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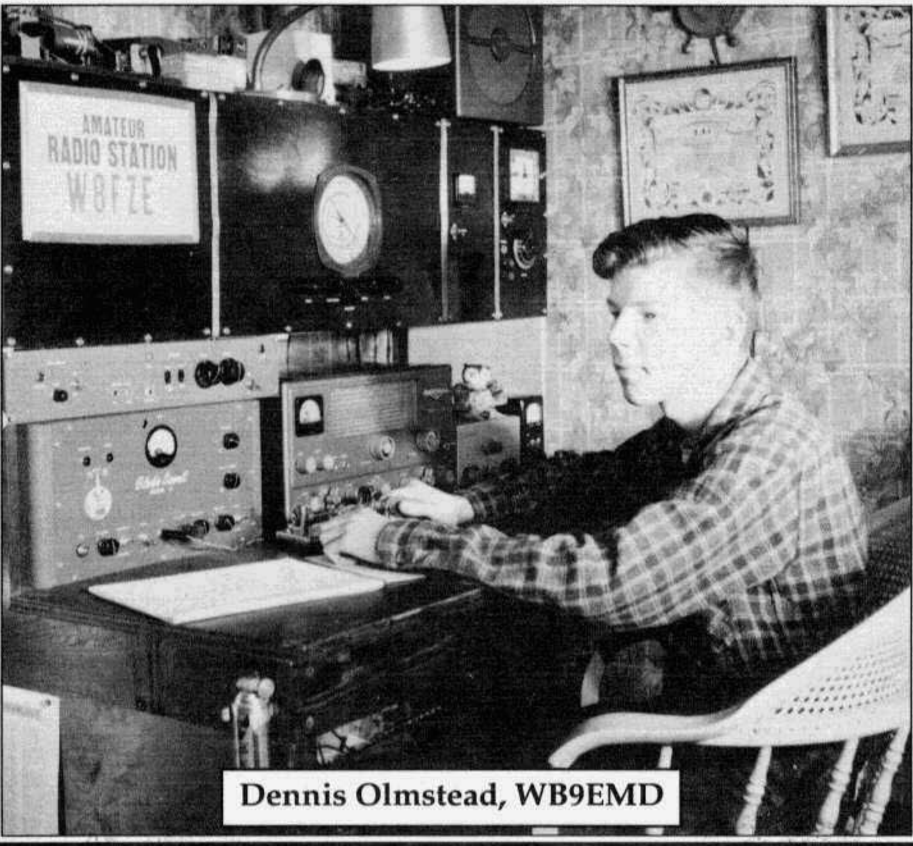
ELECTRIC RADIO

celebrating a bygone era

Number 137 October 2000



Dennis Olmstead, WB9EMD

ELECTRIC RADIO

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

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

Regular contributors include:

Walt Hutchens, KJ4KV; Bill Kleronomos, KDØHG; Ray Osterwald, NØDMS; Dave Ishmael, WA6VVL; Jim Hanlon, W8KGI; Chuck Penson, WA7ZZE; Dennis Petrich, KØEOO; Bob Dennison, W2HBE; Dale Gagnon, KW1I; Rob Brownstein, K6RB; Don Meadows, N6DM; Lew McCoy, W1ICP; Kurt Miska, N8WGW; Warren Bruene, W5OLY; Brian Harris, WA5UEK; Thomas Bonomo, K6AD and others.

Editor's Comments

The Growth of Interest in Vintage Radio

Last week I received two new pieces of vintage radio literature. The first was a book on vintage test equipment by Alan Douglas, "*Tube Testers and Classic Electronic Test Gear*" and the second was a CD containing manuals of vintage military equipment, *Military Boatanchors Manuals, Volume 2* by August Johnson, KG7BZ. As I added these new titles to the lists in the ER Store it occurred to me that most (if not all) of the literature—books, CDs and videos—that we sell did not exist 11 years ago when we started out. I think that's quite remarkable. I doubt if mainstream Amateur Radio has seen this extent of publishing. What does this mean? I think it means that we are more interested (and involved) in vintage radio than our counterparts are in mainstream Amateur Radio. It's also more evidence that vintage radio operating/ collecting is growing in interest and that's a comforting thought.

Alan Douglas's new book should be of interest to all ER readers. I think it's the only book around on tube testers and test gear. It's very well written and illustrated with extremely good, sharp photographs. See Ludlow Sibley, KB2EVN's review on page 25.

August Johnson's new CD, Volume 2, in his series of CDs containing military manuals, is just as great as his Volume 1. I think I've mentioned here before that I really think Johnson's CDs are second to none. They're easy to use, just pop them into your computer and you're away. Finding your way around the CD and around the various manuals is very intuitive, the way it should be. And all of the images are sharp, clear and easy to read. Getting back to historical musing, I don't think computer CDs were available 11 years ago. And isn't it incredible the amount of information that can be crammed onto a disc the size of a CD!

A Thousand Marbles

The author of the article "*A Thousand Marbles*" that appeared in last month's issue on page 18 is Jeff Davis, N9AVG. The article had previously appeared in "*The ARRL Web Extra*", July 7, 2000. We received the article via the internet and were led to believe that the author was anonymous. N6CSW

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MRCA's First Annual Military Radio Meet

by Al Klase, N3FRQ
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The newly-formed Military Radio Collectors Association held their first meet at the Tobyhanna Army Depot in Northeastern Pennsylvania on September 8th and 9th. This event was held in conjunction with the Red Ball Military Transport Annual Fall Rally, so the green and black radios and Larry Damour, N1PHV's commo-carrying deuce-and-a-half, fit right in.

MRCA was assigned a two-acre grassy field with tall trees at one end and uncommitted 50-foot poles at the other, a perfect place for antennas. Dale, KW1I strung a 130-foot center-fed antenna between these supports. He used a bow and arrow for the tree end, and with a couple of other helpers, lashed a mast to one of the 50-foot poles in a maneuver that looked a lot like a May-pole celebration during installation! The club provided a 20 by 40-foot tent to protect the equipment. There was ample lodging in nearby Mt. Pocono, and camping was permitted at the site.

Friday was a laid-back affair given over to setting up, horse trading, playing with the radios and searching the adjoining military vehicle flea market for radio items.

