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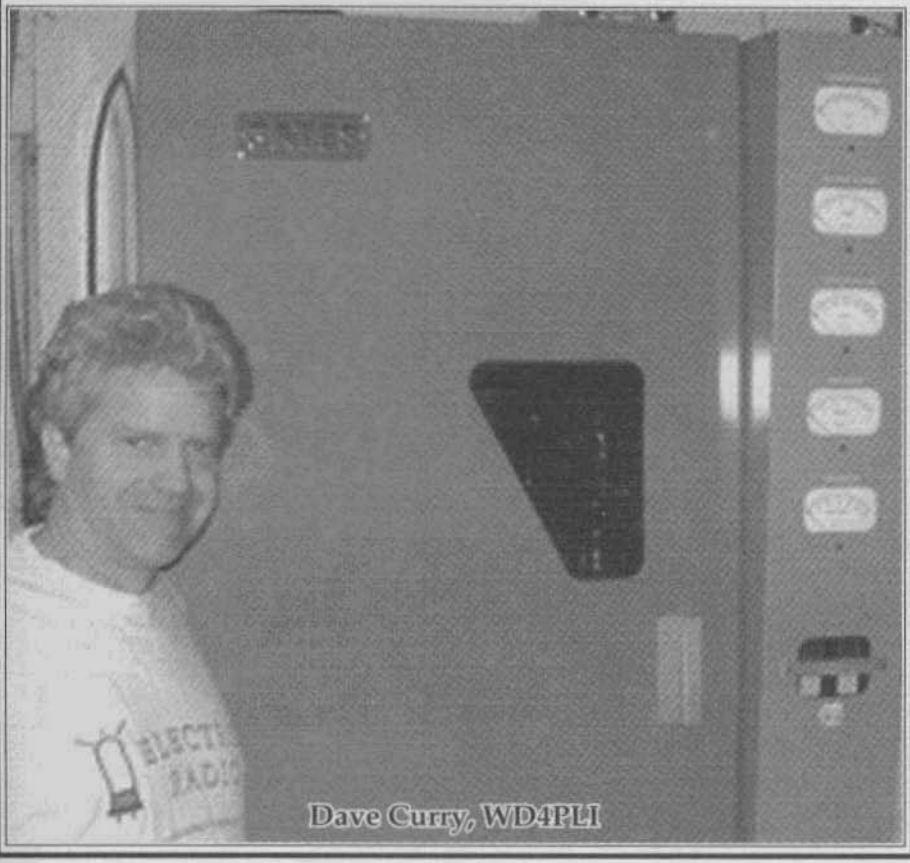
ELECTRIC RADIO

celebrating a bygone era

Number 158 July 2002



Dave Curry, WD4PLI

ELECTRIC RADIO

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

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

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

Editor's Comments

Vintage Field Day, 2002

This year we didn't go to Utah as we have done in years past. Instead I set up shop in a country school yard about 5 miles down the road from where we live. There was none of the great scenery we enjoyed in Monument Valley but it was a whole lot easier and much more convenient.

The school was out for the summer so I had the whole yard to myself. I set up the 160-meter dipole on the 30-foot telescoping mast in the center of the playground and piled my gear on a nearby picnic table. I put the generator at the end of my 100-ft heavy-duty extension cord and I was in business. Whenever I needed refreshments I could just call Shirley on the cell phone and she'd deliver whatever I needed. Mostly I needed company as there were long periods of time when I couldn't raise anyone to talk to.

I started out on 40 meters at 10:45 a.m Saturday morning and by noon had worked about 15 stations. All signals were loud, even the distant low-power stations. After lunch I went to 15 where it took two hours to work 3 stations. I then went to 20 for the remainder of the afternoon. I worked about a dozen stations there. They were from all over the country. Sunday was a miserable windy day so after listening around the bands for a while I packed up and went home.

Generally, propagation was very good. For instance, I worked Dennis, W7QHO, in San Pedro, Calif. on three bands—40, 15 and 20. Signals were S9+ on all contacts with him. I think if there would have been more participation this would have been one of the best VFDs yet. But I'm not discouraged. I know if we keep at it VFD will become an established ham event.

Over the winter months we'll talk more about VFD with the hope that we can create more interest in this event. If you have any suggestion that you think would be helpful I'd be glad to hear them. N6CSW

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Return to Dobbins Island !

AM Expeditioners pick Aug. 1-4, 2002

by Paul Courson, WA3VJB
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Dobbins Island, Chesapeake Bay, Md. – The next major AM expedition will take a crew in August to this uninhabited, ten acre parcel of land at the mouth of the Magothy River. It is the site of the 1993 AM Expedition which became the first AM-oriented exotic operating event in modern times. [see ER, September, 1993]

Using the call sign **K3L**, which itself was made famous last year during the AM Expedition to Thomas Point Lighthouse, the latest trip hopes to build on the experience and excitement of such events. The same sort of equipment lineup will be deployed as in past events. It will be all vacuum tube, all vintage, and all proven reliable in harsh environments.

We at first thought it was just sweat and exertion that we were feeling from grunting this heavy gear around in the series of "expeditions," as well as what's been set up for AM Festival Stations established at major hamfests. But it turns out we had discovered quite the adrenaline rush from successfully replicating how it must have been done years ago when this equipment was new and prime for portable operation.

Same with the audience reaction – very enthusiastic — as stations line up to hear our crews "on location." There actually is the occasional pileup, but generally it's an ever-changing group in a roundtable, allowing us to share with them what it's like to be on an island powered only to the outside world with a generator, some wire in the trees, and good luck.

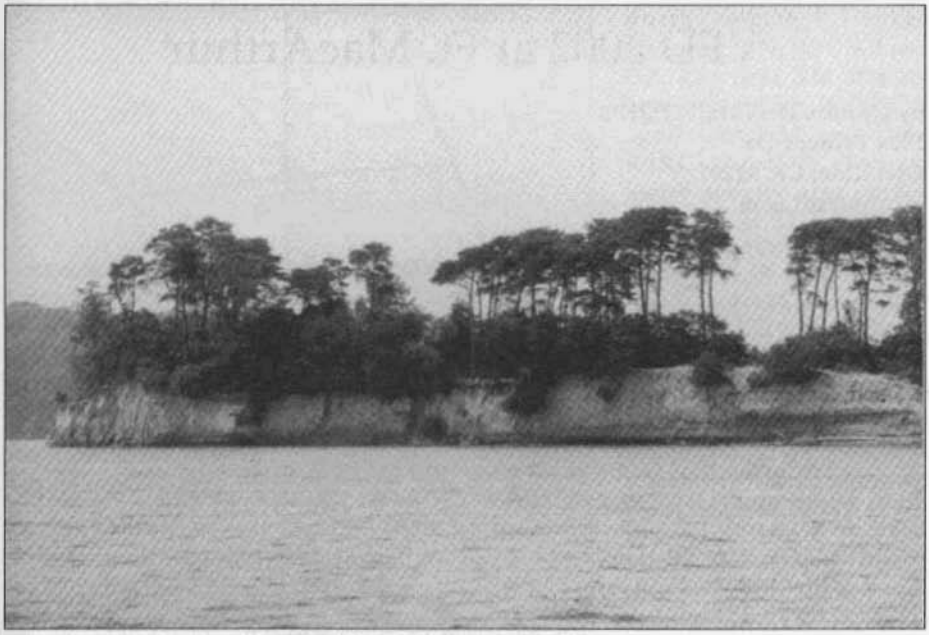
The pictures show some fairly tall trees on Dobbins Island that are spaced in such a way to support antennas placed with bow-and-arrow to the height and direction wanted. We plan to again use a 130 foot dipole and open wire feed-line through a Johnson KW matchbox, as deployed during the Thomas Point Lighthouse event last summer.

Equipment lineup will probably include the usual R-390A in the ruggedized and now rare tabletop cabinet, lined with tight mesh to keep out dirt and jungle bugs. The diode output of the receiver will be fed in the usual fashion to a high fidelity audio amplifier and loudspeaker setup. On the transmit side, we plan either the "TPL Ranger" which proved itself at Thomas Point Lighthouse, or a newer "Ranger 150" now undergoing research and development at the workbench of W2INR, Syracuse. Each has enhanced audio characteristics to bring out the warm and inviting sound of AM.

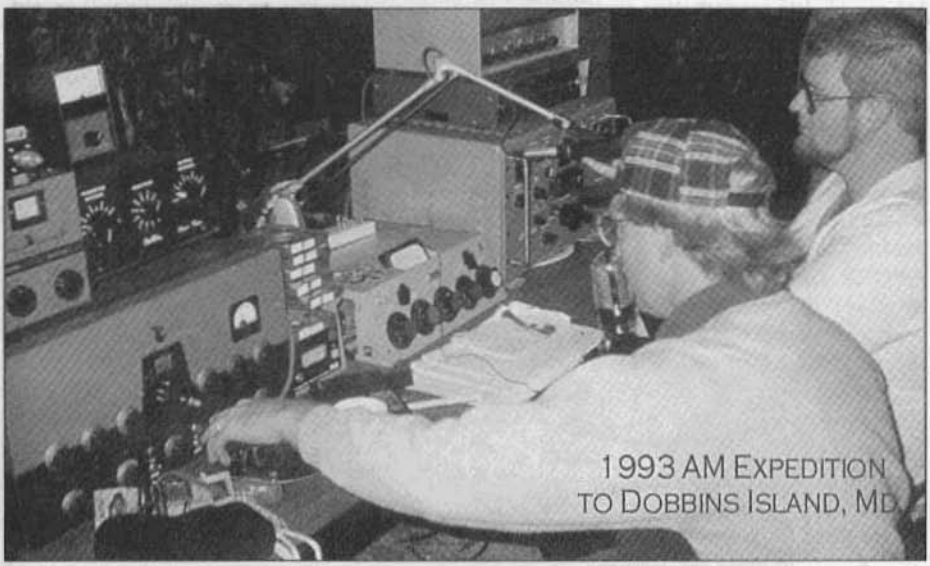
We had hoped for a return to TPL to help celebrate the founding of the U.S. Coast Guard, Aug. 4, 1790. But the events of Sept. 11 have raised security consciousness everywhere, and the prospects are now very slim for civilians to ever be allowed to return to that site, which is a mile offshore near a major shipping channel on the way to the Port of Baltimore. We look back with fond memories at our time on the lighthouse, circa. 1875. We have the story in our archives at the website www.amfone.net/K3L/

So, a Return to Dobbins, it is !

Please visit the internet web sites below for operating schedule and updates.
www.amfone.net, and see "Return to Dobbins Island" and www.amwindow.org/wwwboard/wwwboard.html



A view of Dobbins Island in Chesapeake Bay, Maryland.



Steve Ickes, WB3HUZ (left) and Tim West, N3DRB operating the Dobbins Island Special Event Station back in 1993.

VFD 2002 at Ft. MacArthur

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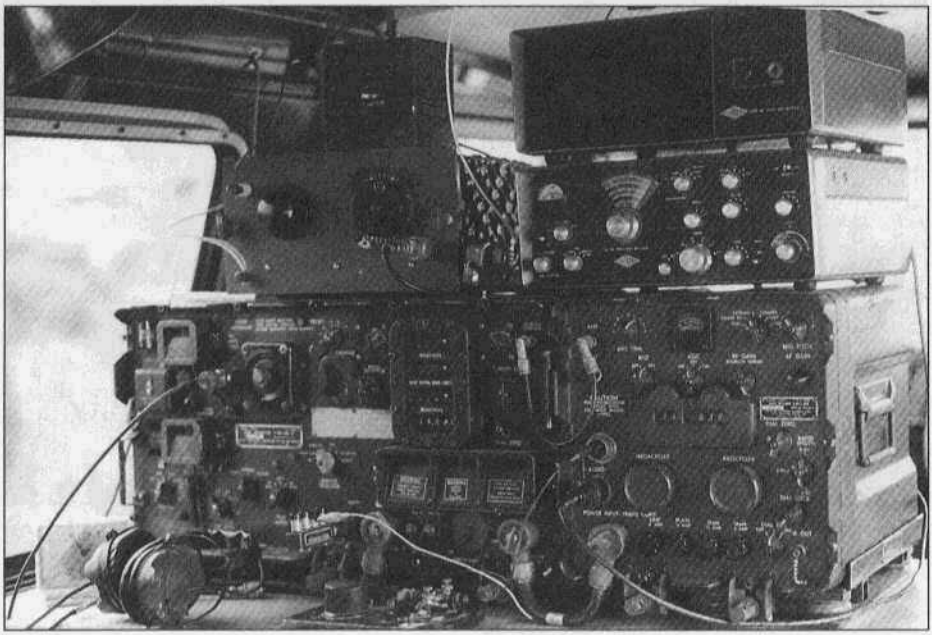
I operated at Ft. MacArthur in San Pedro, CA, again as I did three years ago (see ER #123, July 1999). This time around I set up on a bluff overlooking the Museum grounds and the San Pedro Channel, a location regularly used by area hams on ARRL Field Day. I operated from my 1985 G-20 van with a 30-ft. pump-up mast mounted on the back, an accessory I acquired from my friend Dale Gagnon, KW1I several years ago (see picture). I set out with a beam this year for 20, 15 and 10 meters and an end fed 130-ft. wire for the lower bands. I operated a GRC-19 again as my main HF rig (T-195 transmitter and R-392 receiver) powered by a home brew 28 VDC 50 amp power supply. I also took a Gonset G-76 along for 15, 10 and 6 meters and a vintage SBE-33 SSB rig (more on this below). AC power for all this was provided by a 5KW MG set.

I arrived on site at 0700 PDT on Saturday and was setup and running on 40M about an hour later. My first contact was with a curious SSB station (KB7NEI) quickly followed by WB6HQK on AM and then by Bob, WB6BTV/7 for the first (and one of very few) field stations worked. We were then quickly joined by the regular weekend morning 40M crowd including W1ZD, KO6SM, K7JEB, XE2/W7ISJ, K6LQI, W6BCN, and W6QMU. W7MD/



Equipment inside the author's van: T-195 (lower left); R-392 (lower right); Gonset G-76 (upper right).

A tri-band yagi is held aloft by a 30-foot military surplus pump-up mast. An end-fed 130-foot wire was used on the lower bands.

7 operating VFD portable also joined in but I was unable to hear him at that time. Barry, N6CSW/Ø operating portable near his home QTH called in at 0950 followed by K6UU and finally W9FGJ (AZ) at 1020 for the last 40M contacts of the morning.

My next contact was with N6CSW/Ø, on 21.420 MHz for my only 15M contact. At 1340, Bart, WB6HQK, one of several of my local friends who dropped by over the weekend, made a CW contact with K5KS on the T-195 using my call. I worked Barry again on 14.286 kHz at 1400. A short burst of 20M activity followed for the next half hour during which I worked stations in IN, WA, AR and OR. The next AM stations heard were Bob, W6BTV/7 again on 40M and Don, K4KCL at 1700. Twenty meter activity also perked up again at 1715 with the arrival of W8VYZ and the K6HQI Net. This activity continued up until 2000 and I picked up a few more contacts and reports here.

I called the West Coast Military Collectors Net to order at 2100 on 3986 kHz. Checkins here included K6VW, W6GER, WA6OPE, WA7DIA and KD6TKX. Following the net I tuned down to the usual AM haunts lower in the band (3870 - 3890) but found no activity, and after calling and listening for a while I secured the station and turned in for the night.

Came back on the air at 0630 Sunday morning and checked in with the regular weekend 3855 kHz group. This is generally the same bunch that meets on 40M later but I picked up a couple of new contacts here including K6CJA and K7JWA. Then it was on to 40M at 0900 where I heard W7MD/7 faintly for the first time. At 1000 I QSYed to 50.4 MHz and worked K6AN, AB6QY and K6XOL on my G-76 using a whip antenna on the van. At 1045 I tried to keep a schedule on 20M with W6GER without success, but W7MD/7 broke in and we finally made a solid contact (5X9 both ways).

The final contacts of the weekend were made on the Vintage SSB Net that meets on 14.293 kHz on Sundays at 1900Z (1200 PT). Here I picked up WBØSNF and K5LYN on my SBE-33. Following this activity, I checked 40 through 10M, made calls and listened

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AM Booming in Southern California

by Joe Tyburczy, W1GFH/6
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Two things happen when AM enthusiasts meet. Voices get matched with faces, and good friendships only get better. Such was the case when more than thirty AM'ers, friends, and spouses gathered for a barbecue on April 27th at the breezy Palmdale, Calif. estate of Bill Feldmann, N6PY.

"I can't believe how many people came" says Bill. "It really shows how AM is growing in popularity". On the sun-splashed "Left Coast" where palm trees often sprout 75-meter dipoles, the high-fidelity, low-stress, easy-listening mode of AM is claiming new devotees daily. "Out here, AM stands for Angel Music" declares Skip Alminas, K6LGL. But what makes the Southern California AM scene so unique is the diversity of people it attracts. Reach for a hot dog at this barbecue and you might rub elbows with prominent physician Damon Raphael, W7MD; Emmy Award-winning broadcast engineer, Mike Dorrough, KO6NM, or legendary rocker Joe Walsh, WB6ACU.

Heavy metal changed hands as tailgates swung open revealing both vintage gear and exotic new projects. Trevor Jacobs, KG6CYN demonstrated a beta version of a direct digital synthesis VFO he designed for use with boatanchor, homebrew, and broadcast transmitters. Dave Curry, WD4PLI let the group test-drive a prototype of his new 1750-meter LOWFER transceiver kit. And Dennis DuVall, W7QHO brought a trunk-load of working "green radios" for everyone to try out, including a PRC-70 and a GRC-9 featuring a hand-cranked generator.

