611 to trade. Steve Bartkowski, 1-708-430-5080, 7702 Austin Ave, Burkank, IL 60459

WANTED: R390, R390A and R392 receivers dead or alive or parts/ assemblies. Any condition considered. Will pickup if you have enough items. Glenn, WA4AOS, 864-684-2956

WANTED: Mint, complete or parts sets. Hammarlund SP-600 JX-28 version, hasnomenclature tag R-620, doesn't have name engraved on panel like others, 1937 RCA ACR-111, RCA CR-88B version, RCA AR-8516, TMC CV-1758 SSB

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WANTED: Cabinet similar to unit on page 32, August 2007 ER issue, holds 7" x 11" chassis. Louis L. D'Antuono, WA2CBZ, 8802-Ridge Blvd., Bklyn, NY 11209. 718-748-9612 AFTER 6 PM Eastern Time.

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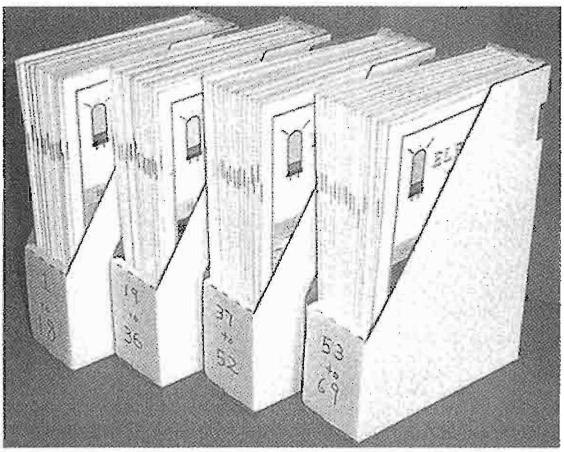

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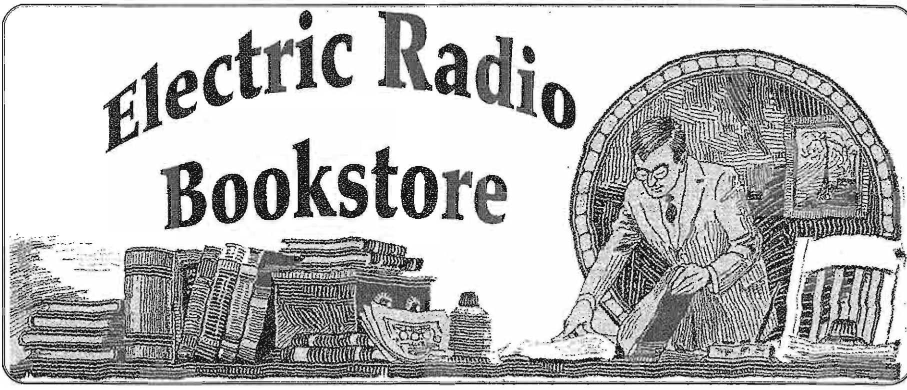

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Miller's Collecting Science and Technology: 160 pages of high-quality color photographs from museum collections make this hardback volume an excellent introduction to this new collecting field. Written by Lindsay Sterling -- **$29.95-10% = $26.95**

The Collector's Vacuum Tube Handbook: This is a 205 page book that is full of unique, hard-to-find information on tube types that were released before 1934. Includes history and good photos. ---**$25.95-10% = $23.35**

Radio-Craft: 50 Years of Radio by Gernsback: This is a high-quality 141-page reprint of the March 1938 edition of Radio-Craft magazine and is about the first 50 years of radio, and contains hundreds of vintage advertisements. -------------------------------------- **$15.95-10% = $14.35**

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Radio Tubes and Boxes of the 1920s by Fathauer: If you appreciate the rare and colorful vacuum tubes and advertising art from the early days of radio, then this great 104-page book will be very interesting and informative. -- **$26.95-10% = $24.95**

The All-American Five Radio: Although this book is about classic American 5-tube broadcast receivers, it also contains a wealth of accurate information on vacuum tube receivers, proper troubleshooting, and alignment and is recommended for experienced repairmen and novices alike. 92 pages by Richard McWhorter ---**$21.95 - 10% = $19.75**

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