Things started early on Saturday with Ted Young, W3PWW, NCS, calling up the Old Military Radio Net via KW1I's Meissner 150 (U.S. Signal Corps transmitter Type 02520 and matching exciter unit Type 02433) on 3885 kHz at zero-five-hundred hours. It was surprising that we had as many check-ins as we did. Ted had expected a light net because so many of the regulars were in attendance. Conditions were good and some net members checked out early in order to drive down to Tobyhanna later in the day.

The new logo for the Military Radio Collectors Association.

By 9:30 AM most of the attendees had arrived and at least eleven people set up displays of vintage gear (see photos). The formal talks got under way at about 10 o'clock.

Dale, KW1I, started things off with a slide presentation covering the vintage radio equipment on the battleship, USS Massachusetts, the cruiser, USS Salem and the destroyer, USS Cassin Young, all on display in the Northeast. Through the efforts of a few dedicated volunteers, many of these vessels have operational gear that is sometimes heard on the ham bands.

Norm Chipps, N3RZU, followed with a talk on the RCA aircraft radios AVR-20 (RX) and AVT-112 (TX). These small sets were originally designed in the late 1930's for use in light planes. A quantity of these radios were built during WW II for anticipated use in gliders,

The tent used for the meet was 20 by 40 feet. The vehicle to the left is Larry Damour, N1PHV's commo-carrying deuce-and-a-half.

A group photo. Standing, left to right: John Phipps, K1KHP; Dave Kormanicki, KB3ELD; Tom Mackie, W2ILA; Bill Donzelli; Paul Cavalla, N2SPJ; Larry Damour, N1PHV; Steve Finelli, N3NNG; Mike Oxen Rider, WB3CTC; Paul Bernhardt, KF4FOR; Pete Hammersma, WB2JWU; Joe Long, W2EJT; Norm Chipps, N3RZU. Kneeling, left to right: Hank Brown, W6DJX; Lou Ribble, KD3BS; Ted Young, W3PWW; Dale Gagnon, KW1I; Meir Ben Dror, WF2U; Al Klase, N3FRQ.

Mike Hanz, KC4TOS, explaining how to make reproduction cables

but they were displaced by the BC-721, a slight modification of the famous BC-611 handytalkie from Motorola. The RCA sets were ultimately used for temporary installation in aircraft being ferried. Norm had a working demo of both the RCA's and the BC-721.

Paul Bernhardt's presentation did a comparison of high-end European communication receivers of the 1950's and 60's. Paul's collection includes sets from such notables as Telefunken, Racal, and Rhode and Schwartz. He brought along a Racal RA.17 and Telefunken "rainbow" set for all of us to drool over. Paul gave each attendee a thick copy of his presentation loaded with reference information and diagrams.

Mike Hanz, KC4TOS, noted aircraft-radio collector and admitted "cableholic", made the ten-hour turnaround trip from Virginia to show us how to make credible reproduction cables from common hardware-store items. Mike also distributed a valuable handout.

Al Klase, N3FRQ, covered clandestine radios. These included a reproduction of a regenerative receiver in a GI canteen that was used for years in a Japanese prison camp, an example of the mysterious CMS agent(?) set, and two CIA designed radio stations: the RS-1/GRC-109 with GRA-71 burst keyer and the miniaturized RS-6.

A total of twenty-three people registered at the site. We hosted more than fifty folks from the military vehicle group, and were visited by four or five National Guard troops who were spending the weekend setting up a tactical microwave shot. One nice surprise was the visit of Hank Brown, W6DJX from the West Coast military radio group. He had been up at the AWA meeting in Rochester, NY earlier in the week. Since the West Coat military radio group has had much success and has had a lot more experience, Hank's encouraging words were much appreciated.

Event chairman Steve Finelli, N3NNG, was very pleased with the turnout, and wishes to thank everyone who worked to make MRCA's inaugural event an unqualified success. **ER**

More photos on page 40

RCA aircraft sets: AVR-20 and AVT-112 by Norm Chipps, N3RZU.


Dale Gagnon, KW1I's Meissner 150 (U.S. Signal Corps transmitter Type 02520 and matching exciter unit Type 02433)

The SST-1 Transmitter

by Chuck Teeters, W4MEW
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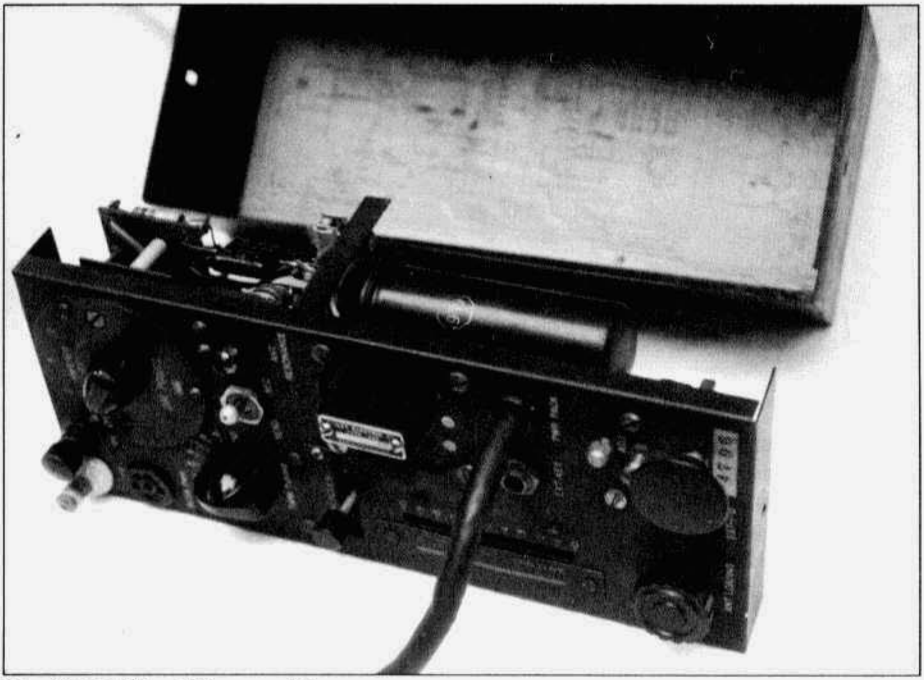
Based on most of my contacts, lots of hams have never heard of the SST-1, the OSS, or any of the cloak and dagger clandestine radios that came from the Fort Monmouth, NJ Signal Corps labs. I've used four different model 'sneaky pete' radios on the ham bands. My current one is the SST-1. I found it at a ham estate sale, and have been using it on 80 and 40 meters for the last year. It has created so much interest on the air that I put this article together.