The AM Barbecue tradition was originated three years ago by Ken Hale, K6CJA as a way for the AM community in this geographically spread-out state to meet and socialize on a face-to-face basis. Attendance has grown exponentially ever since, and it's not hard to figure out why. "It's simple" explains Brian Thompson, NI6Q/F5VQ. "AM brings good people together".

A complete list of the attendees:

Bill Feldmann, N6PY; Jim Casper, N6PIQ; Justin Blais, K6CPZ; Pat Jasper, WR6S; George Silva, WA6HCX; John Movius, WA6JUS; Jean Movius; Bob Schreiber, N6JZJ; Dave Curry, WD4PLI; Trevor Jacobs, KG6CYN; Elena Scott; Adrienne Sherwood, WA6YEC; Dan Sherwood, WA6PZK; Damond Raphael, W7MD; Mickey Siegel, WA6FIZ; Barbara Siegel, KF6JXV; Rosemarie Vallette, K6WKH; Bob Vallette, K6BT; Dennis Jones, K6RCL; Jim Cottingham, WA6WRF; Charles Turner, KC6ARU; Joe Tyburczy, W1GFH; Don Grantham, W6BCN; Mary Grantham; Ken Hale, K6CJA; Bernie Doermann, WA6HDY; Robert Burger, WB6VMI; Leone Burger; Dave Jennings, KF6YKZ; Mike Dorrough, KO6NM; Hank Arney, KN6DI; Doug Charis, KJ6DI; Phaseuth Arun, AC6NX; Larry Bolster, N6PPO; Brian Thompson, NI6Q/F5VQ; Gary Ponte, W6GY; Skip Alminas, K6LGL; Dennis DuVall, W7QHO; Joe Walsh, WB6ACU.

(L to R) Bob Schreiber, N6JZJ, Trevor Jacobs, KG6CYN, Joe Walsh, WB6ACU, and Damon Raphael, W7MD gather in the shack of Bill Feldmann, N6PY.

Only a few of the 30-plus AM'ers at the N6PY barbecue. (L to R) Jim Cottingham, WA6WRF; Mickey Siegel, WA6FIZ; Joe Walsh, WB6ACU; Brian Thompson, NI6Q; Ken Hale, K6CJA; Dennis Jones, K6RCL; Dave Curry, WD4PLI; Trevor Jacobs, KG6CYN; Joe Tyburczy, W1GFH; Bill Feldmann, N6PY; John Movius, WA6JUS; Dave Jennings, KF6YKZ; Jim Casper, N6PIQ; Doug Charles, KJ6DI; Robert Burger, WB6VMI; Mike Dorough, KO6NM; Gary Ponte, W6GY.

Causes of Hum in Sensitive Circuits

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Frequently in the restoration of vintage equipment or in design of new homebrew equipment, we run into problems with excessive hum voltage. Depending on the source, it can be either easy to reduce, or in some cases, very difficult. This article will be going into the physical causes of hum, which will hopefully equip the reader with the tools necessary to get rid of excessive hum, or as my wife April says, "Teach your radio the words!"

This is not an article on how to check for capacitor leakage, we all know how to do that. I'll only briefly go into the procedure for the new technicians among us, because it can be the cause of severe hum. In restoration work on vintage radio equipment, the first thing we do is usually to check or replace the power supply filter capacitors. Electrolytic capacitors which have dried-out dielectric material are well-known hum sources. Old paper bypass capacitors have the same problem. Table 1 is a chart compiled from the Electronic Industries Association (EIA) that I use as a guide in determining limits for capacitor "leakage". A variable power supply is used in series with a sensitive microammeter and the capacitor to compare with the chart. The capacitor must be disconnected from the circuit, and slowly brought up to its rated working voltage. Large electrolytic caps have a large time constant and may take quite some time to reach a minimum leakage value. The ammeter current should continually drop to some low value, but should not begin to rise again, as this indicates a problem in the dielectric material. Actually, a physicist will tell you that a capacitor does not store a charge. What it does is to maintain equilibrium between equal magnitude and oppositely charged particles across the capacitor dielectric material; so that the charge stored is zero. This is known as the "zero charge theory", but is only valid for DC and low frequencies. Electromagnetics describes charge behavior across the dielectric at higher frequencies and at RF. When the dielectric breaks down the equilibrium is disturbed, and excessive current will flow. The current flow is what is responsible for the increase of AC ripple voltage that is superimposed on the DC developed by the power supply rectifier.

Vacuum tube design has been gone now over 35 years, and useful information on the causes of hum of this sort is hard to find. Engineers in the field 40 years ago, or longer, commonly agreed that sources of hum fell into two main categories. The first were causes external to a tube acting on components connected to the tube's circuit, or on the tube itself. Causes here obviously include hum from alternating magnetic and electrostatic fields, but also includes hum that can be traced to leakage and stray capacitance in the circuit wiring.

The second cause was hum with a source developing inside a tube as a result of its characteristics. This is generally more complicated, and includes heater-to-cathode leakage and the action of the AC heater field within the tube structure.

Here are some common sources of

	Working Voltage														
	1.5	3	6	10	15	20	25	35	50	100	200	300	400	500	600
uF															
1	5	5	5	5	5	5	5	5	5	5	10	15	20	25	30
3.3	5	5	5	5	5	5	5	6	8	17	33	50	218	244	267
4.7	5	5	5	5	5	5	6	8	12	23	47	225	260	291	319
10	5	5	5	5	8	10	13	18	25	50	268	329	379	424	465
22	5	5	7	11	17	22	28	39	199	281	398	487	563	629	689
33	5	5	10	17	25	33	41	204	244	345	487	597	689	771	844
47	5	7	14	24	35	47	206	243	291	411	582	712	823	920	1008
68	5	10	20	34	192	221	247	293	350	495	700	857	990	1106	1212
100	8	15	30	50	232	268	300	355	424	600	849	1039	1200	1342	1470
220	17	33	218	281	345	398	445	526	629	890	1259	1541	1780	1990	2814
330	25	50	267	345	422	487	545	645	771	1090	1541	1888	2180	2437	2670
470	35	225	319	411	504	582	650	770	920	1301	1840	2253	2602	2909	3186
680	192	271	383	495	606	700	782	926	1106	1565	2213	2710	3129	3499	3832
1000	232	329	465	600	735	849	949	1122	1342	1897	2683	3286	3795	4243	4648

Table 1. Maximum allowable leakage in microamps for standard aluminum capacitors. Note that not all capacitor values are given; other leakage limits may be interpolated from the table.

hum in sensitive circuits, and approximate voltage levels to be expected:

1) AM modulation of plate current caused by stray flux from power transformers and chokes:

Glass-envelope pentodes:2 millivolts

Glass-envelope triodes: 300 microvolts

Metal pentodes: 100 microvolts

Metal triodes: 20 microvolts

Often can be cured by correct orientation of tube structure with respect to power transformer, see text below.

2) Heater-to-grid leakage across tube socket:

Expect 10 to 15 microvolts for each megohm of grid resistance and each volt RMS that the heater is above ground. Can be cured by hand-selecting tubes, the use of double-ended tubes, or a rheostat acting as an adjustable center tap on filament transformer.

3) Input grid circuit leakage or ground loops: As high as 50 to 75 microvolts

4) Heater-to-cathode leakage: Internal currents up to 1 microamp.

Can be cured by bypassing the cathode for AC and harmonics, and by use of low cathode impedances.

Hum sources external to a tube

A common cause of hum is modulation of a tube's plate current by stray magnetic flux from power transformers and chokes. "Stray flux" is the name given to lines of magnetic flux existing outside of the transformer core. Its effect is easily reduced for homebrew designs if a few facts about the mechanics of the flux linkage are known. The stray fields are measured in gauss, after Karl Gauss, a German mathematician and astronomer who proved the inverse square law for magnetism in 1833 and derived expressions for the strength of field near a magnet.

A common misconception is that hum comes from the heater wiring. While there is a small field surrounding the heater wiring, it can be ignored when compared to strong transformer fields. For example, in a solid copper conductor carrying 1 amp of current, the field in air at a distance of 1 inch from the wire has been measured at .08 Gauss, or 80 milligauss. The stray flux from a power transformer at the same distance is easily more than a hundred times greater. There is no way to know exactly what the stray flux will be, because it depends on the quality of the transformer and its style of construction. A rule-of-thumb for commonly available commercial transformers, i.e. the Hammond or Stancor vertical mounting styles is between 5 to 10 Gauss at a distance of two inches from the core. The choice of chassis material also directly affects the amount of stray flux at nearby tubes. For a conductive steel chassis, there will be very little effect on

continued on next page

the field strength of the stray flux 2 inches or more above the chassis. However, the near field along the chassis and on its surface will be extended. The flux lines are enhanced, in effect. This is because of the lower reluctance path in the steel material. It is for this reason that vertical mount transformers are preferred to the half-shell types for communications equipment or sensitive audio gear. With an aluminum chassis, the reluctance path will be higher, so the requirement will be less stringent.

About 1947, an engineer by the name of Arthur Dickerson compiled a great deal of data on several representative tube types under varying magnetic field intensities and circuit conditions. He wrote this up for *Electronics Magazine*, and the results he provided can be of great use to us 55 years later. Dickerson obtained several types of communications receivers and broadcast sets. He disconnected the antenna, turned all the gain controls up and increased his 60-cycle field until audible hum was 1 or 2 dB above random circuit noise. He found that a field of 50 gauss RMS would produce hum if applied to the RF amplifier, mixers, IF amplifiers, or the 1st audio stage. Fields as high as 150 gauss RMS did not affect the audio PA and detector stages if separate tubes were used for the detector and 1st audio. Obviously, we need to keep these sensitive tubes at least 2 inches from transformers and chokes. As will be seen, hum level is affected by circuit design as well as the strength of the stray field, so that the 5 to 10 gauss field may induce hum if circuit design is not right.

Dickerson came up with a unit he called "microvolts-per-gauss" referred to the grid of the tube under test. It is useful because it takes into account the gain of the tube under test and also the stray field strength, and microvolts correspond to the signal levels we find in radio work. I'll abbreviate this unit as mV/g. He found that the hum level of a pentode amplifier does not increase linearly with an increase of field strength. It increases exponentially at a rate between the first and second power of the magnetic field strength. For a glass envelope, there is about 250 mV/g with a field of 45 gauss, but at 5 gauss it dropped to 20 mV/g. 20 millivolts is enough to cause a problem with low-level RF amplifiers. Surprisingly, triodes respond differently. They show hum levels of 30 mV/g in a 45 gauss field, and only 7 mV/g in a 5 gauss field. This is one of the reasons they are preferred in audio work.

It's easy to orient tubes on a chassis in order to minimize hum pickup. Figure 1 is a sketch of stray flux lines for a typical transformer with E-core laminations. The X direction is parallel to the open end of the "E" shape of the core. Figure 2 is a sketch of a typical vacuum tube using concentric construction. The electron stream in the tube emerges from the cathode at the center, passes thru the grid wires, and onto the plate (not shown). If the flux vector in the x-direction from a transformer (or an air-core coil) is perpendicular to the plane of the grid side-rods, hum modulation of the electron stream will be minimum. Note that rotating tube 180 degrees will not change the amount of hum modulation. It needs to be rotated by 90 degrees to be effective. By observing this orientation rule, you can bring the hum level down 35 dB in glass-envelope tubes. It can be reduced another 10 dB by using a metal shield, but don't use one of the shiny tin shields or the working life of the tube will be greatly reduced by the heat the shield traps.

In homebrew work, the choice of circuit constants has a direct effect on the level of hum in a tube's output. I'm going to skip the math, and present the facts a builder needs to get good re-

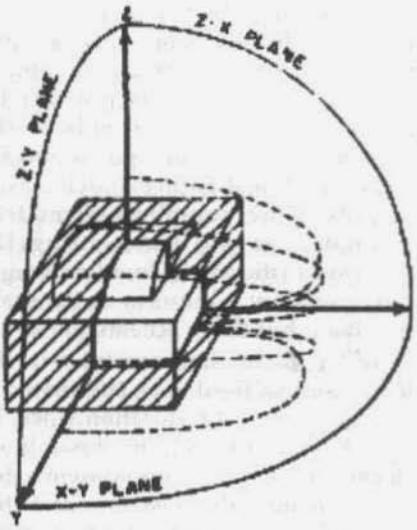

Figure 1. Flux vector pattern for E-type transformer cores

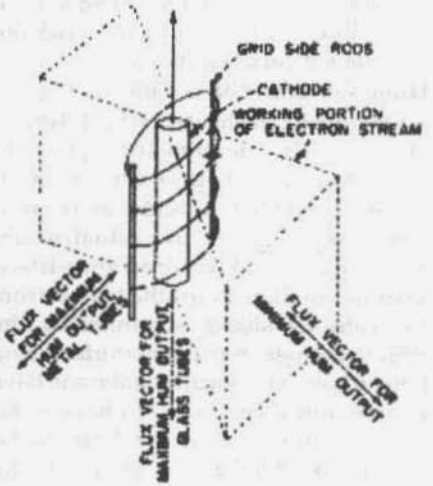

Figure 2. Concentric tube construction

sults. If a tube is assumed to be a resistance-coupled amplifier operating in a magnetic field with no signal on the grid, the effect of the field is to increase the static plate resistance at the operating point. It can be shown that the peak-to-peak output hum voltage for any tube is proportional to the load resistance and changes inversely with the sum of the load resistance and the static plate resistance. There is also a constant that is a multiplier. For a triode amplifier, static plate resistance is mostly independent of load resistance. In a pentode however, static plate resistance increases directly with load resistance because they are usually the same magnitude. Here is what is important in this: In a triode, output hum level is mostly independent of load resistance. In a pentode, if the load resistance is increased to obtain a lot of gain, gain will increase by an amount less than the increase in load resistance, but the output hum level increases directly as the increase in load resistance. In other words, use only as much load resistance in pentodes as absolutely necessary for the gain required in your circuit, or use a separate power supply chassis and shield all of the RF transformers. It may still be possible to find shielded transformers from military surplus.

Metal tube types were superior to glass tubes in suppression of hum voltage. A metal tube can easily be 40 dB down in hum level because of the envelope, but a good shield on a glass tube will be within 3 or 4 dB of the metal type. For some reason never fully understood, the output wave shape of the hum voltage is mostly fundamental 60-cycle in metal tubes, while glass tubes will show mostly second harmonic energy and varying amounts of higher order, even harmonics. A 60-cycle note needs to be about 3 dB stronger than a 120-cycle note to sound as loud by ear. An easy way to cure harmonic energy in the heater string is to use one of the low-pass filters designed for power cord input circuits. They are easily found on the surplus market, Corcom and others make excellent units. Also be certain that the cathode bypass caps are adequate, and in good condition.

The leakage impedance between the pins on a tube socket is dependent upon grid-circuit impedance, pin-out ar-

continued next page

rangement, socket material, and the tube's heater-to-cathode capacitance rating. (There is also a resistive component of this leakage impedance.) I have found by measurement that most of the values given in the tube manuals for inner-electrode capacities are not even close to what they actually are. Differences of 50-60 % are common, and you will need to hand-select optimum tubes if your gear is having a problem with leakage caused by the tube socket impedance. These impedances act like voltage dividers in the grid circuits. If their values are not held to a minimum, a lot of AC hum voltage will drop across them as in any other voltage divider. Ceramic tube sockets have the highest isolation; almost all of the leakage impedance is capacitance. The next best sockets are polystyrene, mica-filled Bakelite, and black Bakelite, in that order. The amount of resistive impedance with these sockets varies with the manufacturer.

So what does this entire description mean to a builder in 2002? Most of the leakage impedance is capacitive, even in the worst sockets, and it will increase for higher-order harmonics. A sine-wave heater voltage will be a sine wave at the plate, but heater voltage with distortion caused by harmonics will be reproduced at the plate with higher harmonic content, higher voltages, and more audible hum. Also, stage gain will go up unexpectedly in certain designs because of these harmonics.

In most of our communications equipment, one pin of the tube heater is grounded. This provides a single source of hum leakage voltage. Leakage voltage arrives at the signal grid leading the heater voltage by 90 degrees. It is difficult to cancel this type of hum completely. In some types of equipment you will find neither pin grounded. The heater string is operated in parallel directly from the filament transformer with a grounded secondary center tap. The advantage to this design is that leakage from the two pins arrives out of phase and with differing magnitudes. Cancellation of hum is possible by connecting the outside ends of the filament secondary to a potentiometer and grounding the arm to the chassis. A slightly more complicated modern method is to use series-string DC filaments in the critical low-level stages fed from an adequate solid-state regulator, but that's "cheating"!

Again, all of the harmonics in the heater supply need to be eliminated in new gear, and in restoration work, be sure that the chassis ground points are clean and tight, that there is no corroded wiring with high resistance, and that the filament center-tap, if used, is tightly bonded to the chassis. Make sure the tube sockets are as clean as possible; clean them with contact cleaner until they look new to reduce leakage impedance between the pins.

Hum Sources Within Tubes

Obviously, the heater is the only tube element that intentionally carries 60-cycle AC current. In a tube with an indirectly heated cathode, as in most tubes we use now, the actual heater material is coated with a ceramic-based material that insulates the heater from the cathode sleeve surrounding the heater. In spite of every manufacturing precaution, occasionally a tube will have excessive leakage between heater and cathode that will cause hum to be noticeable. The exact causes of the leakage was never fully understood, except that it was established that modulation of the plate current by this leakage is NOT the cause. There were three main sources identified as possible causes of heater-to-cathode leakage. The most obvious is capacitive coupling between heater and cathode. Less obvious are resistive leakage between heater and cathode across the ceramics, and direct thermionic emission from the heater and cathode. The leakage

waveforms from all types of heater-to-cathode leakage shows rich harmonic content, which further compounds the hum problem.