The SST-1 is a one-tube, CW transmitter that covers 3 to 15 MHz in three bands. A 6L6 is used as a crystal oscillator and produces between 8 and 10 watts output. It has a built in antenna tuner that can load most anything that will conduct electricity. The tuner has an antenna current indicator. A CW key is built into the transmitter and the whole works is in a case which is 12" long by 4" wide and 4" deep and weights just under 3 lbs. It was the transmitter part of a small suitcase sized radio set consisting of the transmitter, a regen receiver, and a power supply. It was built just before WW II for use in Spain. During WW II it was used by the Office of Strategic Services, the OSS, the fore-runner of the CIA. Complete radio sets are scarce these days but a number of transmitters have survived, most probably saved from extinction by some enterprising amateur with larceny in mind.

I guess my fascination with these "spy" type radios is because my first boss when I went to work at Fort Monmouth, NJ was Lloyd Manamon, W2VQR. Lloyd would sometimes talk about the fun he had building and testing spy radios during WW II. Lloyd worked both ends of the power spectrum for the Tactical Radio Division of the Signal Corps Radio Laboratories when they were located at Camp Coles, Red Bank, NJ during WW II. He was a project engineer on the highest power tactical radios the Signal Corps had back in WW II, the BC-610 and AM-141 as well as the low power spy radios.

Lloyd was an EE who got out of Northeastern in the middle of the depression. The only job he could find was writing specifications and supervising radio installations for the Civilian Conservation Corps. The CCC operated HF CW nets for communications and radio operator training. He was working on Cape Cod for the CCC when he met two fellow hams, Oswald (Mike) Villard, W1DMV (later W6QYT of early SSB fame), and Phil Rand, W1DBM (of typewriter, early computer and TVI reduction fame). Lloyd had been licensed in 1934 as W1HUZ while in school. He got active on 160 meter TV with W1DBM and W1DMV using scanning disks. Their buzz saw signals were well known (and somewhat disliked) by the East Coast 160 meter operators.

With the war clouds building up over Europe, the Signal Corps needed engineers, so Lloyd transferred his government job to Fort Monmouth, NJ. His first assignment was to go to Spain using his CCC employee identity to look at foreign military radio equipment that had been left there after the revolution. Lloyd wanted ham radio communications with home and his new wife, Mae, so he built a small 20 meter CW rig to take along. When he got to Spain he found he could not operate legally so he bootlegged. He got caught the second week he was on by the Spanish Government. He was sent home with a notice of reprimand to the United States Government. When he got



The SST-1 "Spy" Transmitter

back to Fort Monmouth the big boss, General Dawson Olmstead, called him in. He was sure he was going to be fired, but instead he was told to build a radio that could be used in Spain without getting caught. That was the start of the Tactical Radio Special Projects Branch. The TRSPB started with three hams, Lloyd, one engineering aid, Harry, W2KQJ, and one assistant, Sol Cotton, who was a ham but I never found his call listed in any of Lloyd's records.

Lloyd said his problems in Spain were power and antennas, not so much the radio itself, but if the boss wanted a radio he would build him a new one and see if he could take care of the antenna and power problems at the same time. He stayed with the same 6L6 grid-plate crystal oscillator he used in Spain but added a rotary inductor antenna coupling circuit and a reasonably accurate antenna current indicator with a tap switch and indicator lamp. The rotary inductor is very unusual, as it has two fixed taps in addition to the variable rolling tap. The fixed taps are connected to the band switch, and the rolling tap is the antenna loading adjustment. He built it to load antennas as short as 15' at 3 MHz.

The built in CW key has a key click filter that gives very soft keying. Lloyd had the idea that why he was found so quickly in Spain was due to his key clicks being heard all over the short wave bands. He also added a parasitic suppressor so the 6L6 would not go wandering generating random frequencies. He built the transmitter to use an external power source. That way the power supply could be tailored to meet different operating conditions. There were two different supplies originally; the first a very conventional transformer operated 50-60 cycle, 90-270 volt input unit that provided 6 volts for the filament and 425 volts for the plate of the 6L6. The second was a very lightweight voltage tripler or quadrupler with no transformers or filter chokes. The 6L6 filament was in series with a light

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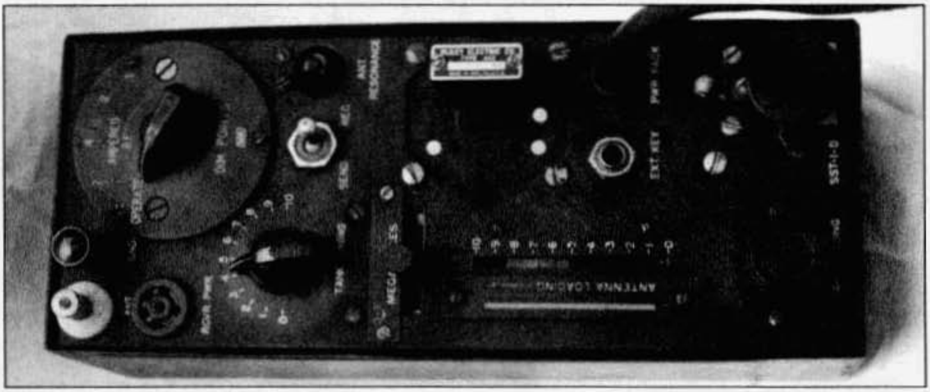


Front panel view of the SST-1

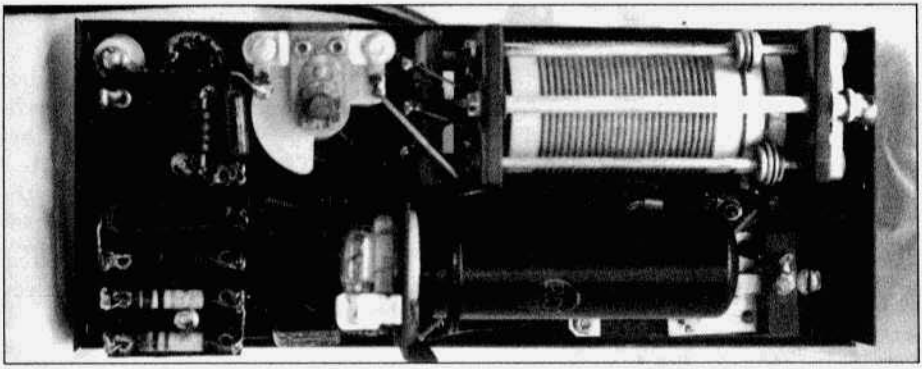
bulb. By using different bulbs for the filament and switching to either a tripler or quadrupler configuration most any primary voltage could be used. The transmitter could also be powered from batteries—6 volts at 3/4 amps for the filament and anything from 180 to 450 volts for the plate and screen of the 6L6.

There were five different versions of the SST-1 transmitter built. The original transmitters were built in the Fort Monmouth Coles radio lab. The next were contracted out to Continental Electric and the last were built by Radio Development and Research Company in Jersey City, NJ. There is nothing in Lloyd's records indicating the number built, nor is there any record of the changes if any between models, other than the ones by RDR were moisture and fungus proofed and all threads were sealed with lock tight.

Lloyd always talked of problems with vibration in the BC-610 test program and was a great believer in that greenish blue glue to keep things from coming apart. He also liked strong metal cabinets, so the SST-1 reflected his design. The cabinet for the SST-1 is heavy gauge copper clad steel. You can stand on it without bending anything. He also, in good ham fashion, put a schematic inside the cabinet. There is nothing in Lloyd's notes about the associated receiver, but there is a note that Ed Razor, W3ZI (W2ZI after the war) did most of the testing.

Lloyd's next project was a 200-watt HF transmitter in a suitcase, complete with power supply. This unit used the light bulb, voltage quadrupler type power supply to keep the weight down. The only thing I know about this transmitter was that it had an HK 257 in the final, and used fixed air caps, with rotary inductors. He took the unit to South Dakota for testing. He had a layover between trains in Chicago, so he locked the super secret transmitter in a dime locker at the train station and went sight seeing. The original unit apparently never went anywhere else as it was used after WW II by the Jersey Shore Radio Club for Field Day. It had been converted to use a very conventional transformer operated power supply when I saw it with the JSRC. How many others if any were built is not mentioned in the notes.

His next project was a very small battery powered transmitter. The best miniature battery tube available during WW II was the 3Q4. It was rated at 90 volts max at 12 mA plate and screen current. Lloyd wanted at least 1 watt output so he borrowed the Frank Jones 6A6 ham technique of running push-pull crystal oscillators. With 135 volts on the plates and screens of two 3Q4s in a push pull crystal oscillator he got 1 watt, and didn't cook the tubes. This radio was about the same size as the SST-1 but included the receiver in the case. There were many dif-



Underchassis view

ferent models of this radio, some as late as 1965. The last built were made by Delco Electronics in Indiana. The nomenclature was AN/PRC-64 and the CW power output had been upped to 5 watts. The receiver was crystal controlled like the transmitter.

Lloyd also worked the Janet 1 and 2 projects, which were VHF meteor burst systems for use by agents in the Soviet Union. Canadian Marconi built the equipment for the Army. The Janet high speed CW burst keying equipment was very successful and he applied it to other radios. Lloyd retired just about the time the GRC-109 came along, but the AN/GRA-71 burst keyer was from his meteor burst communications project.

When I got the SST-1 I connected it to a 390 volt power supply I had. After a few contacts and getting used to it, I took time out to build up a supply just for the SST-1. I kept it small and light with the thought that I would use it as originally intended, portable. I have only 235 volts on the 6L6 so it runs a little less power than normal but it keeps every thing cool and doesn't strain any of the components. Even with only 4 or 5 watts I can work anything I hear. Tuning just a tad on the high side of max output provides T9X reports all the time. I have yet to find an antenna that it won't load. The built-in key is very tiring in use as I never seem to be able to get my arm at a height that matches the key. The transmitter has a jack for an external key and that's what I use most of the time. The only spare in the unit is a #49 pilot lamp for the antenna current indicator. The first time you key the transmitter with a short in the antenna you find out why Lloyd included the spare.

Most of my field trips with the SST-1 are made with my Echophone EC-3. It is a lightweight SX-24 equivalent that provides excellent reception. I operate from 110 volt AC outlets at a rest stop, roadside park, welcome center, or occasionally a McDonalds. The EC-3 is AC-DC and would be difficult to run on batteries, so for battery field operation I use a National SW-3 and operate from a 6 volt storage battery and vibrator supply. The SST-1 works great this way but the SW-3 doesn't think much of the vibrator supply. It takes some experimental placing of the pieces to get the receiver quiet.

The greatest fun operating this rig is that it takes you back to the cloak and dagger days of yesteryear, but without any of the associated dangers (other than some McDonalds managers). Also for us older guys that operate boat anchors, this rig doesn't cause a hernia when carrying it around. And it sure is a conversation starter anywhere you set it up. **ER**

A VFO "Bake Off"

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Did you ever wonder just how long to let your VFO cook before attempting to use your vintage radio on CW? We all know our VFOs drift a bit right after being powered up. But how much do they drift, and for how long?

When we operate AM, we really don't have a clue. With receiver bandwidths of 3 kHz or more, and no telltale beat frequency, your VFO would really have to have a problem for someone to notice it drifting on AM. But with a receiver's narrow CW filter switched in, it doesn't take much excursion for you to slip right out of the passband.

I had often toyed with the idea of doing a marginally definitive comparison of VFO drift among my Globe and EICO units. I have three Globe 755s and an EICO 722. All are self-contained with built-in power supplies, and their circuits are reasonably similar—6AU6 oscillators, 6CB6 buffers. The differences, if any, would be due to materials and packaging. For example, heat expansion occurs on frequency-determining inductors and variable capacitors. Until the units reach some thermal equilibrium - where new heat generated equals heat being dissipated through conduction to the external environment - there will be a fairly continuous change in inductance and capacitance, and a concurrent change in frequency, or drift. If one manufacturer did a better job of thermal design, that VFO should become stable sooner. Thus, all the makings for a VFO "bake off" were coming together in my head.