If the cathode is DC grounded, or if a cathode bias resistor is bypassed with a big capacitor that is not leaky, hum voltage shouldn't be a problem. In sensitive circuits such as detectors, cathode followers, FM ratio detectors, or in audio work using phase inverters, the heater-cathode leakage current can cause a voltage drop across the un-bypassed cathode resistance, even with the degenerative effect of the un-bypassed resistor. The heater-cathode impedance is very large compared to the average value of cathode resistors, so the hum current is essentially a constant current source. Fortunately, most "modern" tube types were manufactured with processes designed to minimize heater-to-cathode leakage, so the leakage current is very small, about .04 microamps or less. Swapping out tubes in cases where this leakage is suspect is the best thing to try.

Hum modulation of VFOs

In homebrew VFOs, heater-to-cathode leakage can cause FM modulation of the VFO frequency that can be heard farther on down the signal chain, either in receiver audio or on the output of a transmitter. It sounds like a distorted type of hum signal, and on a scope the trace of the desired waveform is wider than normal due to the FM. Sometimes trying several different tubes won't stop it. Here is how it happens, and a suggestion for its elimination.

Figure 3 is a simplified schematic of a typical VFO circuit. The capacitors in the dotted lines represent the grid-to-cathode (C-gk) and heater-to-cathode (C-hk) capacities. What happens to cause hum on the output frequency is that either thermal variations of the heater's insulation or mechanical vibrations -microphonics- of the heater element causes C-hk to vary at the power

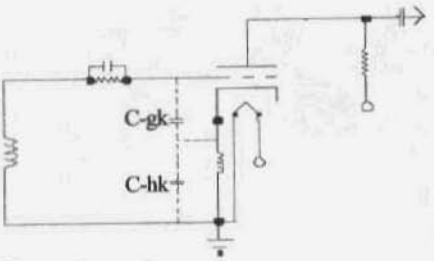

Figure 3

frequency. C-hk is in series with C-gk, and both capacitors are across the oscillator tank circuit. The repeated variation of the series combination FM-modulates the oscillator signal similar to a reactance modulator. Although it doesn't change the signal frequency much, a repetitive shift of .8 pF in a 5-mc oscillator, for example, will change the output at a 120-cycle rate.

The solution to this problem is shown in figure 4. Identical chokes are used so that the cathode and heater operate at the same RF potential and the leakage current becomes minimal. This technique was used years ago up into the VHF range and is good for any HF frequency.

Other hum sources: Input circuit ground loops

Sometimes an unintentional ground loop is formed in the low-level input of certain circuits, such as transmitter speech amplifiers. Despite the use of high-quality shielded audio cable, a persistent hum is present. Figure 5 is a simplified schematic of a speech amp with length of shielded cable connecting a microphone to its input. Alternately, the input could be anything else one could connect to an amplifier, such as a phono cartridge. The dotted line connecting the capacitor near the mic represents stray coupling to anything carrying AC current. It is not necessarily a physical connection. Coupling can also happen by magnetic means into the loop or directly into the mic element.

Figure 6 is an equivalent circuit that shows what causes the "ground loop"

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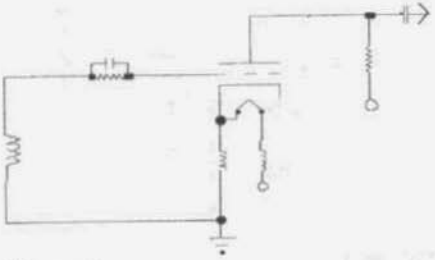

Figure 4

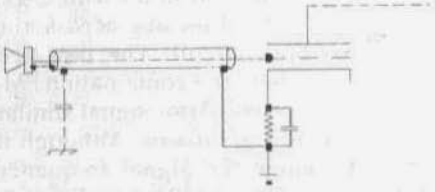

Figure 5

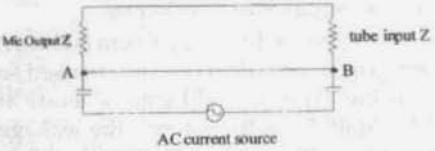

Figure 6

to form. To keep the description simple I have shown the impedances as resistances.

C1 and C2 are leakage capacitances to some conductor carrying AC current; they are not physical units. The loop is in the closed circuit that has become part of the grid-return lead between points A and B. The ground loop can act either as an electrical leakage path, or as a magnetic loop. This depends on how the physical connections are made and the size of the leakage capacitances. The resistance of average shielded conductor is about .003 ohms per foot. A voltage drops across the combination of the shield resistance and the reactance of the leakage capacitance, and levels up to 75 microvolts have been measured across 3 feet of this style of cable. Sometimes operators will try connecting both ends with a thick ground strap, which shorts out the leakage capacitance. To our great surprise the hum

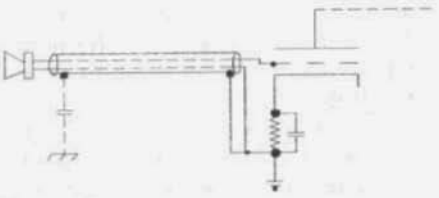

Figure 7

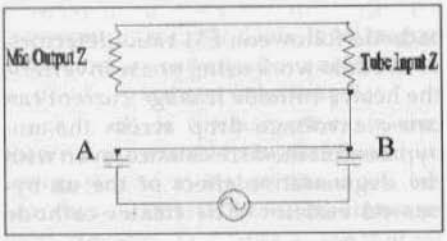

Figure 8

does not go away. What is going on is that we have changed the ground loop into a magnetic coupling loop that picks up stray flux from anything and everything that carries AC current. Believe me, it will drive you nuts because as soon as you think an arrangement has been found where the hum level drops, some condition changes and it is back as loud as before. The fix is to change to two-conductor shielded cable as shown in Figures 7 and 8, although in studio work, balanced center-tapped transformers are sometimes used on each end of cable runs to cancel the hum voltage.

The use of shielded two-conductor cable isolates the amplifier input circuit from the closed loop the shield makes with the microphone. With no closed loop, there is no voltage drop along the shield that would cause the hum voltage to be reflected through the mic output impedance and into the tube's grid circuit. Figure 8 is an equivalent circuit that describes the isolation.

Elimination of closed loops in equipment grounding will reduce the overall hum level in our equipment. In homebrew gear, be sure that the cathode ground point and the ground end of the grid circuit are firmly bonded to the

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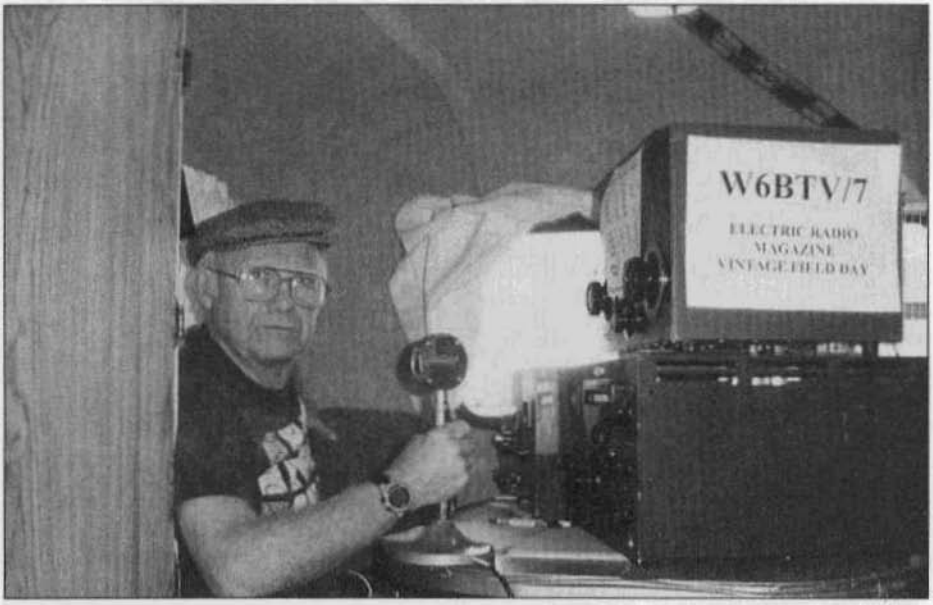
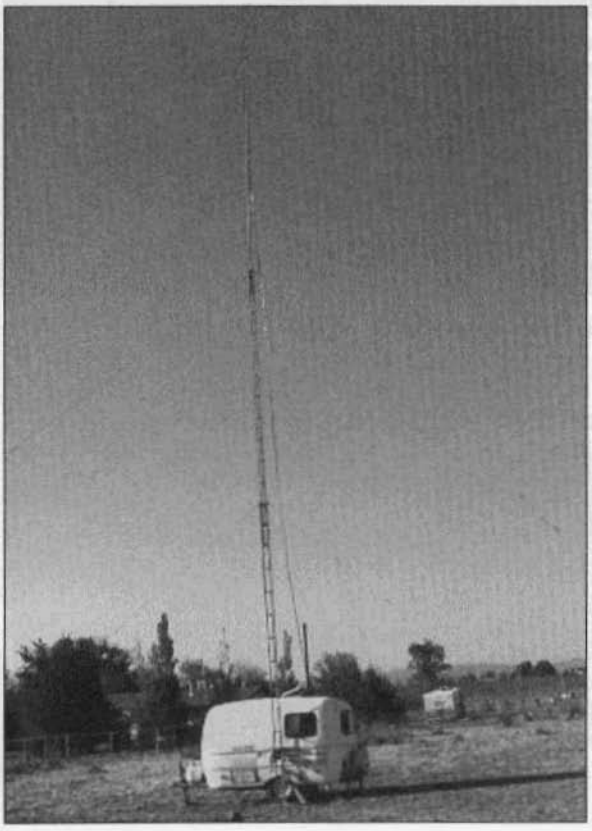




W6BTV/7 VFD Report

Bob Sitterley, K7POF and Dennis, KM5UI/7 operated VFD from near Bob's home in Chino Valley, AZ using club callsign W6BTV/7. As you can see the trailer and mast made for a neat VFD setup. The gear consisted of a Viking II transmitter and a 75A-4 receiver. The 57 foot mast was used as a center support for a 160 meter inverted V. They worked a total of 56 stations. ER

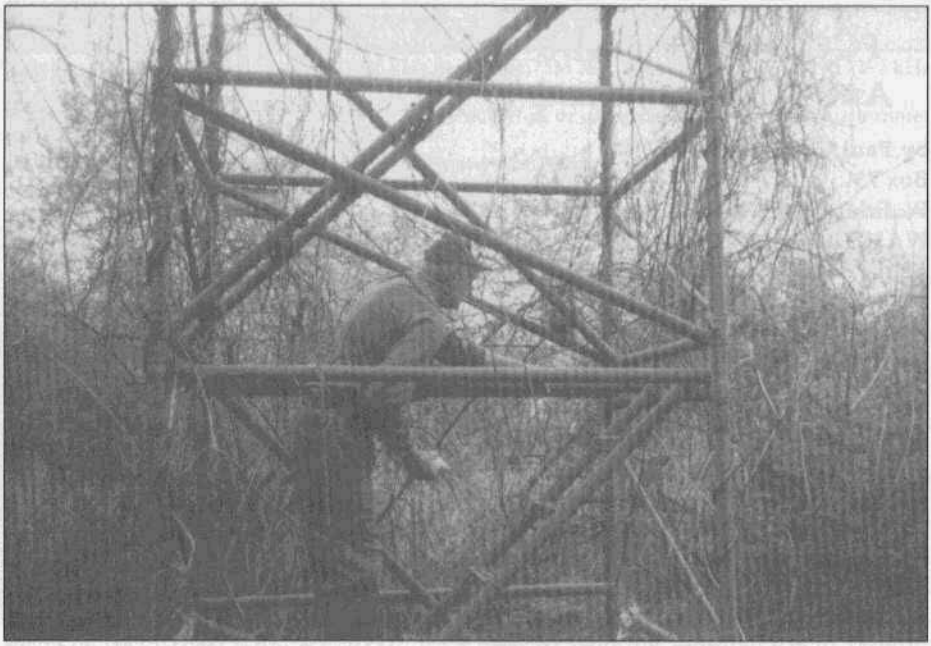
AMer's Gather at Indianapolis

by Roger Lowary, W9BZ, 465 Lacy Dr., Greenwood, IN 46142

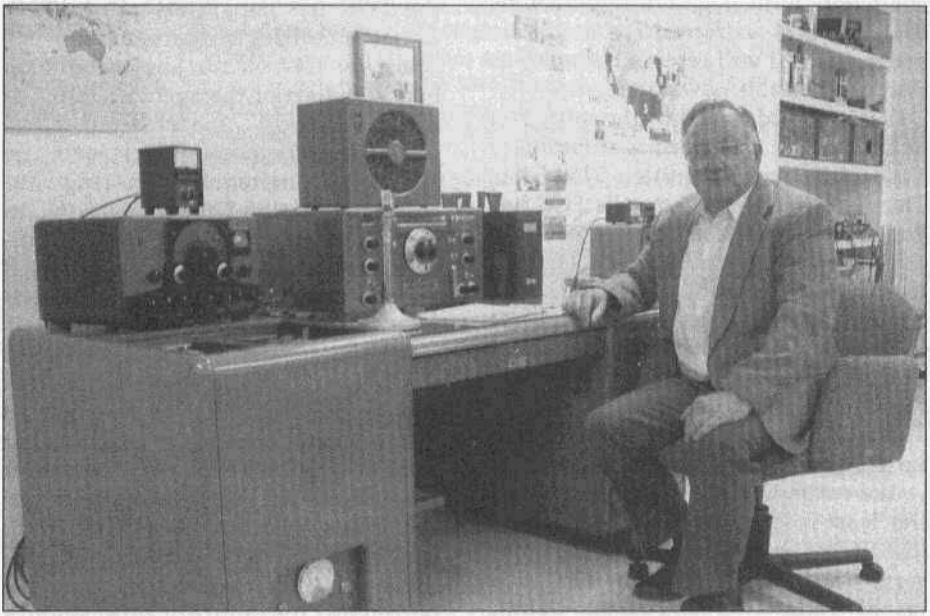
AMer's at the Indianapolis Hamfest on July 6, 2002 pose for their picture. From left to right: Roger Lowary, W9BZ; John Wampner, N9DAW; Emmett Dodson, K9YKX; Ken Poe, K9POE; Steve Benson, N9NZI; John Warren, W9BFO; Gil Parsons, W8OGL; and Charlie Sears, N9MEW.

Amateur AM enthusiasts from Ohio, Indiana, and Illinois gathered for a cook out at the home of Roger Lowary, W9BZ, the evening of July 6, 2002. Fourteen were in attendance. A quiz was given to the attendees covering vintage amateur and commercial AM history. Gil Parsons, W8OGL, won the grand prize for correctly answering the most questions.

The following day most of the group reassembled at the Marion County Fairgrounds for the 32nd annual Indianapolis Hamfest for fun, food, and picture taking. A good supply of vintage AM, equipment was offered for sale, including some extra fine pieces of Johnson and Hammarlund gear. Good friends said good-by with a pledge to return again next year. ER



This is an ex-military airport control tower recently acquired by George Rancourt, K1ANX. The 48' tower is 6'x4' at the base and is comprised of 6 foot sections with stairs between sections. The guys are all stainless steel.



Jim Wilson, N7JW, with his AM station which is comprised of the Johnson Desk KW with Ranger driver and HRO-60 receiver. *Photo by Jerry Chandler, K6PKO.*

FCC Docket Draws Anti-AM Comments

by Paul Courson, WA3VJB
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The FCC has proposed granting secondary use to the Amateur service a portion of the 60 meter shortwave band, 5250-5400 kc, and asks for comments from those interested in the proceeding known as Docket 02-98. The proposal also encompasses a possible longwave authorization and an upgrade for hams operating on an existing allocation at SHF.

As of this writing, commenters have offered overwhelming support to the 60 meter proposal contained in the Docket that this editorial report covers. However, there is also a handful of comments with negative implications for the AM community and the prospects AM will remain included as proposed on this new band.

Please consider reading the entire text of the Docket, with special attention to the middle section entitled 5250-5400. Thus equipped with how the FCC has generously proposed the allocation, then pick through the Comments section in the FCC's Electronic Comment Filing System available on the internet at http://www.fcc.gov/e-file/ecfs.html The proposed docket is the very first of the comments stored in this system. The most recently filed comments pop up first, and number close to 200.

In a nutshell, the FCC has proposed the least-restrictive protocol it could justify in its conclusion the Amateur service will benefit from an allocation on this band. There are no sub-bands, and no upper-class license segregation. All existing modes and activities are given equal stature in the FCC's proposal, in line with the agency's prevailing philosophy of minimal regulation or other federal mandates governing the Amateur service. Full power authorization is proposed (1500 watts PEP).

Members of the AM community, myself included, have filed their support for the plan as written.

It is this writer's opinion that certain factions in the hobby seek to protect their specialties and are using this docket to attempt to carve out additional protected zones for their operating activity. Weak CW proponents, for example, have filed comments that generally express hope the FCC will replicate the leftover sub-band protocol found on older HF bands when "code" held a substantial place in Amateur operating. Others have proposed federally-enforced reservations for emerging activities that have not gained popular support, such as what's referred to as "digital" technologies.