The HA-5 factor

Like so many of my "projects," this one had been allowed to ferment for a while, but a new factor arose and stirred me into action—I bought a Hallicrafters HA-5 VFO. I remembered seeing an advertisement for the HA-5 back in the early 1960s. It was being touted as a "heterodyne" VFO. At that time, the heterodyne adjective had little effect on me. I was still immersed in CW and AM, with receivers and transmitters that drifted unpredictably. I hadn't experienced the stability afforded by a stable low-frequency VFO heterodyned with a rock-stable, high-frequency crystal oscillator. But over the years I had gained that experience and so was intrigued by the prospect of a stable VFO that could be used with 1950s vintage transmitters. With the new HA-5 in hand, I had renewed interest in my VFO bake off. And so I began.

A level playing field

I wanted to make the comparison as meaningful as possible. To me, that meant testing the VFOs under the same conditions. All five VFOs— the 3 Globes, the EICO and the new HA-5—were connected to a constant load of 56 k-ohms shunted by a 0.001 uF capacitor. All would drive their load for an hour. And frequencies would be monitored and recorded after 15 minutes, 30 minutes, and one hour. The first frequency measurement would be made as soon as the VFO began putting out a measurable signal, and that would constitute both the starting frequency and the starting time. I choose a starting frequency of between 7.000 to 7.100 MHz for each, then began monitoring the drift at the aforementioned intervals.

I used the same frequency counter and loading circuit for each VFO, and the measured intervals were timed using a digital timer. Thus, any errors introduced through measurement of frequency or time were the same for each unit.

I expected all of these VFOs to drift. And they didn't disappoint me. What I had no notion of was the extent of the drift, nor its duration. I did expect there would be greater similarities in drift results among the three Globe 755s than among the more diversified group. And I hoped the HA-5 would prove to be superior because I had paid much more than I ordinarily would have in order to satisfy my curiosity.

The results

The table at the bottom of the page shows the results I observed.

The first interval values are the changes in frequency after the first 15 minutes. The second interval is the change after the second 15 minutes. The third interval is the subsequent 30 minutes. And the "From start" values are the total change from first reading to last reading after 60 minutes. All values are in Hz.

The three Globe 755s are numbered 1, 2, and 3, respectively. Globe 1 is the VFO I use with my Viking Adventurer. Globe 2 is the one I use with the Globe King 500. And Globe 3 is a recent estate sale item that I've never powered up before. As you see by the results, I'm glad I never used Globe 3 on the air!

Of the five units, the Globe 2 was the most stable over the full 60 minutes. During the first interval it drifted up 376 Hz, but then it drifted down 390 Hz during the second interval. As a result, after 30 minutes, the net drift was only 14 Hz. It had drifted only 241 Hz over the 60-minute interval, and the maximum change over 15 minutes was only 390 Hz.

Globe 3 obviously has a problem. It drifted nearly 6 kHz over the 60 minutes. I'll have to get inside that one and find out why.

The EICO did about what I expected it to do. Its enclosure has few openings, so it builds up heat quite fast. During the first half hour, it drifted down nearly 1 kHz. But during the second half hour it drifted less than 100 Hz—which is actually within its published specification.

The HA-5 drifted mightily during the first 15 minutes—more than 1 kHz. But, it did settle down during the last 30-minute interval, drifting only 143 Hz.

	Start freq	15 min	30 min	60 min
Globe1	7049903	7049756	7049381	7049158
Globe2	7090012	7090388	7089998	7089771
Globe3	7089975	7087035	7085443	7084080
Eico	7049991	7049581	7049104	7049008
HA-5	7010000	7011231	7011612	7011755

	1st interval	2nd interval	3rd interval	From start
Globe1	-223	-375	-223	-745
Globe2	376	-390	-227	-241
Globe3	-2940	-1592	-1363	-5895
Eico	-410	-477	-96	-983
HA-5	1231	381	143	1755

The first interval values are the changes in frequency after the first 15 minutes. The second interval is the change after the second 15 minutes. The third interval is the subsequent 30 minutes. And the "From start" values are the total change from first reading to last reading after 60 minutes. All values are in Hz.

continued on next page


The author's multi-station hamshack

If you compare the change from start-up through 60 minutes, only Globe 2 did a respectful job. But if you looked at the 3rd interval results, only, then all except Globe 3 drifted less than 250 Hz. This would have been noticeable but not seen as sudden changes in frequency.

The HA-5

As I had already mentioned, the catalyst for this project was my purchase of the HA-5 VFO. My logic told me that a heterodyne circuit would have little, if any, effect on stability when used in conjunction with conventional 1950s transmitter designs. My experiment bears this out.

Where heterodyning does affect stability is where it is used to produce the actual transmitted signal frequency. In the HA-5, for example, a 5.0 to 5.5 MHz VFO is heterodyned with a crystal oscillator operating at 9 MHz to produce sum and difference frequencies. The difference frequencies are 4.0 to 3.5 MHz —the 80 meter band. For 40 meters and multiples, the variable oscillator is heterodyned with a 12.5 MHz crystal.

The crystal oscillator's drift would be negligible, and if the VFO portion drifted, say, 300 Hz, the total drift would be 300 Hz. Now, on 10 meters, if the same VFO were heterodyned against a crystal frequency of 34 MHz, the difference frequencies are 29.0 to 28.5 MHz. But the drift is still only 300 Hz.

However, in most 1950s transmitters, we use fundamental frequency for 80 and 40 meters, but a multiple for the higher bands. As a result, a VFO with 300 Hz drift and an output of 3.5 MHz would produce only 300 Hz drift on 80 meters. But if that output were multiplied eightfold to produce a 28 MHz signal, then the drift component would be eight times 300 Hz, or 2.4 kHz.

Thus, the fact that the output frequency of the HA-5 is produced using heterodyning does not mean it will be better than a conventional VFO when used in conjunction with a vintage transmitter. Whatever drift the heterodyne VFO has will be multiplied just like that of a conventional VFO. So, unless the variable oscillator portion of the HA-5 is exceptionally stable (which it isn't), it will not compare favorably with a conventional VFO of comparable stability (and it doesn't). In fact, during the third interval —the HA-5's best —the EICO 722 would have been considerably more stable as a 10 meter frequency source.

I was intrigued with why Hallicrafters would have produced the HA-5. Certainly they knew that heterodyning applied in that context would have meant little in terms of real stability. And, I'm assuming that the cost of building the HA-5 would have been higher than that of a conventional VFO. Both types still require a variable-frequency oscillator, and both have isolating buffer sections, but the HA-5 also needs a crystal oscillator circuit and crystals.

I have to conclude that the HA-5 design was driven purely by marketing rather than by technology. By the early 1960s, the first spate of heterodyned

The VFOs tested. The three on the left are Globe 755s. The Hallicrafters HA-5 is on the top right and the EICO 722 is in the lower right.

transceivers had been absorbed by the ham market, and the relative stability of the 32S-1 and SB-400 was surely being noted. By calling its new VFO a "heterodyne" VFO, Hallicrafters was hoping to differentiate its product from Globe 755s, EICO 722s, Johnson 122s, and Heathkit HG-10s, and associate it with the stability of the new SSB transmitters, receivers and transceivers.

It would have been a better use of their money, perhaps, to have designed a more stable variable oscillator section and to have foregone the cost and complexity of the heterodyne underpinnings. But that's marketing for you.

Conclusions

Back in the good ol' 1950s, hams actually did operate CW with Heathkit VF-1s and DX-100s. VFOs drifted, receivers drifted, and we all just "rode" the tuning dials. Nowadays, however, 200 Hz of drift is more than noticeable when operating CW, and that's about as good as our 1950s VFOs get—after an hour's worth of warm up, that is!

The root cause of drift is heat, and more specifically, thermal expansion of metal. The electrodes in vacuum tubes expand with heat, and interelectrode capacitances change. The turns on a coil expand, and intercoil spacings and coil diameters change, changing their inductances. And the spacing between rotors and stators on variable capacitors changes, changing their capacitances. Where any of these inductance or capacitance values are part of a frequency-determining circuit, their changes will cause frequency changes. If you eliminate the expansions, you eliminate the drift. If you allow the VFO to reach thermal equilibrium, subsequent expansions will be minor compared with those that occur during the first 30 to 60 minutes after power up.

So, what did I learn? I learned that letting my VFOs cook for at least 30 minutes before operating CW with them is a good idea, and an hour is even better. The excursions after 30 minutes were far less than those that occurred within the first half-hour. I also learned that heterodyning (as I expected) contributes little to stability when used in frequency-multiplying applications. ER

Three-Way QSO Using HB Gear

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On Wednesday (6-14-00) at 12:30 PM, we had a three-way QSO between Ozzie Diaz,W6ICM; Jay Goodwin,W7JWA and myself Bill Hooper, KF6AR on 3555 kHz. This three-way QSO was on CW and was a real historic first for the three of us. We had previously been talking about building receivers and transmitters from scratch with our own designs (or a design "borrowed" from a construction article in QST or CQ, ER or other handbook). This discussion was prompted by Jay telling us that he was ready to test a home-built (home-brew) station that he had just completed. All three of us were so enthusiastic when we listened to its signal that both Ozzie and I decided that we would unearth some old gear that we each had built many years ago and try for a three-way contact on the 75 meter band. Each station would consist strictly of gear that we had built from scratch—no modified military gear or kits. In fact, Jay not only built the rig from scratch, he also built the hand key and the paddle and keyer from scratch! The tricky part was that all three rigs run less than 10 watts each (Ozzie 8 watts, me 10 watts and Jay 4 watts), and that 75M at noon is a brute-force band . The distance between Ozzie and Jay is about 350 miles.

Bill Hooper, KF6AR, with his homebrew transmitter.

Jay, W7JWA, with his homebrew station. Besides the xmtr and rcvr he also built the keyer, a paddle and a hand key.

Ozzie's rig (W6ICM):

The transmitter is a 6AG7 xtal oscillator and it drives a 6L6. Output is 7-8 watts. It covers 80 and 40 meters with plug-in coils.

The receiver is a 6BA6 RF, 6BE6 mixer, two 6BA6 IF, 12AU7 2nd. det. and BFO, 12AX7 audio and 6AQ5 audio output.

My rig (KF6AR):

Transmitter is a keyed crystal oscillator using two 6AQ5s in parallel. Receiver is a straight regenerative with a 6AK5 RF amp, 6BQ6 detector and a 12AX7 audio stage.

The transmitter and receiver are for 80 meters only. It measures 5 inches high, 7 inches wide and 5 inches deep. The transmitter, receiver, power supply and sidetone oscillator are all on one chassis. It provides about 10 watts with a "distinctive" note and it has a pure note at about 6 watts out. I carried this rig in my briefcase for 15 years and kept contact with Jay from all over the western US and from some locations in the South Pacific!

Jay's rig (W7JWA):

The regen receiver circuit I found in the 1971 edition of "*How to Become a Radio Amateur*". It has 3 transistors, an FET detector/oscillator and 2 NPN transistors for the audio amp. The Hi Z headphones, 2K ohms, provide the collector load for the last audio stage. The receiver is powered by a 9-volt battery and draws 11 mA. With the audio gain half open, you can copy Q5 with the headset on the desk. I modified the design a bit in order to have more bandspread. A CW signal covers 10 dial divisions.

The transmitter came from the '71 Handbook with a lot of modifications. The tube line up is 6C4 Xtal Osc. and a 5763 final. The power supply is on the same chassis and I added a keyer and sidetone circuit. The power supply also provides 12 VDC for the keyer and sidetone. The keyer circuit came off the WWW, from a ham in Sweden, and uses a relay, 3 caps, a diode and a resistor. It has a slow speed and a fast speed con-

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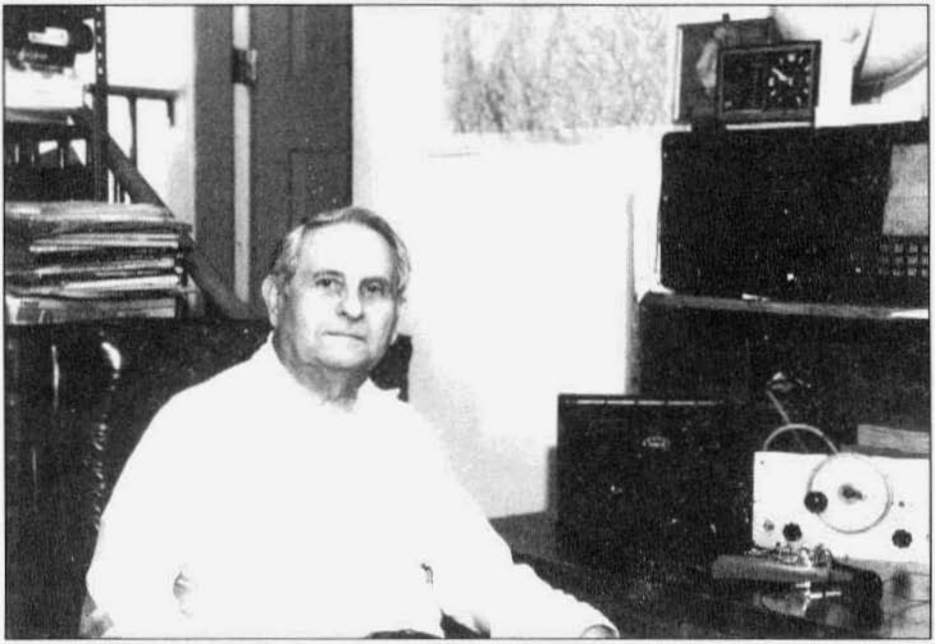