This misguided hope comes at a time the FCC has separately proposed a dramatic cutback in reserved frequency space for CW on the shortwave ham bands as part of the agency's effort to more closely match sub-band protections to present-day levels of activity. Commenters ignoring that realignment plan have filed asking, in effect, to repeat the imposition of full-time spectrum set-asides that are rigid and cannot adapt to potential under-use.

Such under-use is a serious issue for the Commission and should be of great concern to hobbyists as they try to demonstrate that we utilize our allocations to the greatest extent possible among the various modes and activities. Commenters filing in contradiction to the FCC proposal down-play this issue, and cite what they perceive as the failure or shortcomings of a voluntary system of operating.

None of the commenters opposed to

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VINTAGE NETS

Arizona AM Nets: Sat & Sun, 160M 1885 kHz at sunrise,75M 3855 kHz at 6 AM MST, 40M 7293 kHz 10 AM MST; 6M 50.4 MHz on Sat. at 8 PM MST; 2M 144.45 MHz, on Tue. at 7:30 PM MST.
West Coast AM Net meets Wednesdays 9PM Pacific on or about 3870kc. Net control alternates between John, W6MIT and Ken, K6CJA.
California Early Bird Net: Saturday mornings at 8 AM PST on 3870.
California Vintage SSB Net: Sunday mornings at 8 AM PST on 3860 +/-
Southeast Swap Net: Tuesday nights at 7:30 ET on 3885. Net controls are Andy, WA4KCY and Sam, KF4TXQ. This same group also has a Sunday afternoon net on 3885 at 2 PM ET.
Eastern AM Swap Net: Thursday evenings on 3885 at 7:30 ET. This net is for the exchange of AM related equipment only.
Northwest AM Net: AM activity daily 3 PM - 5 PM on 3875. This same group meets on 6 meters (50.4) Sundays and Wednesdays at 8:00 PT and on 2 meters (144.4) Tuesdays and Thursdays at 8:00 PT. The formal AM net and swap session is on 3875, Sundays at 3 PM.
K6HQI Memorial Twenty Meter AM Net: This net on 14.286 has been in continuous operation for at least the last 20 years. It starts at 5:00 PM PT, 7 days a week and usually goes for about 2 hours.
Colorado Morning Net: An informal group of AM'ers get together on 3875 Monday, Wednesday Friday, Saturday and Sunday mornings at 7AM MT.
DX-60 Net: This net meets on 3880 at 0800 AM, ET, Sundays. Net control is Jim, N8LUV, with alternates. This net is all about entry-level AM rigs like the Heath DX-60.
Eastcoast Military Net: It isn't necessary to check in with military gear but that is what this net is all about. Net control is Ted, W3PWW. Saturday mornings at 0500 ET on 3885 + or - QRM.
Westcoast Military Radio Collectors Net: Meets Saturday evenings at 2130 (PT) on 3980 + or - QRM. Net control is Dennis, W7QHO.
Gray Hair Net: The oldest (or one of the oldest - 44+ years) 160-meter AM nets. It meets on Tuesday nights on 1945 at 8:00 PM EST & 8:30 EDT. www.hamelectronics.com/ghn
Vintage SSB Net: Net control is Andy, WBØSNF. The Net meets on 14.293 at 1900Z Sunday and is followed by the New Heathkit Net at about 2030Z on the same freq. Net control is Don, WB6LRG.
Collins Collectors Association Nets: Technical and swap session each Sunday, 14.263 MHz, 2000Z, is a long-established net run by call areas. Informal ragchew nets meet on Tues nights on 3805 at 2100 Eastern and on Thur nights on 3875. West Coast 75M net that takes place on 3895 at 2000 Pacific
Collins Collector Association Monthly AM Night: The first Wed. of each month on 3880 kHz starting at 2000 CST (0200 UTC). All AM stations are welcome.
Drake Users Net: This group gets together on 3865 Tuesday nights at 8 PM ET. Net controls are Criss, KB8IZX; Don, W8NS; Rob, KE3EE and Huey, KD3UI.
Drake Technical Net: Sunday's on 7238 at 4PM Eastern time hosted by John, KB9AT; Gary, KG4D; Jeff, WA8SAJ and Evan, K8SQG.
Swan Users Net: This group meets on 14.250 Sunday afternoons at 4 PM CT. The net control is usually Dean, WA9AZK.
Nostalgia/Hi-Fi Net: Meets on Fridays at 7 PM PT on 1930. This net was started in 1978.
K1JCL 6-Meter AM Repeater: Located in Connecticut it operates on 50.4 in and 50.5 out.
Fort Wayne Area 6-Meter AM Net: Meets nightly at 7 PM ET on 50.58 MHz. This net has been meeting since the late '50's. Most members are using vintage or homebrew gear.
Southern Calif. Sunday Morning 6 Meter AM Net: 10 AM Sundays on 50.4. NC is Will, AA6DD.
Old Buzzards Net: Meets daily at 10 AM Local time on 3945. This is an informal net in the New England area . Net hosts are George, W1GAC and Paul, W1ECO.
Canadian Boatanchor Net: Meets Saturday afternoons, 3:00 PM EST on 3745.
Midwest Classic Radio Net: Sat. mornings on 3885 at 7:30AM Central time. Only AM checkins allowed. Swap/sale, hamfest info and technical help are frequent topics. NC is Rob, WA9ZTY.
Boatanchors CW Group: 3546.5, 7050, 7147, 10120, 14050. 80 on winter nights, 40 on summer nights, 30 and 20 meters daytime. Nightly "net" usually around 0200-0400 GMT. Listen for stations calling CQ BA, CQ GB.
Wireless Set No. 19 Net: Meets the second Sunday of every month on 7.270 +/- 25 kHz at 1800Z (3760 +/- 25 kHz alternate). Net control is Dave, VA3ORP.
Hallicrafters Collectors Assoc. Net: Sundays, 1730-1845 UTC on 14.293. Net control varies. Midwest net on Sat. on 7280 at 1700 UTC. Net control Jim, WB8DML. Pacific Northwest net on Sundays at 22.00 UTC on 7220. Net control is Dennis, VE7DH
Mighty Multi-Elmac 75 meter AM net: Every Tues eve at 8 PM EST. NCS is Mike, N8ECR
Nets that are underlined are new or have changed times or frequency since the last issue.

The National NC-80X

by Jim Hanlon, W8KGI
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It was early in 1937, and the engineering team at National was on a real roll. They had spent just about all of 1934 creating a revolutionary new, top-of-the-line receiver, the HRO. The following year they developed a way to make plug-in coils into a band-switching design in the NC-100. Then they put a "trick condenser" into the NC-100 to make a one-of-a-kind, ham-band only version for their boss, Jim Millen, and it became popular in its own right as the NC-101X. They also brought out a bare bones, lower cost "Junior" version of the HRO. Using the newly-developed RCA acorn tubes they designed a VHF super regenerative receiver, the One-Ten, and they learned a lot about this new higher frequency range as they worked the bugs out of that design. So in 1937 they had a well-established HF receiver line in the medium and high-priced markets. But aside from their venerable three-tube regenerative SW3, they had no HF receiver offering under the HRO Junior at $99.

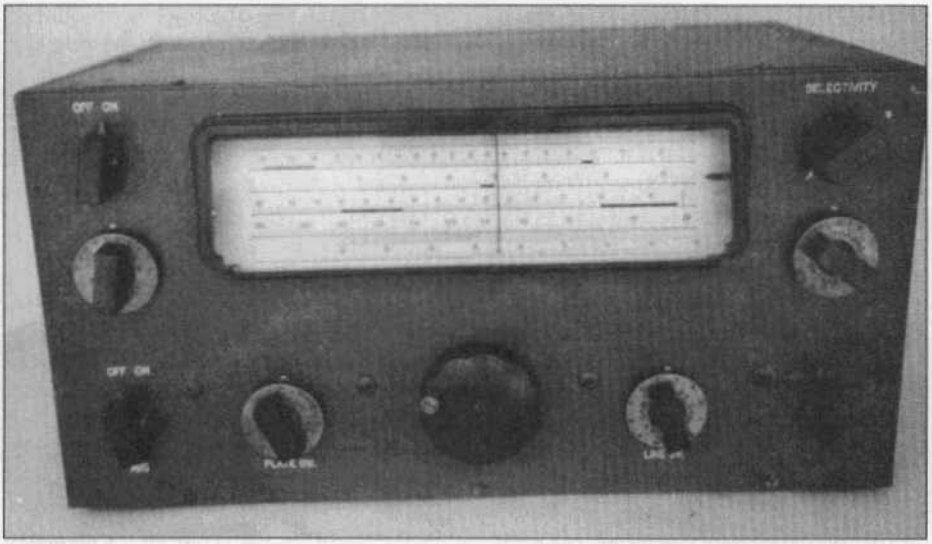
Meanwhile, Hallicrafters had no less than four receivers in the under $100 price range, the 5-T Sky Buddy at $29.50; the S-14 Sky Chief at $44.50; the S/SX-15 Sky Challenger at $69.50 or $81.95 with crystal; and the S/SX-16 at $99 or $111 with crystal.

In 1933 and 1934, National had dominated this market with their FB-7A at $37.50 and FB-XA at $51.90, plus of course $6 per band for coils and $15.90 for a power supply. If you add it all up, an FB-XA fully equipped with coils for five bands and a National power supply cost $97.80, about the same as a Comet Pro with crystal. But the great advantage of the National receivers was that they could be bought in economically priced pieces, so many of the pictures in *QST* for 1933 and 1934 showed an FB-receiver in the shack. For the last two years, however, they had completely abdicated this part of the market, and Bill Halligan was selling a lot of receivers into it. So in early 1937, National set out to develop a new receiver.

Jim Millen devoted four of the "National pages" in *QST* to the development of this new receiver, so we have an unusual opportunity to read about it from the master himself. So I will turn over this article to him for a little while.

The first hint that *QST* readers got that there was something afoot was on the National page in the June 1937 *QST*. "During the past few months Dana Bacon, who heads our circuit development laboratory, and his staff have been working on the design of a receiver to fill the place once taken by the FB-7. Such a receiver must necessarily combine low price with performance of a high order, and like most National Receivers its design has required quite a bit of research. This research has resulted in one very interesting development: the use of a rather high frequency for the IF. Results are quite surprising.

"One result—the practically complete elimination of image frequencies—was to be expected. However, it was found that the use of the high IF also made it possible to design a crystal filter with



The NC-80X. Controls from top left down and around to top right are: BFO off-on, BFO pitch, AVC off-on, Audio Gain and B+ switch, Tuning, RF Gain and AC Line switch, Bandswitch, Crystal Phasing, Crystal Selectivity.

continuously variable selectivity from 200 cycles or so, up to the other extreme of perhaps eight or ten kilocycles. In other words, the selectivity range is so wide that it covers every requirement of amateur work, and the crystal filter is left in the circuit all of the time. We think this is pretty hot stuff.

"The reasons why a high IF frequency helps in the design of the crystal filter are quite complex. The most obvious reason is that the available change of selectivity is shifted to a more useful range of values. In other words, suppose that a certain filter has a selectivity range of from 100 cycles to 1500 cycles when the IF is 475 kc. Then it would be expected to have three times the range (300 cycles to 4500 cycles) when the IF frequency is three times as high (1425 kc). This is a help because 100 cycles is much too sharp for any practical purpose even on CW, and selectivities sharper than about 300 cycles are almost never used. Consequently, the change in the IF can be said to make the useful selectivity range much wider.

"Actually, however, the results are even more far reaching than that. In the HRO (with 456 kc IF) the minimum/maximum selectivity ration is about fifteen when using the crystal. With the new filter, the ratio is thirty or more without sacrificing other desirable characteristics. This improvement is explained best by the vague statement that the high IF helps the designer in a number of small ways that are hard to explain theoretically. For example, crystals ground for 1550 kc are easier to wangle in a filter than those ground for the more usual IF frequencies...

"The major field for the new crystal circuit seems to be in low priced receivers. In our opinion, only a new development of this kind can make the cheap receiver suitable for use in the amateur bands. Of course, the new filter would improve any receiver, but in the HRO the filter is so good already that the possible improvement does not justify a new model."

The new receivers, two of them actually, made their debut in the Sep-

continued next page

tember 1937 *QST*. There was an insert between pages 96 and 97 with a full-page ad for the NC-80X and NC-81X that would subsequently appear in the 1938 ARRL Handbook. Dana Bacon contributed a three-page article, "A New Quartz Crystal Filter of Wide-Range Selectivity." And Jim Millen again devoted the National page to describing the new receivers.

"Several months ago in this space we admitted that a new receiver to fill the place once taken by the FB-7 was being designed by Dana Bacon and his staff. The receiver is now in production. Elsewhere in this issue of *QST* there is a preprint of a page from the new catalogue that describes its major features. However, readers of this page have become accustomed to an unusually frank discussion of new products, and we will try to live up to expectations.

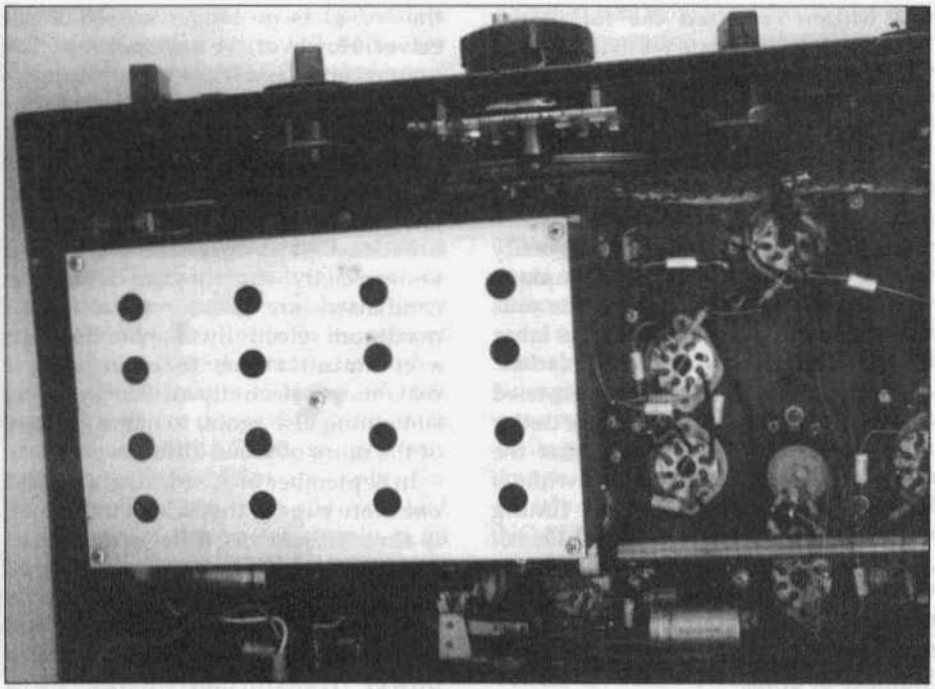
"Most amateurs do not need to be told that when a communications receiver is to be sold for as low a price as the NC-80X it is necessary to make compromises. These compromises can consist either of cutting quality by using cheaper parts, or of simplifying the chassis by eliminating everything not absolutely necessary. In the case of the NC-80X the later course was followed. Possibly some of the features left out are ones that you would like to have, but the pruning has been done very carefully, and we think you will find that the NC-80X is a thoroughly capable receiver in actual use.

"The principal economy in the NC-80X is the elimination of the pre-selector. The reason for its elimination is because a cheap pre-selector is no darn good, while a good pre-selector costs too much. However, the problem cannot be dismissed as easily as all that, and some provision must be made to insure good image suppression and adequate signal-to-noise ratio. In the case of the NC-80X the solution lies partly in the use of a high IF frequency (1560 kc) which results in having the image frequencies removed by 3120 kc. With the image as far away as this the signal-to-image ratio is adequate even with only the one tuned RF circuit. As a matter of fact, image suppression is better than on many receivers with very elaborate pre-selectors.

"The high IF frequency does not of itself improve the signal-to-noise ratio, but it does help by making possible the use of a new crystal filter. This filter has continuously variable selectivity from 300 cycles to 7 kilocycles and is left in circuit continuously. By operating with optimum selectivity, the noise can be reduced sufficiently to make the signal-to-noise ratio fairly good (CW noise equivalent approximately .3(). As we remarked before, the NC-80X is a thoroughly capable receiver in actual use.

"Generally speaking, the NC-80X is a simplified version of the NC-100X and like it employs the movable coil tuning unit which has proved so successful. However, unlike the NC-100X, it has an AC-DC power supply. Aside from the obvious advantage of versatility and low cost, such a power supply has a number of advantages. For one thing, the absence of the power transformer makes the set run much cooler. For another, regulation is much better so that any possible de-tuning effect from adjustment of the RF Gain is reduced by ten to one. The principal objection to AC-DC packs in the past has been that only low audio output was feasible with such a low plate voltage. However, the new beam amplifiers give two watts, which is ample.

"Of course, the schemes described above are mostly only devices to make it possible to build a good receiver at a low price, and we are the first to admit it. There is no complete substitute for a good pre-selector. If you insist on one, the NC-100X has a good one, and the



Under the Chassis of the NC-80X. The coil catacomb, similar to that in an NC-100, slides across the width of the receiver to position the coils-in-use directly under the tuning capacitor. The ceramic tube sockets show that National built these receivers with high-quality parts.