Ozzie, W6ICM, with his homebrew QRP station that he built 40 years ago.

trolled with a toggle switch on the front panel. The sidetone circuit is a phase differential osc. at 700 Hz followed by an op. amp for gain. The output is fed over to the receiver and is wired into the phone jacks. A sidetone gain control is mounted on the transmitter front panel. Power output of the transmitter is 4 watts through a PI network. The unit also operates on 40 meters with a toggle switch to change bands.

The TX chassis measures 9" X 7" X 2" and the RX is 9" X 5" X 2".

The paddle set and hand key are also hand made. The paddle has 2 small short throw microswitches working against a black plastic lever that is supported by an aluminum bracket. The hand pump is a large microswitch w/ lever that is vertically mounted on another bracket. The knob, polished aluminum with black trim, is mounted on the end of the lever. Both instruments are mounted on a wooden base which is painted to match the rig.

Ozzie built his rig 40 years ago. I looked up the notes I had on mine and found that it had been built 38 years ago and Jay's has just been built. Mine had not had power applied to it for over 15 years and I did bring it up slowly on a Variac to be sure that the caps had time to properly form. It worked well.

In 52 years of ham radio I have never participated in this kind of a three-way QSO where all the equipment was homebrew QRP but, we must remember that in the early days of radio (1910 - 1940) this type of roundtable would not only not be unique, but would be the norm. ER

An Inexpensive Power Adjustment Device

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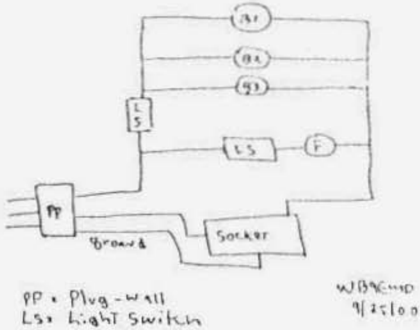
This is a one afternoon construction project which anyone who brings old radios back to life could use. Most of us have brought old radios back to life. The point of greatest interest is when power if first applied to the equipment. The way not to do it is to just plug it in and turn it on. A better method is to ease the power to the equipment through a Variac or through a series light bulb.

The problem with a Variac is cost and finding one large enough to do the job. The problem with the light bulb is that you usually start off with a low wattage bulb and then work up to one about the wattage as the unit being brought back to life. With one light there is a power surge each time the bulb is changed.



There are also times when you always want to ease power to equipment or to run it at a little less than full AC power. As I write this note my SX-42 is sipping controlled AC from the line and the guys are yacking it up on 3885 kc.

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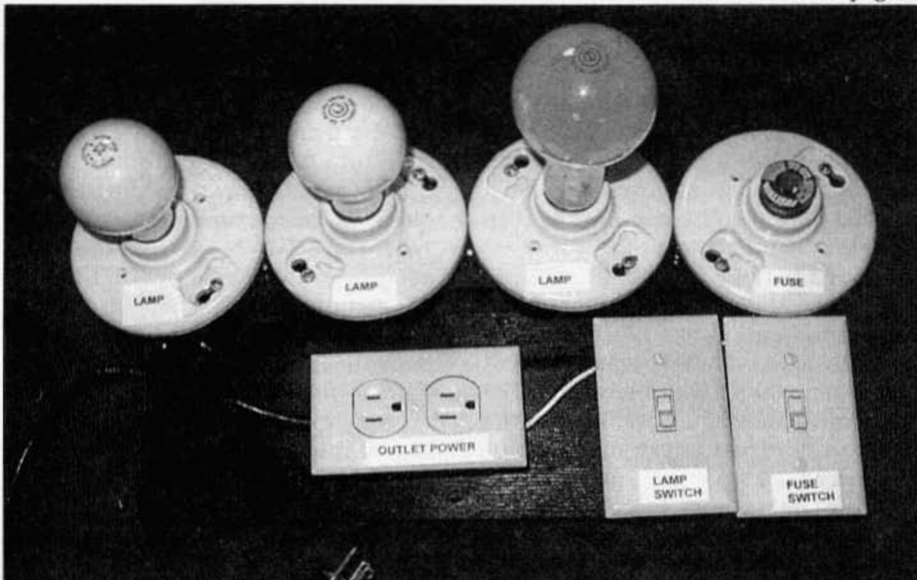

At Last... 10 Meters Lives

by Bob Rose, K6GKU
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10 Meters finally came alive on 4 September here in smoldering AZ after being dead since May. At this writing I have made 53 AM contacts since the band opened. The path lengths span 2500 km to 4000 km and cluster around 3000 km. Up until now I have been really disappointed with Solar Cycle 23. It has been very close to Cycle 20 and a real bummer for 10 meter operation.

On the 4th of Sept.....bingo!!! Solid F2 contacts. Old familiar AMers appeared and were worked; W8GBJ, W3HM, KD4AF, W1VZR, W3VYL, N3GWE, WA4KCY, KC4BDS, and WA2PJP. The stations listed above know the ancient art of "buzzard transmissions"—how to carry on a conversation. All the QSO's were 30 minutes or longer. Today (29 Sept.), I logged 7 QSO's between 1915 and 2230 UT. Solid and loud signals. It is going to be such a fun fall, winter and spring.

It's also been a very hot summer here in Arizona. It was too hot to even be in the garage after 9 in the morning. But then again, 10 was closed too. So I worked on my golf game. 'Zonies' can do that in extreme heat.