HRO has a superb one. But if you want to be thrifty, we think you will find the NC-80X a very fine compromise design. After all, we have no house of magic here; we have to depend on adroit engineering."

The catalogue page further described the features of the new receivers. Both receivers use ten tubes, a 6J7 1st detector (announced as a 6L7 in the ad); a 6J7 HF oscillator, electron-coupled; three 6K7 IF stages; a 6C5 linear 2nd detector; a 6B8 amplified and delayed AVC; a 6J7 panel-controlled BFO; a 25L6 beam power output, and a 25Z5 rectifier. "The tuning system, likewise entirely new, employs a multiple-scale dial of the full-vision type, accurately calibrated in megacycles. Several unusual features are incorporated, such as the mirror for overcoming parallax, the auxiliary linear scale (at the bottom), and the adjustable frequency markers, by means of which any particular stations, or frequencies, such as band limits, may be 'logged' on the dial itself." (These were on the lower edge of the dial and broken off on my receiver.) The tuning mechanism provides two vernier reduction ratios, 16 to 1 and 80 to 1 for fast and bandspread tuning. The NC-80X covers 550 kc to 30 mc in four ranges, and the NC-81X is a special amateur model covering the 160, 80, 40, 20 and 10 meter bands in five ranges. The price for either receiver, including an 8" PM speaker chassis, was $88. A type DCS-8 metal speaker cabinet was available for an additional $4.50.

Unfortunately, things did not go smoothly in the production of the new receivers. In the December 1937 *QST*,

continued next page

Jim Millen reported the following: "Once every few years we make a futile attempt to use the broadcast receiver type of construction somewhere in a National Receiver. We should have learned our lesson by now, but broadcast receiver parts cost so much less than ours that we have to reassure ourselves, now and then, that we really are on the right track. For example, a 'good' broadcast tuning condenser sells for about a third as much as the labor and materials alone in a PW condenser.

"In the NC-80X and 81X we have tried to give as much performance per dollar as possible, and it struck us that the economy would be well worth while if we could use a commercial tuning condenser. We shopped around. One of the best manufacturers in the field agreed to build us a special job with low-loss insulation and other refinements, and we purchased a number of units.

"But when the production sets came through it became apparent that these condensers would not do. The ganging was not good enough and backlash was perceptible when using the high selectivity of the crystal on the bandspread amateur bands. We found that by careful refitting these were satisfactory for the NC-80X (which has general coverage ranges) but not for the NC-81X (which has extreme bandspread on the amateur bands.) But this refitting brought the cost up as high as a PW, so what the heck.

"This unfortunate discovery was made in October, just when we were starting deliveries. This is why these receivers are so late. NC-81X receivers (with PW condensers) will be delivered about the time this page is published. In the meantime, we are filling orders for the 80X by using the refitted condensers described above. Later production will employ PW units exclusively. Of course, substituting the more expensive condenser means that the NC-81 is no longer an $88.00 receiver. However, we have never built a poor receiver and we would rather take a licking than do so. So for the present there will be no price increase.

"This account of our troubles is by way of explaining why the deliveries are late. It is not a criticism of the broadcast parts manufacturers, who know exactly what they are doing. The condensers are fine for a set with a maximum selectivity of about 5 kc, but a communications receiver with a maximum selectivity of 320 cycles is something else again, to name just one of the more obvious differences."

In September of 1938 Millen devoted one more page to the NC-80. In this one it almost seems as if he is talking as much to himself as to the readers of *QST*. "As we have remarked before on this page, there are a number of good reasons why we do not like to put a power transformer inside of a communication receiver. To anyone who has made comparative tests, the increase in temperature drift due to the extra heating and the greater background noise from stray fields is self-evident. So a long line of National communication receivers have had their transformers outside, at the end of a cable. The only exceptions to this rule have been receivers of the NC-100 series. These are rather a special case, because their use for broadcast reception has thrown emphasis on the audio output stage, and tone quality dictated the use of a built-in power unit.

"The NC-80 is also somewhat of a special case, because low voltage beam tubes first became available at about the time it was being designed. We had long realized that 110 volts was entirely satisfactory for the plates of RF and IF stages and that omission of the transformer would improve regulation. Also, it would obviously eliminate heat and background noise originating in the transformer. Consequently, when

the 25L6 made it possible to provide a two watt output with 110 volts, we swung over to an AC-DC design.

"There are two objections to the use of a good AC-DC power supply in a communication receiver. The first is that it costs more than the usual AC supply. To be sure, there is no transformer to buy, but transformers do not cost much anyway. On the other hand, various complications such as insulating both sides of the power line from the cabinet increase the cost of construction more than might be imagined. However, after careful tests we decided that the extra cost of a good AC-DC supply was entirely justified. For example, the stability resulting from the excellent regulation of the power supply is an important factor in the remarkable performance of the NC-80 in the 10-meter band, where it can hold its own with any receiver on the market regardless of price.

"The other objection is more serious from our point of view, and is entirely a matter of prejudice. 'Most gyp sets are AC-DC, therefore all AC-DC sets are gyps'. Most of our customers judge sets on performance, fortunately, but we continually run into men who know that AC-DC sets are no good because they owned one once. Whenever we have had an opportunity to demonstrate the NC-80 in comparison with an AC set of similar price, we have been able to prove our point. We can prove it has no tunable hum. We can prove the tone is good. We can prove it will pull signals in. But we cannot reach all our customers that way, which is the reason we are writing this page.

"We think that in most cases the AC-DC supply is the logical choice for a communication receiver, and we are going to stick to it. If our customers want a transformer inside, they can get one of the NC-100's. But we do wish you would be broad-minded about it. At the next meeting of the Radio Club, borrow an 80 from your dealer and give it a comparative test alongside any receiver of similar price. And invite the dealer too. Apparently some of our dealers also owned an AC-DC set once!"

As mentioned in the ads, the NC-80X and NC-81X originally hit the market at $88. When the cost of the National-built PW capacitors was factored in, that price went up to $99. In comparison to the fully-equipped FBXA at $97.80, they were a much better receiver for the same money. But by 1938 Hallicrafters had brought out the SX-18 with an RF stage, general coverage with bandspread tuning, a 455 kc crystal filter, and an image rejection circuit, all of which clearly out performed the NC-80X and NC-81X and sold for only $89. So the NC-80/81 twins faded from the market, last being advertised in *QST* for January 1939. National's following entry in the low-priced ($50) receiver field was the NC44/45/46 line of receivers that lasted from 1938 through 1947. They were also AC-DC sets with no pre-selector like the NC-80/81, but they went back to the 455 kc IF with its associated image problems, they used switched coils rather than the coil catacomb, and they did not have a crystal filter.

Not many NC-80/81X receivers were on the scene when I first got into amateur radio as a Novice in 1952. The only reason I knew about them was because they were pictured in the catalog section of the 1938 ARRL Handbook that my brother and I inherited from a neighbor. So I was quite delighted when a Boatanchor Reflector friend offered me a somewhat wounded NC-80X for a very reasonable price early this year. It was working, he said, but its original dial drive mechanism was missing and it would need help to put it back on the air.

When it arrived I found that someone had done quite a bit of work on it. All of the capacitors and resistors had been replaced, with the exception of the grid

continued next page

leak resistor for the local oscillator and its bypass capacitor. Both of these are tucked away in a hard to find nook on top of the chassis, and perhaps my predecessor had just missed seeing them. As advertised, the original tuning mechanism was missing and in its place was a type A, Velvet Vernier drive mechanism with a pinch drive trying its best to move the rim of the large drum attached to the tuning capacitor. Unfortunately the friction in the capacitor and dial pointer assembly was so great that the pinch drive slipped badly. After a little experimenting, I modified the pinch drive into a dial cord drive that is working acceptably. I was able to use only one full twist of the cord around the Velvet Vernier drive shaft, more turns than that would wrap over themselves and bind up the operation of the dial. But the single turn slipped badly until I wrapped a layer of old-fashioned, cloth "friction tape" around the shaft and under the cord. That little trick improved the coupling of the cord to the drive shaft so that it no longer slipped at all. A tiny amount of oil on the tuning condenser bearings and on the pulleys in the dial pointer mechanism also helped out.

I also found that one of the fiber bushings that should have been inside the hole on the casting arm protruding from the side of the coil catacomb that grips and positions the catacomb on a steel shaft running the length of the receiver was instead frozen on one end of the shaft. As a result, the coil catacomb was quite wobbly and the receiver tuning was very unstable. I managed to release the bushing from the shaft by slitting it lengthwise and with an overnight application of penetrating oil. It slid back in place into the casting hole where it belonged, and I secured it by gingerly coating both ends with a bead of epoxy.The tuning became much better, and I could sneak up on signals in the 40 and 20 meter CW bands with no trouble. Alignment was next. A bit of De-Oxit made the capacitors in the IF transformers behave properly. The local oscillator and mixer input adjustments came up normally except for the 4.5 to 12 mc band where the calibration was hopelessly off. After a little encouragement from Bill Fizette, W2DGB, I went back for one more try, only this time I adjusted the inductance of the local oscillator coil by bending the half-turn loop that National left inside the coil form. Sure enough, I was able to improve the calibration greatly over the entire band. It's not perfect, the bottom of 40 meters comes in at about 6.8 mc on the dial, but it's a lot better.

After all of this work I was still disappointed at the amount of gain in the receiver. So I started looking at the wiring and component replacement job that my predecessor had done. Sure enough, I found several errors. At least according to the schematic he had miswired the AVC circuit. The cathode resistor on the 25L6 audio output tube was crimped but not soldered to ground. And he had replaced the capacitors from plate to cathode and plate to ground on the 6C5 second detector with new ceramics that had ten times the capacitance of the originals. I replaced them with older micas from my junque box and made the other repairs, and the gain perked up considerably. I also found a 0.01 MFd bypass from the ground terminal of the AVC switch to the switch frame. Since the frame was attached to the outer cabinet shell and that shell was attached to the neutral lead of a three wire power plug, this was essentially a bypass of the side of the AC line attached to the interior chassis to the power line neutral, something my Ground Fault circuit breaker definitely did not like. Once I had removed that little piece of sabotage, I no longer had to run the receiver from an isolation transformer to avoid popping the breaker. So I sup-

pose the moral here is to be extremely careful when you are replacing components to use the proper values of new components and also to check your wiring for mistakes. And it is a very good idea not to defeat the original isolation of chassis to cabinet in an AC-DC set like this.

You can see from the photos that the NC-80X is not a cut-rate receiver. Its cabinet is the same metal gauge, height and width as the one on my HROs and an inch deeper, although it is painted gray rather than black. My receiver came with punched labels on the controls rather than the dial plates that are pictured in later models. I took the liberty of filling them with "White-Out" so they would be easier to read. In contrast to transformer-operated receivers, the top is secured with six screws rather than being hinged—no doubt to keep the operator's fingers away from the potentially hot chassis. It uses the same style knobs as the HRO and NC-100 series receivers (HRP bar knobs and type R knobs with a metal skirt), but instead of being black they are the brown-olive color that later shows up on the NC-200. I had to supply a bar knob for the crystal selectivity control, and I wound up painting a black one from my junque box with a closely-matching paint from the local hobby shop. All of the tube sockets except for the audio output and rectifier are ceramic, and those are sturdy, fiber wafers, still in good shape. The power supply may be a half-wave rectifier circuit, but it includes a filter choke. The tuning condenser in my receiver is marked on the rear frame plate, "Radio Condenser Co, Camden NJ, Patented" and numbered "7232," so obviously this is one of the first batch of NC-80X's that was made with the refitted, commercial condensers. Serial number C761 is punched into the rear of the cabinet, about an inch from the bottom and in the center. The bottom edge of the slide-rule dial bezel is broken away, a common occurrence in these receivers I understand. The dial "glass" in my receiver is a piece of Plexiglas, likely a replacement when the original dial bezel and glass plate were broken.

There is one idiosyncrasy that the NC-80X inherited from it's NC-100, HRO and FB-7 predecessors, the audio-output transformer was included as part of the speaker assembly. That means that the audio-output terminals on the back of the set are connected to the 25L6 plate and to the B+ supply, something to be careful about. Finding an output transformer was not a problem, since the RCA Receiving Tube Manual lists the 25L6 as having a 2000-ohm output impedance just like its 50L6 cousin. That means that an output transformer from any "All American Five" superhet will do. Because the gain of the set is still a little marginal when driving my 2000-ohm Trimm headphones from the back-panel phone jack, probably because there is no "first audio" stage between the detector and the audio output, I am using a 2000-ohm to 500-ohm transformer on the 25L6 output to drive my phones. That way there is plenty of gain.

On the air, the NC-80X is almost everything that Jim Millen promised it would be and a considerable improvement over its FB-7 predecessor. Where my FB-7 has objectionable images even on 80 meters, the NC-80X has no images even on 20 meters. Dana Bacon's high-frequency crystal filter is adjustable for either AM phone, SSB or CW, and the phasing notch works well to eliminate unwanted signals. There is a fair amount of warm-up drift in the NC-80X at this point, perhaps a consequence of the status of the dial drive and the coil catacomb when they came to me. The radio does not seem to be sensitive to line voltage sag that occurs when I switch on my SB-200 linear to get through the QRM—the lights

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Radio Service in the Golden Age
1930's through the 50's

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Episode 14

Public Address System Rental (How to get old in a hurry)

During the depression years Gernsback Publications could be found in the home of every radio enthusiast in America—young or old. In my humble opinion, no publication since has impacted American Youth like 'Radio Craft' magazine. I remember the depression years well. I can understand why magazines devoted to radio broadcasting, and short wave radio, were so popular with those born between 1910 and 1930.

When you have a generation growing up with a new, almost mystical technology in which they can participate without a large cash expenditure, the interest generated is tremendous. With the crash of '29, and the deep depression that followed, our nations youth found itself with plenty of time to experiment. Remember, over half of our population at this time lived in rural areas. I was among those fortunate enough to live in the country. During the great depression there was a world of difference in the living standard enjoyed by city dwellers and their rural counterparts.

Those in the city had expenses to meet every month; rent or house payments, utilities, transportation costs, food, and school expenses. Most farmers lived on small farms, usually paid for, had no utilities, small transportation expenses, and raised most of their own food. While they had very little money, they had a home, a rural school for children, and plenty to eat. If you lived on a farm and were hungry it was because everyone in the family was either too sick to work, or too lazy to grow their food. I knew of no rural families in which every member was too sick to work. Little sympathy was wasted on those who were lazy.

I spent much of my childhood with my grandparents. My grandfather was a blacksmith. He married my grandmother when she was 14 years old. She was well educated for that time having completed the sixth grade before getting married. During the depression my grandfather worked in his shop shoeing horses, fitting wagon tires, sharpening plow shares, and other blacksmithing. Since we were in the midst of the depression no one had money. Most of his work was done on credit-bills that were never paid. Sometimes he received a ham, a few chickens, or a bushel of potatoes or turnips through barter. The latter method was much preferred. Jim, for example, might show up at the shop with two bushels of apples in the back of his wagon. The apples were offered in exchange to have his horses shod, or a wagon wheel repaired.

But I am 'way off the subject. With all the spare time people had they looked for something to take their minds off of their troubles—something that was time consuming and downright cheap. That is when the jig-saw puzzle craze swept the country. Many of us felt the need for something more constructive than a

time consuming puzzle. Enter Mr. Hugo Gernsback to the rescue. For a few cents at most any kid, or unemployed adult, could build a crystal radio receiver.

Radio was improving daily, and older radios could be had for nothing in many instances or for a few cents if it was a pretty good old radio. The first transmitter I built from scratch, completely unassisted, was built from parts salvaged from a radio I paid 40 cents for at a farm auction. It was a pretty good little transmitter. I worked over 20 states using it.

Complete short wave radio kits were available from many manufacturers for prices as low as $4.95. Of course such radios were less tubes, coils, headphones, and batteries. Still it was easy to get a nice short wave receiver operating for less than $15.00. Radio building became a national craze. The term 'Short Wave' had a magical sound to it-visions of far off lands or maybe even getting a ham license and actually talking to people far away.

Many of those who built receivers and enjoyed the experience were more than anxious to find a way to make money from their new hobby. Remember those ads that ran in all the radio magazines as well as in other magazines that might interest radio builders? The ads usually pictured a sad, poorly dressed man walking down the street. Up pulls a snazzy convertible, and stops by the unhappy pedestrian. The driver is a smiling, well-dressed young man. He greets the pedestrian something like this, "Hey Tom, is that you? I have been wondering what happened to you since we graduated from high school."

"Well, it is sure nice to see you Jack," said Tom. "I have not been doing much of anything. Mary and I had planned to get married, but you know how it is with the depression and all, I suppose we will just have to wait until times get better. Say, where did you get the fancy new car and those nice clothes? Did you have a rich Aunt that died or something?"

"Tom, I got into radio. You can too. Get in and let me drive you over to meet my new wife, and I'll explain the whole thing to you."

The next picture shows Jack and Tom arriving at Jack's new five-room bungalow.

Inside the neat home, Irene, Jacks wife serves the two schoolmates coffee in their well appointed living room.

"Tom, five months ago I was out of work, and Irene and I thought we would never save up enough to get married and rent a home. Now we are in our own home and able to enjoy life once again."

Jack picks up a *Popular Mechanics* magazine and holds it in front of Tom. "See this ad here? He shows Tom a full page ad, illustrated with six cartoon pictures.

"This is the 'United Radio Institute' ad Tom. 'United' is one of the best radio schools in the country. They taught me radio repair by mail. I was able to keep my old job and complete a modern course in radio service. Would you believe that in only four weeks after starting the course I was earning ten dollars a week in my spare time. Now, I have quit my job at the factory, and often make over $40.00 a week working from my home here. My shop is out in the garage."

"Gee, Jack, that sounds great, but I barely getting by now. I could never afford to pay for such a training course."

"Of course you can Tom. 'United' has a time payment plan, you pay as you learn. Soon you will be making more than enough in your spare time to pay for the course."

"Take this magazine home with you and fill out the coupon on the bottom. All it will cost you to get the entire course information plus one free lesson is a postage stamp."

In the last cartoon picture Tom is smiling and looks ten years younger. "Jack, I am sure glad I ran into you today. I am going to send this to 'United' tonight."

You, dear readers, are probably thinking that no one would fall for such an ad. You would be wrong. I still remember my 'free' first lesson. It taught me 'The Circuit Disturbance Test.'

Start at the audio output stage and work backwards. A wet finger on the grid of the audio output tube should give you a loud 'burp' or 'buzz.' If it does, you have a good indication that the power supply, the output stage, and the speaker and output transformer are all OK. You keep working back until you find the 'ailing' stage. Pretty basic but a pretty darn good way to quickly isolate problems.

Correspondence schools and radio magazines of the 1930's stressed the importance of 'public address' installation and rental as a means of creating additional income for radio repair shops. I was not about to pass up a way to bring in some extra cash.

It all started quite by accident. A gentleman came into the shop one day and asked if I had a 'PA' system for rent. He explained that he was with the Oak Grove Baptist Church and they were having their annual 'singing convention' the following Sunday.

"Odd that you should ask about a PA system," I said. "I have been thinking of buying such a rental system. What are your requirements? Do you need outside speakers as well as speakers inside? Do you need more than one 'mike,' and if so, how many? Will you need an operator on duty, or do you have someone who can operate it after we check them out? How many hours, or days will you need the system?"

All they needed he explained was one mike for the different quartets that would be singing. Remember, dear readers, this was in 1947, long before it became popular for members in a musical group to spread themselves 15 feet apart on a stage half the size of a football field.

The little country church was about 35 feet wide, and 70 feet deep. It would seat about 150 people if everyone squeezed in tightly. The stage was approximately 10 feet deep and 18 feet wide. They had no need of amplified sound inside the church. This was summertime and they had no air-conditioning—every window and door would be open They always had a large crowd for their all-day singing, and 'dinner-on-the-ground.' This year, as in years past, many of those attending-especially the men and boys would prefer to remain outside under the many large oak trees. What they needed was speakers placed about the outside area. He thought, and I agreed with him, that the Oak Trees would provide an ideal place to hang the speakers from.

I rented him a system I did not have for the sum of $10.00. All I had to do to earn my ten-spot was install the system and remove it once the convention ended. Talk about easy money!

I drove to Ft. Smith the following day and bought $400.00 worth of sound equipment from Elmo Wise, owner of Wise Radio. This gives you an idea of my business ability. Let's see—a day spent driving the 150 miles to buy the gear, two hours to string speaker cables all over the churchyard, and another two hours to tear down the equipment and return it to the store. Oh yes, there was the two trips from my store to Oak Grove and back-a ten mile round trip. High finance was never my thing.

Word traveled quickly in our little town. Within months, Bruce's Radio became known as the place to rent sound equipment. I expanded my sound business when I rigged up a sound car complete with a six-volt, 25-watt, amplifier with a 78-RPM turntable. On top of the 1937 Ford sedan I mounted

three 'University' horns and drivers. I had the horns, and the car painted in a light cream color with my name on the side of the car in big red letters. I had a sign painter paint my name prominently on each horn. If I was going to make a noise, I might as well get some advertising out of it. Unfortunately, such showmanship had a down side, as you will learn later on.

I even covered local high-school football games free of charge. They let me read commercials from sponsors who paid two bucks for each reading. Sometimes I made as much as $14.00 just for a few hours work at the football field.

One rather interesting incident happened on a warm summer night when I rented both my mobile sound car, plus a fixed installation to a 'daredevil' automobile thrill show. None other than 'Captain Bob Ward' came in my store and reserved a sound system for his 'Thrill Show.' He left my store driving his brightly painted and lettered Chevrolet convertible-top down of course.

I might explain the Springdale at that time did not have many entertainment facilities, but they did boast one of the most outstanding Rodeo's in the entire United States—with a stadium to match. One thing was wrong with the stadium. In an effort to be the best, they built it too large. The arena itself was so big we used to have auto races in it. The infield was later cut down to a more ideal size for Rodeo's, but when 'Captain Bob Ward' appeared there the infield was BIG.

The 'Captain' wanted my mobile unit to make a one day tour of smaller surrounding towns advertising his show. Then I was to drive the sound car to the stadium and make it available from 5:00PM until midnight. The day before the show I was to install six horns and drivers on light poles in front of the grandstand. I used my 75 watt amp for the six horns and drivers, with a 40 watt unit standing by in case of a failure.

I arrived at the appointed time and found the place a beehive of activity. Captain Ward took a few minutes off to explain exactly what was expected from my sound crew. (me and a high school kid who helped out in his spare time)

A number of stunts were explained to me. There was a board wall which would be doused with gasoline and when the flames were at their peak one of the drivers would drive an automobile thru the wall.

There were ramps where the cars would run up with the right wheels only tilting the car up at a 45 degree angle—the driver completely circling the area on the left wheels only.

The concluding act would be the Captain himself driving an old car across the arena and being blown to bits by ten sticks of dynamite buried underground. A switch activated a pressure switch buried underground. Of course the Captain wore all sorts of protective gear and the old car was somewhat modified as I understood it.

"When my car blows all to hell, there will be a few seconds of silence. My crew will run out and act as though something may have gone wrong. At that time I want you to come running across the field with a 'mike.' I will slowly emerge from the mess and stagger around like I am dazed. When I yank off my helmet, hand me the mike and I will thank everyone for attending etc. Then the show is over."

"There is one problem Captain-you never mentioned that I would need a 100' long mike cable. The cable on the mobile unit is only about 25 feet long.' I said.

'Hell, Bruce, I thought I told you I needed a long cable." Said the daredevil driver. "Do you have one at your shop?"

"Sure, I have one there, but I don't have a way of going to get it. My sound truck is already set up and playing records for the early arrivals."

continued on next page

The Captain reached in his white overall pocket and handed me a car key. "Here take my convertible and hurry back," said Captain Ward. "We are getting ready to kick this thing off before long."

I got in the new Chevvy convertible. It was pointed west, and the arena entry gate was to the east. As long as I had to turn it around I thought I might make a rather large circle around the arena and let the crowd see me in the 'snazziest' car I'd ever driven. Half way through the turn I saw a dozen drivers, and workers with the show running toward me waving their arms like crazy. I could not figure out the problem. I slammed on my brakes and stopped. The Captain run up to the car out of breath—he could hardly talk. "You damn near ruined my show," he said. "Do you realize that if you had gone another ten feet you would have ran over the switch that sets off the dynamite. You, my show, and my new convertible would have been blown to bits."

They directed me out of the arena and I returned a few minutes later with the long microphone cable. I might mention that the show went off without any more problems.

The 'Rodeo of the Ozarks' had its first performance during WW II. It has been an annual event since that time. The rodeo usually lasts for four days and is always planned for the July 4 holidays. In 1947 they rented my complete sound system for the sum of $250.00. This included every performance and all associated activities leading up to and during the week of the rodeo. I might say that I came to dread rodeo time as much as I dreaded Christmas. One of the most trying activities was advertising in about a dozen towns in our trade area.

Our 'Rodeo Caravan' was the primary means of creating publicity for the big event. About one week before the rodeo, the caravan would form on 'Emma Avenue,' the one business street in our town. A State Police Patrol car lead the caravan. Next in line was a truck towing a flat-bed trailer, followed by my sound car. This trailer would serve as a stage once we arrived at a predetermined location in whatever town we were visiting. The cars next in line carried our entertainment and dignitaries. Our entertainment was a local group of businessmen who formed a 'Hill-Billy' band known as "The Skunk Holler Boys." Normally the Secretary of the Chamber of Commerce, our Mayor, Police Chief, and other prominent figures made up the VIP list. All the caravan planning was done weeks in advance. The Mayor of the city we were visiting usually met the caravan and made a welcoming speech. The caravan spent about 20 minutes in each town. In addition to a couple of short speeches, and two or three tunes by the band, others in the caravan handed out souvenirs, trinkets, and a lot of advertising material for the coming rodeo.

Our caravan could normally visit about eight small towns in a day. By seven AM we were under way and returned home about dark.

One year it was decided that we would do a little advance advertising ahead of the caravan. One young man who was active in the local Chamber of Commerce had a small two-place Taylorcraft. Someone got the idea of having him drop leaflets from the plane over many of the towns to be visited by the caravan. Then someone got the bright idea of having my sound car make a sweep through the town playing music and advertising the rodeo at the same time the leaflets were falling from the sky. One problem arose immediately. The plane-even a Taylorcraft—was faster than my 1937 Ford.

The pilot and I got together and worked out a schedule. We planned on hitting town 'A' for example, and while

I was proceeding to town 'C' the plane would drop flyers on town 'B'. In other words I would hit 50% of the towns while the plane dropped flyers. The plane would hit the other 50% without benefit of a sound car. It was the best idea we could arrive at. The larger towns, those with a population of 1000 or more would get the full treatment, while smaller towns of 100 to 1000 population would get the airplane only.

This noteworthy and infamous morning we had made the first town right on schedule. Our ETA for both plane and car was perfect. Everything seemed to go off pretty well. My next stop was about 14 miles away. The plane would make a drop over a smaller town and meet me at 'Podunk'. I do not wish to put in the real name, even fifty years after the fact.

I had my usual helper with me, a 17-year old boy just out of High School. He was a very fine young man, but like most 17-year old boys his hormones were in high gear even when his mind was in neutral. We parked at the upper end of the business district just as planned. All was ready. My helper stepped from the car to look for, and listen for, the sound of the approaching light plane. All was quiet. It was a beautiful summer day, not yet unbearably warm. The few cars on the small town's main street moved at a leisurely pace while here and there a few early shoppers drifted from the bank to the one dime store, and maybe to the hardware. All was as it should be and the world was a great place to live.

Then it happened. A young lady, about the age of my young helper, stepped out of the local Bank, and crossed the street directly in front of us. Now this was no ordinary young lady-she was doubly blessed with both looks and figure. It was obvious that she knew what her strong points were by the way she dressed. She wore a modest pair of shorts, a very tight tee shirt, and little more.

Darryl, forgetting that the sound system was on, and the mike, suspended from the headliner was only inches from his mouth let out a exclamation I'll never forget. "My Gawd, what a pair of knockers!"

Sound carried well that morning. It literally reverberated from one side of the street to the other—down the narrow canyon of small town business houses.

Never had my Ford ran as well and as fast. We made a 180 degree turn in the middle of the street and left town in a cloud of dust. I am sure the town did not have a patrol car or one would have been in direct pursuit.

My sound car, and its two embarrassed occupants returned home-no more stops were attempted for that day. Oh yes, the Rodeo committee never received a bill for that extra service we rendered. **ER**

Military Collectors Meet

The Military Radio Collectors Association will hold it's second annual meet at the Tobyhanna Army Depot, Tobyhanna ,PA , 13-16 September 2001. The event will , once again be held in conjunction with the Red Ball Military Transport Annual Rally . " Offical " hours are 08:00 to 17:00 . This is a golden opportunity for anyone interested in vintage military electronics .Activities include equipment displays, on the air operation , formal presentations , and a swapmeet.

See the MRCA webpage for complete informaton : http://www.milradio.org/

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Running on Weedeater Power

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Introduction

Vintage Field Day 2001 was the inspiration. The little lawn tractor battery did let me work in the field, but only with gear that was mostly solid state and only by running the tractor every couple of hours to recharge. There had to be a better way, and when Barry announced VFD 2002, I started thinking in earnest. I had a Coleman 2500 watt generator but the noise level was way too high. A tiny gas powered generator would be a possibility—Honda and others make machines from 300-1000 watts that are all but silent. But when I checked some prices that idea went out the window: new units were around $600 and even on eBay they were in the $300 range. No way I was going to pass up several vintage radios for a piece of gas powered machinery I might only use two days a year!

There things sat, until one sunny April afternoon at a fleamarket. Huh—that's a whole bunch of cheap weedwhackers that guy's got ... Gosh ... small 2 cycle engine ... would it drive a car alternator? I didn't know for sure, but it seemed like the RPM and power rating would be in the ballpark. For $10 I took away a Weed Eater LT7500 with most of the 'business end' gone but a running motor — heck, it even had a full tank of gas!

Design

I had never even picked up a gas trimmer before so I didn't know much about them.

At home I started taking out screws and marveling at the amount of machinery in there. The trimmer is driven by a flexible shaft (think: big speedometer cable) running in nylon bushings inside the wand. At the motor end there's a centrifugal clutch so the string stops when the motor is idling. Behind the clutch is a recoil starter, then the flywheel with the magneto. The off switch shorts the magneto. The entire outer case is plastic—how the heck was I going to mount the thing? But this motor was so clean inside and out that it had to be almost unused, in spite of a serial number indicating it was made in 1994.

Among issues I might not have thought of was this warning in raised letters inside the case: "Starting motor without all parts in place will result in serious injury." Not 'may', but 'will'. Huh... when the weights fly off the clutch... I resolved not to start the motor without all parts installed. If you decide to build this project, be careful! You are dealing with very high speed rotating machinery that is not designed to be excessively strong, and gasoline and high temperatures are involved.

Hoping for some design guidance I dived into the 'net. 'Weedeater' and 'generator' turned up a whole bunch of farm auctions and one tantalizing description of a portable generator along the lines I had imagined. But although the guy claimed it worked, he gave no output figures and he had hooked the motor to an alternator using a V-belt and pulleys. There was no way that would work for the machine I had because it had only a single bearing on the clutch and with any side load the life would be very short.

I found some email list dialog among guys using Ryobi trimmer motors in large model aircraft. They had some

Front view of the Weedeater-powered generator

encouraging performance numbers and I learned that those motors can be fitted with a mounting plate where the cylinder bolts to the crankcase. Unfortunately that wouldn't work for my Weed Eater brand because of various interferences.

Next day, I went over my pile of 'eater parts again, looking for a way to get hold of solid metal structure for mounting. Ahha! The output side of the crankcase was flat except for the flywheel, magneto coil, switch insulator, and wiring. I could put a plate there, screw it to an open box, mount an alternator to another plate on the facing side of the box, and couple the shafts directly; the rotation directions worked out right.

Construction

The box had to be very stiff, strong enough to take hour after hour pounding from the motor, and reasonably square. I used oak scraps 6-1/2"x9" for the sides, 2x4's on the bottom, and 1x3's on top. I assembled it with 2" coarse wallboard screws. Some pieces had to be relieved to clear parts of the motor. When everything was 'right', I took off one piece at a time and glued it back in place with epoxy resin.

It took half a day to cut a 3/32" aluminum plate to fit the crankcase face. Nothing particularly hard about it, just a lot of cut and try. Interfering flanges on the plastic cover half that mounted to that face were sawed away along a line allowing for the thickness of the plate so the recoil starter and clutch would align correctly. I used a drill press as a poor man's milling machine to finish this surface—it would be easy to tear up a finger on this step! There are alignment pins on the cover; I carefully left those and drilled matching holes in the plate. I cut a clearance hole for the flywheel and notched it to clear the magneto coil mounting and other parts. When I finally got all the fitting done, I sandwiched the plate between the crank case face and the plastic cover and put the bolts in. Now I had a motor sticking through a 9" x 12" aluminum plate.

Next came a trip to a local junkyard. Nothing fancy needed—I asked for an old Delco alternator with a nearly flat

continued next page

face and an internal regulator. The first one on the shelf to test 'okay' was a 65 amp unit from an '82 Buick Skylark and cost me $25, with the fan, pulley, nut, and electrical connector. I mounted it on a 3/4" plywood plate with a pair of 3/8" carriage bolts stuck through fender washers and fastened it and the motor assembly on the open ends of the box with a bunch more 2" wallboard screws. No glue here as the end plates would need to be removed to install a different motor or alternator.

Hooking up the two shafts turned out to be simple. There was a square hole in the center of the clutch output shaft to accept the flex shaft. The hub from the bottom end of the Weed Eater wand had the same and I sawed this off, welded the 3/8" stub shaft into the center of a heavy 3/8" washer, and welded the washer on the end of the nut that had held the pulley and fan on the alternator. I now had a screw-on coupler matching the one on the motor; I put it on with Loctite. My first thought was to use a piece of the flex shaft as a quill shaft but the flats are squeezed into the twisted steel wire shaft and I had no way to do that. I cut a piece of 1/4" mild steel stock, filed the ends to fit the respective couplings, and screwed the plywood alternator plate on the box. I had made the alternator mounting holes oversize so I could align the two machines so the quill fit freely.

By adding a spacer it would be possible to keep the alternator fan but (remembering that auto alternators are designed to function at full output at ambient temps of around 200 degrees), I decided to try with no fan to reduce the motor load. The Weed Eater used a spring-return trigger throttle. I mounted the trigger on a machine screw on the side of the case, ignored the spring, and used a wing nut to lock the setting.

Electrical Hookup

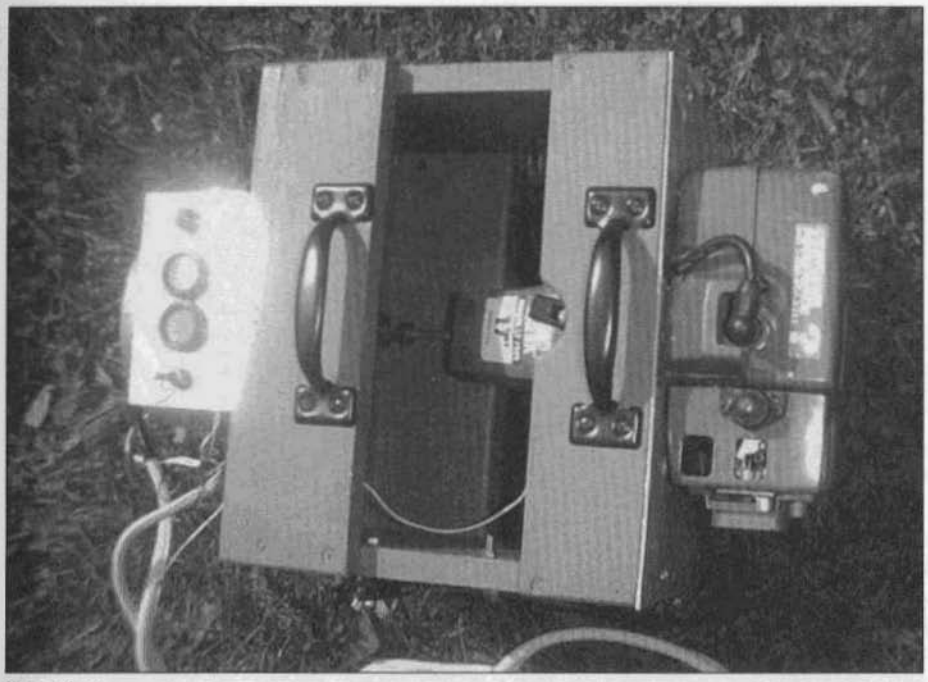
These alternators (used on GM cars from about 1975-83) have a 10-24 machine screw 'B' terminal which connects the output to the battery, terminal '1' on the two-blade connector hooks through the idiot light to the ignition switch, and terminal '2' goes to the voltage to be regulated. I hooked '2' directly to 'B'. A recent single lead alternator would have simplified the wiring but it would have been much more expensive and I don't think they are made in a flat-face package so mounting would be more difficult.

I had expected to use cheap automotive gauges as the voltmeter and ammeter but although the ones I looked at at AutoZone were definitely 'cheap', the price was $35. I pulled a couple of 1" diameter instruments from the KJ4KV junque box and mounted them with an idiot light and a DP switch on a small aluminum plate. The switch was wired to disconnect the idiot light (to eliminate the drain) and short the ignition when turned 'off'.

To deliver the output I permanently connected a pair of 12' x #6 jumper cables to 'B' and ground. The positive wire could serve as a meter shunt. I ran a small wire along the '+' lead to the clip at the far end to pick up the voltage drop and later chose a series resistor to give the right meter scale.

In cars the ammeter is connected between the battery and the junction of the load and alternator so it reads either negative or positive amps depending on whether current is flowing into or out of the battery. I wanted to keep the WeedEater motor as far as possible from the operating position, so it seemed that the best bet would be to put the battery at the operating position and the charger a cable length away. With that setup an ammeter at the alternator would indicate just its output. Good enough —that was the interesting thing anyway.

The output of an auto alternator has considerable ripple so when powering ham gear it is most practical as a battery charger. In addition I was using the tiny



Top view

original gas tank, so the Weed Eater motor would stop regularly. One approach would be to use a battery just large enough to carry the load until refueling would be convenient—say 15 minutes to half an hour. My trusty lawn tractor battery would do that. Or I could use a battery that would power the rigs for several hours, then run the generator long enough to recharge, perhaps during an operating break. As it happened our local K-Mart went out of business just in time to provide a top-grade battery for one of our cars at a very good price, so that made the decision.

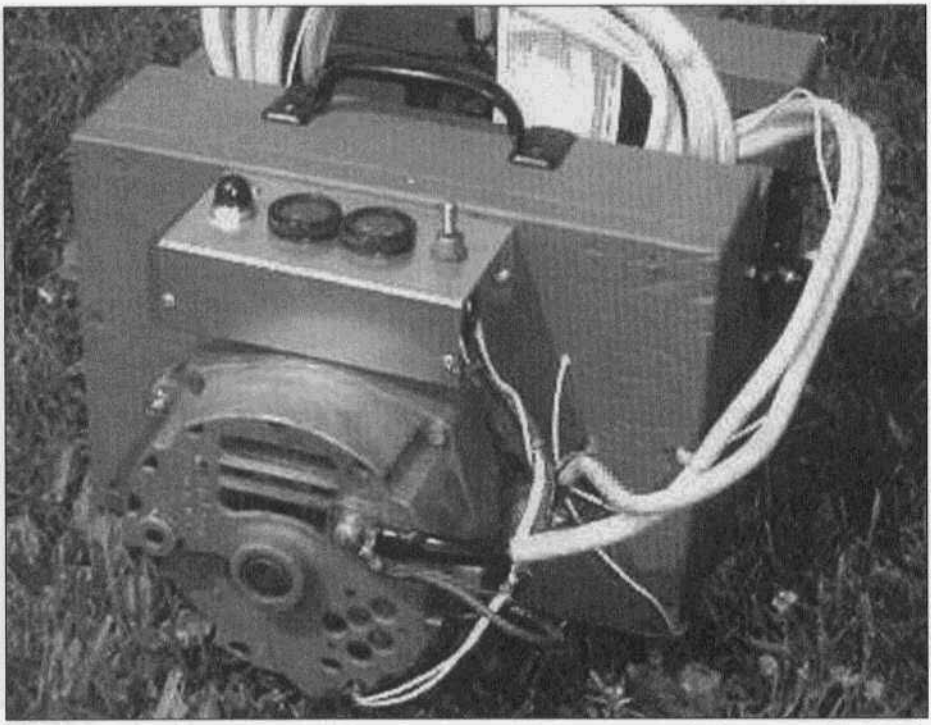
Motor Problems

The darn thing wouldn't start reliably and when it did, it often died. After a few preliminary checks, I disassembled the carburetor and sure enough the diaphragm was stiff as a playing card. Diaphragm carburetors control the fuel level by balancing the weight of fuel behind the diaphragm against spring tension. Neither force is large; if the diaphragm is the least bit stiff the machine will either flood or shut down due to lack of fuel. I ordered a kit and replaced the diaphragm. The other side of the carb has a second diaphragm that is operated by the pulsating pressure in the crankcase and serves as a fuel pump; I replaced that too.

I learned later that people who are really serious about their trimmer motors (it doesn't get more serious than using one to power an ultralight aircraft!) rebuild their carburetors every year.

There's supposed to be a 'priming bulb'—a tiny squeeze bulb used to squirt some fuel directly into the carburetor for starting when the machine is dry. My motor had the plastic base but no bulb. It started okay on warm days but from experience with other small engines I had my doubts about cold weather. Web vendors wanted a part number but lacking the manual I had

continued next page



Rearview of the generator. The alternator is a 65-amp unit from an '82 Buick Skylark and cost me $25.

none and the Weed Eater web site denied knowledge of my model. Finally I noticed that the bulb base on the motor would fit the priming bulb replacements sold for other makes at my local store. A hacksaw and some polyurethane glue solved the problem.

It Still Didn't Work!

I hooked it up to the battery, started the motor, and the clutch began to smoke. Okay ... I locked the clutch with a couple of machine screws and tried again. Bad idea — it twisted my quill shaft. Back to the drawing board...

The problem was that torque curves of a trimmer motor and automotive alternator are badly matched. Older regulators like the one in this alternator call for it to deliver a certain current at a certain voltage, regardless of RPM, meaning a very large torque requirement at low RPM. Two-stroke-cycle trimmer motors, on the other hand, depend on air velocity in the intake and exhaust passages to get and keep the mixture in the cylinder. (There are no valves—just the piston, blocking the ports!) They have very little torque at low RPM, rising to a maximum at something above 5000 RPM—the LT7500 is supposed to max out at 8500 RPM! The motor stalled when started with the battery connected but if started with the battery disconnected, the torque requirement was so great as the alternator accelerated through the RPM at which it started to charge that my (intentionally weak) coupling shaft failed.

The solution was simple. I opened up the alternator, disconnected the regulator from the field, and brought the two wires outside the case. Then I selected a series resistance that would allow the

alternator to just develop a full load for the motor at what seemed to be the RPM for maximum horsepower. This allows the regulator to limit the alternator output to 14.7 volts but does not allow it to demand high output at low RPM.

And Now, The Alternator?

Ready to roll at last—but now there isn't any alternator output? I pulled the electrical end to investigate and discovered that the rotor had been running with the slip rings against the bearing and the connection from the coil to the slip ring had worn through. Evidently my junkyard alternator had previously been opened and a thrust washer was missing. I stuck a couple of flat washers down there and soldered the stub of the wire back to the slip ring. It wouldn't work on a car installation because of the temperature but in this application—maybe.

That got it working. Once I got the field resistor right (15 ohms for my machine) half an hour of careful tweaking of the carburetor adjustments got it running smoothly at idle with the clutch disengaged and at full throttle, delivering a bit less than 15 amps to a half charged battery. The alternator could do considerably more but my 21 cc motor is maxed out at that power level and 200 watts is enough (barely) for my FD needs.

Some Lessons Learned

Vintage Field Day would be the test, but already a few things are obvious.

It's not quiet. I mean really not quiet. But at $50 total cost the ratio of price to quietness is acceptable. Ditto for ignition noise. S9, more or less, on the lower bands—forget any idea of running the generator while on the air. But for $50 ...

I'll bet you could make a hardware cloth (1/4" wire mesh) box to drop over it and make it a lot quieter.

A 21 cc Weed Eater motor really isn't large enough to do this job well. While the flyers hop them up to get considerably more power, doing so definitely increases the cost, and probably shortens the life. Doing it again, I'd look at one of the 30+ cc motors used for the largest trimmers.

A smaller diameter alternator would give a smaller windage load. Cooling of my unit is adequate without the fan at the low output I'm getting.

The emphasis on stiffness and strength was wise. The vibration level is extremely high and if anything is the least bit loose or weak, it won't last long.

In normal weedwhacker use these motors are 'floated' on the shoulder sling and a hand grip on the wand. They aren't really built to be mounted. The weak point of my machine is most likely the crankcase-to-end plate bolts and before Field Day I put them in with Loctite and run a bead of polyurethane glue around the mounting-plate-to-case joint for added stiffness and damping.

You need the centrifugal clutch to avoid having to spin the alternator when starting. Not all string trimmers have them.

Unless using a brand new motor one should start by rebuilding the carburetor. Get the owner's manual; you can order them free from the web site for popular models and via an 800-number otherwise. The instructions for carburetor tuning are invaluable.

Be sure your motor is broken in before using it to run an alternator load. New motors run hot and combined with the other problems of this load, you'll have no end of troubles.

According to the manual my model was not designed for continuous full throttle operation and it seems to have a muffler that throttles the exhaust if the temperature gets too high. The symptom was slowing down after a few minutes of operation. Make sure the mounting plate cutout doesn't block air flow and use enough of the plastic

continued on page 42

Tools of The Trade!!
The Cleaning of Wafer (band) Switches

by Mark Gilger, WBØIQK
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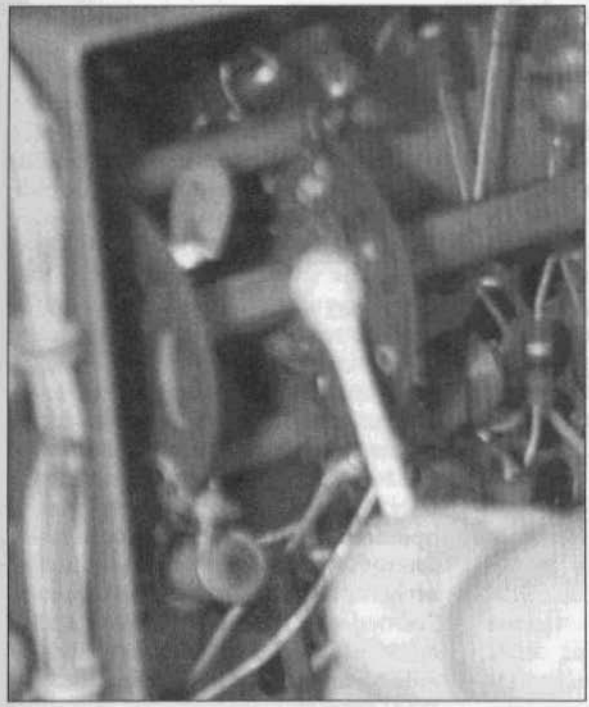
There is a right way, and of course there is a wrong way. You can pay me now, or pay me later. Either one of those sayings could apply here.

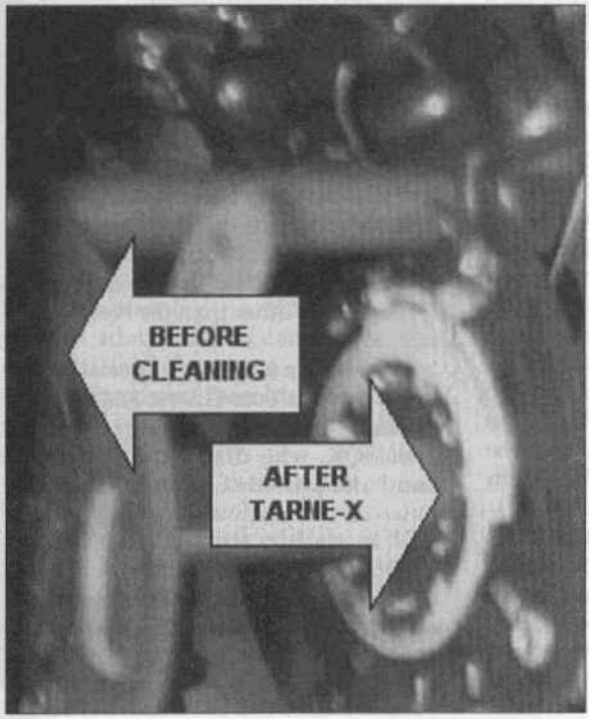
When the band switch, or other wafer switches, need to be cleaned, you can take a short cut and do a quick cleaning, or you can take a bit more time and do it the "right way". A quick cleaning would be using one of the many spray type contact cleaners and giving each wafer a good dousing. There are more brands than you can shake a stick at, but the one most popular with a good majority of boatanchor restorers, is DeoxiT D5. This can either be sprayed on, or applied with some type of applicator, like a Q-Tip.

The other method, and the one I prefer to use, is the "Right Way". Or at least in my mind. I use a multi-part method, utilizing a product called Tarn-X, Denatured Alcohol, and DeoxiT. The reason I think my method works so well is that I think of the corrosion, or tarnish that accumulates on the switches over time, as a cancer, or rust on your car. If you don't get it all removed during the cleaning process, it comes right back a short time later. I've found that if you remove it all, it will be many months, if not years before you have problems again.

Tarn-X works very quickly. It often only takes several seconds to clean a switch. The following picture shows the before and after results. It's applied using a Q-Tip or other small applicator.

Use the following procedure for reliable, long life, positive results.





1) Apply Tarn-X with a Q-tip to 1 wafer at a time. Go sparingly, and try not to drip it on other components. Don't forget to apply it to the contacts that rub across the wafers surface.

2) After the single wafer switch and its contacts are clean, apply Denatured Alcohol using a toothbrush and/or small spray bottle.

3) Use a second tooth brush to scrub the switch down with the Alcohol. Don't intermix the brushes.

4) As an option, you can use a can of compressed air and spray all excess Alcohol off the wafers and surrounding components.

5) Move to the next switch and repeat procedure.

6) Once all wafers have been cleaned in the above procedure, spray a very light mist of DeoxiT on each wafer and rotate switch back and forth several times.

7) Let the radio sit overnight before applying power.

Probably most important, of the above procedures, is the cleaning process that takes place using the Denatured Alcohol. It's important to get as much of the TarniX off, as possible, and the Denatured Alcohol does a good job of this. ER

Hum in Sensitive Circuits from page 14
same point on the chassis. This point should be isolated from any other circuit, except at the single point ground. In many designs, this single ground is located at the audio input connector, and the speech amp is located as close as possible to this ground. ER

The following material was used in part to prepare this article:

Antennas, John D. Kraus, McGraw Hill, 2nd Edition, 1988
Electricity and Magnetism S.G. Starling, Longmans, Green and Co. Ltd, 5th edition 1929
Electronics magazine, McGraw Hill, various issues, 1939 to 1952
Radiotron Designers Handbook, 4th edition, 1953
Electronic and Radio Engineering, Terman, McGraw Hill, 1955

Weedeater from page 39
housing to duct the flywheel fan output across the cylinder. Cutting away the grill in the end (see photos) was the final step in solving the problem.

Don't plan to control the charging rate by adjusting the motor RPM. Most of these machines have Walbro carbs designed for a motor that runs at either idle or full throttle and it is darn near impossible to get them to work well across the full range. Even with the added field resistor I had to compromise the carb settings slightly to get the motor to accelerate smoothly through the alternator turn-on RPM. I believe the ultralight flyers use a substitute carburetor but the expense didn't seem justified so I did not explore that.

Don't use a coupling shaft over 1/4" diameter. You won't make my mistakes but other things can happen and a coupling that's much weaker than the equipment on either end is important to provide a mechanical 'fuse' in case of problems.

Radio type instruments aren't very satisfactory. They don't handle vibration well even when mounted at the alternator end of the machine and in that location the magnetic field of the alternator may cause problems. The voltmeter is not needed. See you next Field Day! ER

VFD 2002 from page 5
with no results and I struck the station at 1400.

All-in-all a disappointing weekend, with most of the time being spend trying to find someone to talk to. I made a total of 53 contacts which was an average of only 2.3 per hour over the time period operated. There were apparently only four of us running in the field this year, at least on this side of the country. Seemed to be very thin fixed station activity during the period as well. I was able to make only one contact on 15M (see above) even though the band appeared to be open. I heard no one at all on 29 MHz even though there was plenty of SSB activity lower down in the band. On 20M I heard no one east of Ohio and again the band appeared to be open. Even the usual 75M AM frequencies were quiet Saturday night. The busiest activity I encountered was the Vintage SSB group, but the way this net is run discourages receiving reports from anyone other than the Net Control station(s).

I would like to extend a special thanks to my friends Tom Grove, K6LQI, Neal Hudson, N6NW, and Bart Rowlett, WB6HQK, who dropped by to lend a hand and provide encouragement. ER

Clatternet: 850 shift RTTY roundtable, on 10137 kcs USB Saturday, starts 0930-1000 Pacific time.

FCC Docket from page 18
the FCC's proposed un-segmented band plan have acknowledged that a certain amount of intermodal interference is a natural and acceptable part of an experimental, generally nonessential medium of communicating.

But of specific concern to the AM community are comments like those from Doug Dunn, K7YD, of Montana, who is part of a numerically small but fairly vocal handful of opponents trotting out anti-AM arguments that were seen 35 and 40 years ago when SSB was struggling for acceptance. Such arguments are obsolete today when AM enjoys its place as a well-regarded specialty, broadly accepted, and as the issue of "mainstream" communications has long since been resolved.

Dunn wrote in part, "AM has outlived its usefulness and I belive (sic), has no place on today's crowded phone bands." Dunn calls for the use of AM "to be limited or not allowed," and adds an insult that the mode carries with it, in his view, a "seemingly concurent (sic) spatter (sic) and spurious emissions." The Extra Class licensee goes on to propose a protected segment for the exclusive use of weak signal-CW emissions.

Let his remarks be a representative example of the type of comments needing rebuttal and challenge from those favoring a united 60 meter band and an operating protocol allowing greatest adaptation to conditions and use. The FCC has set a deadline for "Reply" comments of mid-August. The deadline for initial, stand-alone comments is mid-July.

For folks not on the internet, I can take fax'd Reply comments with your signature and mailing address at 503-213-9853, and file them with the FCC on your behalf, and on behalf of the AM Community. ER

The National NC-80X from page 27
bounce but the NC-80X stays on frequency. It is not as sensitive as my HRO or NC-200, especially on the higher frequency ranges, but there are still plenty of signals it can hear especially with the crystal filter cranked in. And I just found an RME pre-selector that helps out too. At this writing, I have "modified" it for QSK per my *ER* article of October 1996, with a single transfer relay that inserts an additional gain control in series with the RF gain control and that shorts the signal input grid of the mixer to ground when the key closes. I've been using it on my weekly, 40-meter schedule with my friend Mac, WQ8U in Ohio. I've decided that it's definitely a keeper, and it will have a permanent place on the shelf in my Classic Exchange lineup.

Just eight months after his last National-Page editorial on the NC-80 appeared in *QST*, on the first of May, 1938, Jim Millen left National and started his own company. When he left, a lot of his innovative spirit seemed to leave as well. While National receivers continued to be mechanically solid and electrically sound, they were mainly just updates on the previous NC-100 and HRO themes or "me-too" renditions of the receivers made by Hallicrafters, Hammarlund, and RME. That 1934 through 1937 "roll" of new, groundbreaking developments at National led by Millen had ended with the NC-80X and NC-81X. ER

A complete index of the entire 13+ years of ER is available for viewing or downloading at the following website: http://www.qsl.net/n9oo

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Deadline for the August Issue: August 1

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

FOR SALE: New Ranger 1, Valiant 1, & Navigator plastic dials, freq numbers in green, with all the holes just like orig. - $17.50 ppd. Bruce Kryder, W9LWW, 336 Sliders Knob Ave., Franklin, TN 37067

FOR SALE: Military Radio manuals, origs & reprints. List for address label & $1. For specific requests, feel free to write or (best) email. Robert Downs, 2027 Mapleton Dr., Houston, TX 77043, rwdowns_wa5cab@compuserve.com

FOR SALE: War surplus items: modulation xfmr NIB PP-parallel 807s to PD 807s RF 240WV Stancor part 4A61 - $12; ARC 3/T-67 aircraft xmtr 100-156 MHz AM - $25. Mel, WØMLT, 67750 Ridge View Dr., Montrose, CO 81401. (970) 249-1544

FOR TRADE: Two good RCA 833A's for one Taylor 833A; also looking for Taylor 204A, 813, TR40M. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS 66213. (913) 782-6455, jhwalker@prodigy.net

FOR SALE: Hallicrafters, RME, Gonset, others. Also some military, test equipment,VHF/RF amps, more. LASE, Don Jeffrey, POB 1164, Monrovia, CA 91017.

FOR SALE: New Collins winged lapel pin, still have meatball version, either type - $5.95 + 75¢ s/h. W6ZZ, 1362 Via Rancho Prky, Escondido, CA 92029. (760) 747-8710

FOR SALE: Send SASE for large list of excess parts, publications, ham & test gear. K4AFW, 104 Glenwood Dr., Williamsburg, VA 23185

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WANTED: Any info relating to ASB-8 Airborn Radar set. Pete Deierlein, KD2LN, 6257 Perryville Rd., Chittenango, NY 13037. (315) 687-5456, p.deierlein@worldnet.att.net

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WANTED: National Co. emblems, escutcheons, logos from equipment, also National AN/WRR2 in working order. Don Barsema, 1458 Byron SE, Grand Rapids, MI 46606. (616) 451-9874. dbarsema@prodigy.net

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WANTED: Tektronix T-192 storage oscilloscope volts/division knob #366-1646-00 or parts unit. Thanks! Robert, (303)988-2089, rgbdenver@att.net

WANTED: Still looking for manual, schematics, trouble-shooting, RCAF Rx by TMC R-5007A/FRR502. David Boardman, VA2DVD, (418) 877-1316, radioman@dbtubes.com or

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WANTED: TBX radio and/or accessories required by military radio collector. Ray, VK2ILV, ROBINSON@SHLRC.MQ.EDU.AU

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Produced by Floyd Soo, W8RO (ex-KF8AT)

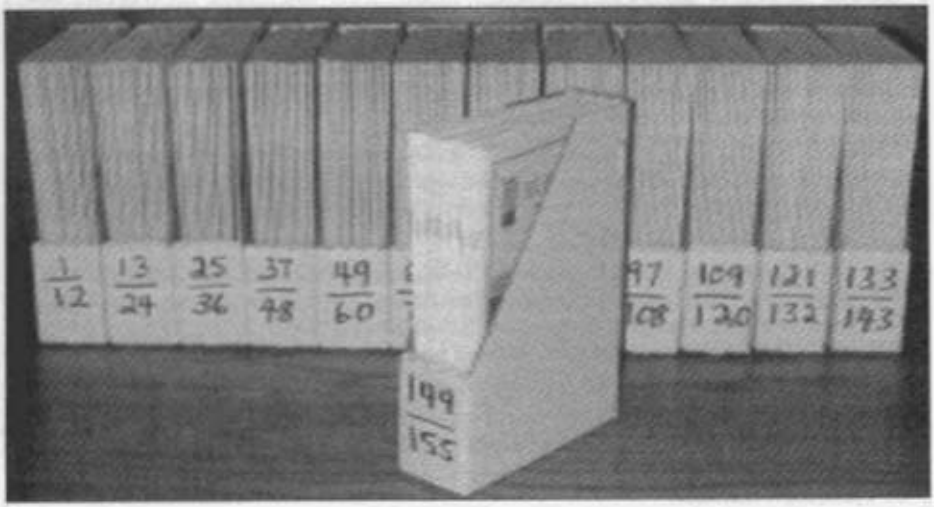
ER Bookstore, 14643 County Road G, Cortez, CO 81321

WANTED: Info & references on PRC-6 walkie/talkie. Louis D'Antuono, 8802 Ridge Blvd., Brooklyn, NY 11209. (718) 748-9612 after 6 PM

WANTED: Info on Audio Development Company xfmrsA5428A (ADC 14) & A5556 (ADC1). Bob, WØCAB, MO, (816) 356-0462. bealmearr@msn.com

WANTED: National Radio HRO-500 table spkr #HRO-500TS. Roger Zaun, W9UVV, 4902 W. Parkview Dr., Mequon, WI 53092. (262) 242-4931, w9uvv@aol.com

WANTED: Exc front panel & cabinet for R-388 (51J3). Roger, WY, (307) 347-2510. kd7hh@trib.com



FOR SALE: RCA tube manuals, RC-15, RC-20, RC-25; ARRL Handbooks, 1965, 1968, 1972 & 1978. LSASE for list. Charles Brett, 5980 Old Ranch Rd., Colorado Springs, CO 80908. (719) 495-8660, brett3729@aol.com

FOR SALE: Repro Nameplates, R-390A generic - $9; 51J-3 and 51J-4 exact replicas - $12. Tom Marcotte, N5OFF, 210 Clem Dr., Lafayette, LA 70503. courir@yahoo.com

FOR SALE: Used technical books - radio, electronics, math, military, magazines, etc. List: $1 (stamps OK). Softwave, 2 Dept. ER, 1515 Sashabaw, Orionville, MI 48462

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

NOTICE: Visit HamRadioUSA.com a website dedicated to traditional ham radio & vintage radio resources. http://www.radioing.com. let's radio. W5AM

FOR SALE: Treasures from the closet! Go to www.cjpworld.com/micromart to find some unique items many Hams would lust for! Gus, WA, (360) 699-0038 or gus@wa-net.com

FOR SALE: Vacuum tubes NOS, used, some xmtg. SASE for list. E.F. Hayes, WØJFN, 3109 N. Douglas Ave., Loveland, CO 80538

FOR SALE: Heath Nostalgia, 124 pg book contains history, pictures, many stories by longtime Heath employees. (See BOOKS inside back cover.) Terry Perdue, 18617 65th Ct., NE, Kenmore, WA 98028

FOR SALE/TRADE: Manuals: S53A; DX100; 75A4; DX40; 75A1; Ranger; TR5; 30L1; HA350; NC183D. A.J. Bernard, POB 690098, Orlando, FL 32869. (407) 351-5536

FOR SALE: Scott Communications rcvr RBO2 - $425; Hallicrafters S-38B, C - $45 ea; R-48 spkr - $50; 8R 40, S-110 parts units - $15 ea; National NC57B - $65; Coronado Tombstone - $125; Magnavox M-1 horn type spkr - $75; (2) Vibroplex bugs - $125 ea; FT243 xtals - $5 ea; several antenna tuners. **WANTED:** Hallicrafters xcvr. Tom Stiefel, ABØER, 611 2nd St., Yutan, NE 68073. (402) 625-2013

FOR SALE: New Eimac 4-1000A - $175; glass chimney - $55; aluminum air socket - $60. Joel, W4SLH, 337 Compass Point Dr., Oriental, NC 28571. (252) 249-2344

FS/TRADE: Collins R-392 - $250; BC-306B - $100; CE/100V - $850; B&W/LPA-1/LPS-1 - $1200. e-list Sam Timberlake, KF4TXQ, POB 161 Dadeville, AL 36853. (256)825-7305, stimber@lakemartin.net

FOR SALE: Hickok KS15560L2 (539B) tube tester, all chart data and manuals - $350 + shpg. Heath IM-11 VTVM - $50. David, W6MKA@ARRL.NET.

FOR SALE: DX-35, DX-40 reproduction crystal doors. $11.50 shipped. Texans add 8.25% sales tax. Glen Zook, 410 Lawndale Dr., Richardson, TX 75080

FOR SALE/TRADE: Transmitting/rcv'g tubes, new & used - 55¢; LSASE for list. I collect old & unique tubes of any type. **WANTED:** Taylor & Heintz-Kaufman types & lge tubes from the old Eimac line; 152T thru 2000T for display. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS 66213. (913) 782-6455, jhwalker@prodigy.net

FOR SALE: Hallicrafters S-108 in good condx & works good - $100 + shpg. Vern Snyder, 5 Parkview Dr., Winder, GA 30680. (770) 307-1459

FOR SALE: Galena xtals, detectors, radios, parts, etc. L. Gardner, 458 Two Mile Creek Rd., Tonawanda, NY 14150. radiolen@aol.com

FOR SALE: Gates BC1G, nice condx, operating on 1.885 - $1500. K7BDY, AZ, (928) 537-2450.

FOR SALE: (2) National NC183Ds, both need work & cleaning - $400 both + shig. Noonan, SC (843) 726-5762.

FOR SALE: Drake TR-4 w/RV4 - $325; Heath Mohawk - $275; Hallicrafters HT-32A - $350. All in very good condx w/manuals. Bob Braza, W1RMB, MA, (508) 222-5553.

FOR SALE: Tubes; xfmrs; meters; gear reducers; SASE for list. **WANTED:** Philco output xfmr 32-8107. E.F. Hayes, WØJFN, 3109 N. Douglas Ave., Loveland, CO 80538

FOR SALE: Collins SM-1 mic - $300; Hallicrafters R-47 spkr - $75; Hallicrafters R-47 mobile spkr - $75. Richard Prester, 131 Ridge Rd., West Milford, NJ 07480. (973) 728-2454, rprester@warwick.net

FOR SALE: Heath SB300 - $175; SB400 - $175; HW101 w/ HP23 - $250; Drake TR4C - $350; TR3 - $175. Ken Sands, K8TFD, (734) 453-7658, ken.sands@juno.com

FOR SALE: Hallicrafters SX-115 (Ham-Band) rcvr - $2000; Collins 312B-5 (RE) VFO, wattmeter, phone-patch - $900; Drake T-4XB xmtr and AC-4 pwr sply - $375; Swan 500CX and 700 CX, w/both 117xc supplies - $800; Bird 43, with RF sampler, 3 slugs - $300. Jeff Covelli/WA8SAJ (440) 951-6406, wa8saj@ncweb.com

FOR SALE: Heath SB-110 w/pwr sply & spkr - $200 + shpg. Robert Blaney, W9FRU, 127 Westlawn Dr., Decatur, IN 46733

ELECTRIC RADIO STORE

BACK ISSUES

All back issues are available at $38 per year (any 12 issues) or $3.75 for individual copies. Buy the entire first 12 years (#1-#143) for $345 **Special deal on last four years (9th year through 12th year) - $100.** These prices include delivery in the U.S. Foreign orders please inquire.

COMPENDIUMS

Collins 75A-4 Modification Compendium- all the factory modification bulletins from Collins Radio Co., all the articles printed in CQ, Ham Radio, QST and ER, 85 pages- $20 plus $3 S&H

Service Modification Compendium for the S-Line, KWM-1/2/2A series - 260 pages - $45 plus $4 S&H

Service Modification Compendium for the KWS-1, 32V and 75A series - 42 pages - $15 plus $3 S&H

T-SHIRTS

The front displays the logo from the cover of ER (the tube outline, Electric Radio, and 'celebrating a bygone era'). The back has "Real Radios Glow in the Dark" (used with the permission of Classic Radio).The T-shirts are U.S. made by Hanes and come in S-M-L-XL-XXL . The color is just a little lighter than the cover of ER - $15 del. ($16 for XXL)

BOOKS

Vintage Anthology - Book 1 by Dave Ishmael, WA6VVL.....$14.95 - 10% = $13.45

The First Fifty Years: A History of the Collins Radio Company and the Collins Divisions of Rockwell International .....$49.95 - 10% = $44.95

Communications Receivers, The Vacuum Tube Era: 1932-1981 by Raymond S. Moore.....4th Edition .....$19.95 - 10% = $17.95

Oscilloscopes, Selecting and Restoring a Classic by Stan Griffiths.....$24.95 - 10% = $22.45

Heath Nostalgia by Terry Perdue, K8TP.....$14.95 - 10% = $13.45

Radios By Hallicrafters by Chuck Dachis.....$29.95 - 10% = $26.95

Transmitters, Exciters & Power Amplifiers by Raymond S. Moore.....$21.95 - 10% = $19.75

Receivers Past and Present, Communications Receivers, 1942-1997, 3rd Edition, by Fred Osterman, ...$24.95 - 10% = $22.45

Hiram Percy Maxim by Alice Clink Schumacher.....$19.95 - 10% = $17.95

Tube Lore by Ludwell Sibley.....$16.95 - 10% = $15.25

A Pictorial History of Collins Amateur Radio Equipment by Jay Miller, KK5IM.....$39.95 - 10% = $35.95

Tube Testers and Classic Electronic Test Gear by Alan Douglas.....$25.95 - 10% = $23.35

Arthur Collins, Radio Wizard by Ben W. Stearns.....$18.95 - 10% = $17.05

Please add $3 S&H for one book and $1 for each additional book.

Three or more books shipped free!

ER Parts Unit Directory

If you need a part for a vintage restoration send $2 and an LSASE (.34 postage) for a list of parts units. If you have a parts unit, consider putting it on the list.

ER, 14643 County Road G, Cortez, CO 81321-9575

Subscription Information

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