I kept a list of equipment types and there were 21 different combination of boatanchor radios and 17 different JA boxes. So far it is 50-50 boat anchors and Japanese boxes. Of the JA boxes, the 756 Pro sounds about the best. Some of the box operators just punch the AM button and go... AAAGGHH!!!!

Of the boatanchors, there are a lot of Collins and Johnson equipment. So far I have yet to find another Knightkit T-150, either carrier controlled or plate modulated. Right now my garage station is the T-150A, plated modulated with an EICO 730 and a HQ-170. My Den station is the HQ-140X and Johnson Viking Ranger. As an aside, my HQ-170 hates poorly adjusted JA boxes and punishes me by making the signal almost unreadable. Just about when I think the -170 is sick, I hear a 32V, a Valiant, a Ranger and know everything is OK. Howard, W3HM and I talk several times a week and I use the quality of his Johnson Desk to benchmark the quality of signals on the band...HiHi.

KG4DPR and I chatted last week. He was using a Ranger II and an HQ-170 which was his original novice rig in 1969.

There have been some noteworthy happenings even in this short time:

Howard, W3HM just retired! He is about to learn how much fun retirement is. Congrats Howard!!

I5KAP/QRP answered my CQ on 9/11/00 and we talked for 20 minutes. Franco, using a converted CB rig was solid into AZ for over 2 hours.

I was soundly chastised for being too quick on the transmit button (function switch on a T-150... give me a break) so a station couldn't break in. On 10 meters this station couldn't have heard the station I was talking to. So why let him in to break the flow of a long conversation?

I talked to a station for 30 minutes on 10 AM and never once did he acknowledge my call. I no longer respond to stations that give their calls and nothing else. We have a new breed of cat in ham radio.

I talked to a station who had no clue

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VINTAGE NETS

Arizona 40M AM Group: Meets on 7293 kHz at 10:00 AM MST (1700 UTC) on Sat. and Sun.
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 3835
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.
Arizona AM Net: Sundays at 3 PM MT on 3855. On 6 meters (50.4) at 8 PM MT Saturdays.
Colorado Morning Net: An informal group of AM'ers get together on 3876 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. http://www.crompton.com/grayhair
Vintage SSB Net: Net control is Andy, WB0SNF. 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 Tuesday nights on 3805 at 2100 Eastern and on Thursday nights on 3875. West Coast 75M net that takes place on 3895 at 2000 Pacific Time.
Collins Swap and Shop Net: Meets every Tuesday at 8PM EST on 3955. Net control is Ed, WA3AMJ.
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.
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.
JA AM Net: 14.190 at 0100 UTC, Saturdays and Sundays. Stan Tajima, JA1DNQ is net control.
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 8AM Central time. Only AM checkins allowed. Swap/sale, hamfest info and technical help are frequent topics. NC is Rob, WA9ZTY.
Boatanchors CW Group: Meets nightly at 0200Z on 3579.5 Mhz (7050 alternate). Listen for stations calling "CQ BA" or signing "BA" after their callsigns.
Wireless Set No. 19 Net: Meets the first Sunday of every month on 7.175 +/- 5 kHz at 2000Z (3760 +/- 5 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.

Nets that are underlined are new or have changed times or frequency since the last issue.

A Modern Band-Switching Regen

by Bob Dennison, W2HBE
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Recently, the urge to build another radio came over me so I started a notebook to record my ideas. This set was to be a simple regen but one that is thoroughly modern(1) and up-to-date. I listed the desired goals:

1. Must use a band-switch rather than plug-in coils.

2. Set should tune the 160, 80, 40 and 20 meter bands.

3. Dial calibrated to indicate frequency the set is tuned to.

4. Set must have a built-in power supply.

5. Set must have a built-in loudspeaker.

Such a set would be a complete ham receiver requiring only an antenna and ground and 117 volts AC. The finished set is shown in Fig. 1. A handsome Millen dial with calibration marks every 10 kHz sets this receiver apart from the ordinary home-built regen. Next to the dial is the loudspeaker, behind its decorative grill. All controls—regeneration, band-switch, volume and the power switch—are conveniently located on the front panel.

This set uses only three tubes and each (even the power output tube) requires only .15 amperes of filament current. Thus a very small power transformer can handle the load and still run

Fig.1. Front view of the bandswitching regen. Speaker grill is perforated with ten .07 inch holes per inch.

BAND	L1	L2	C2	C3
160	88 μH	10 turns	39 pF	All sections ΔC = 40
80	27 μH	3 turns	22 pF	All Sections ΔC = 40
40	4.1 μH	2 turns	100 pF	Front Sec. ΔC = 12
20	1 μH	3 turns	120 pF	Center Sec. ΔC = 8

Table 1. Data on the tuning circuits for the bandswitching regen.

cool. The transformer is fully enclosed in a metal shield which contributes to the hum free operation of this set.

The basic schematic is shown in Fig. 2. For clarity, I have omitted the bandswitch, the individual coils and the associated capacitors required for each band. Table 1 shows the inductance and bandset capacitances actually used on each band. The bandswitch has three, two-pole sections which are used as follows: One section selects the coil used as L1. Two sections select the start and finish ends of L2. The remaining three sections select one or more sections of C3 as shown in Table 1. All the coils came out of my junk box. The 160 meter coil has a universal type winding and the number of turns is unknown. I removed turns until it had the desired inductance when the powdered iron core was about 75% engaged. For the other coils, since I do not know the manufacturer or the permeability of the cores, I simply give the inductance. You might need to experiment, as I did, to find the proper number of turns on the tickler, L2.

I calculated the inductance, L1, for each band using a formula that I derived back in 1955. (2)

$$L = \frac{50660\,\Delta f}{f^3 \Delta C}$$

Here, f is the mean or center frequency of the band, ^f is the width of the band and ^C is the range of the tuning capacitor. For example: On the 40 meter band where the tuning range is chosen to be 7000 to 7300 kHz, ^f =.3 MHz, the center frequency, f, is 7.15 MHz and ^C is 12 pF. This calls for an inductance of 3.46 uH. But, don't believe it! We should not try to cram the ends of the band up against the ends of the dial. So we choose f=7.16 MHz, ^f=.32 MHz and ^C=10.8 pF. This calls for an inductance of 4.09 uH.

Now, the total capacitance required to tune to the low end of the band can be found from

$$C = \frac{25330}{f_L^2\ L} = \frac{25330}{6.99^2 \times 4.09} \approx 126\ \text{pF}$$

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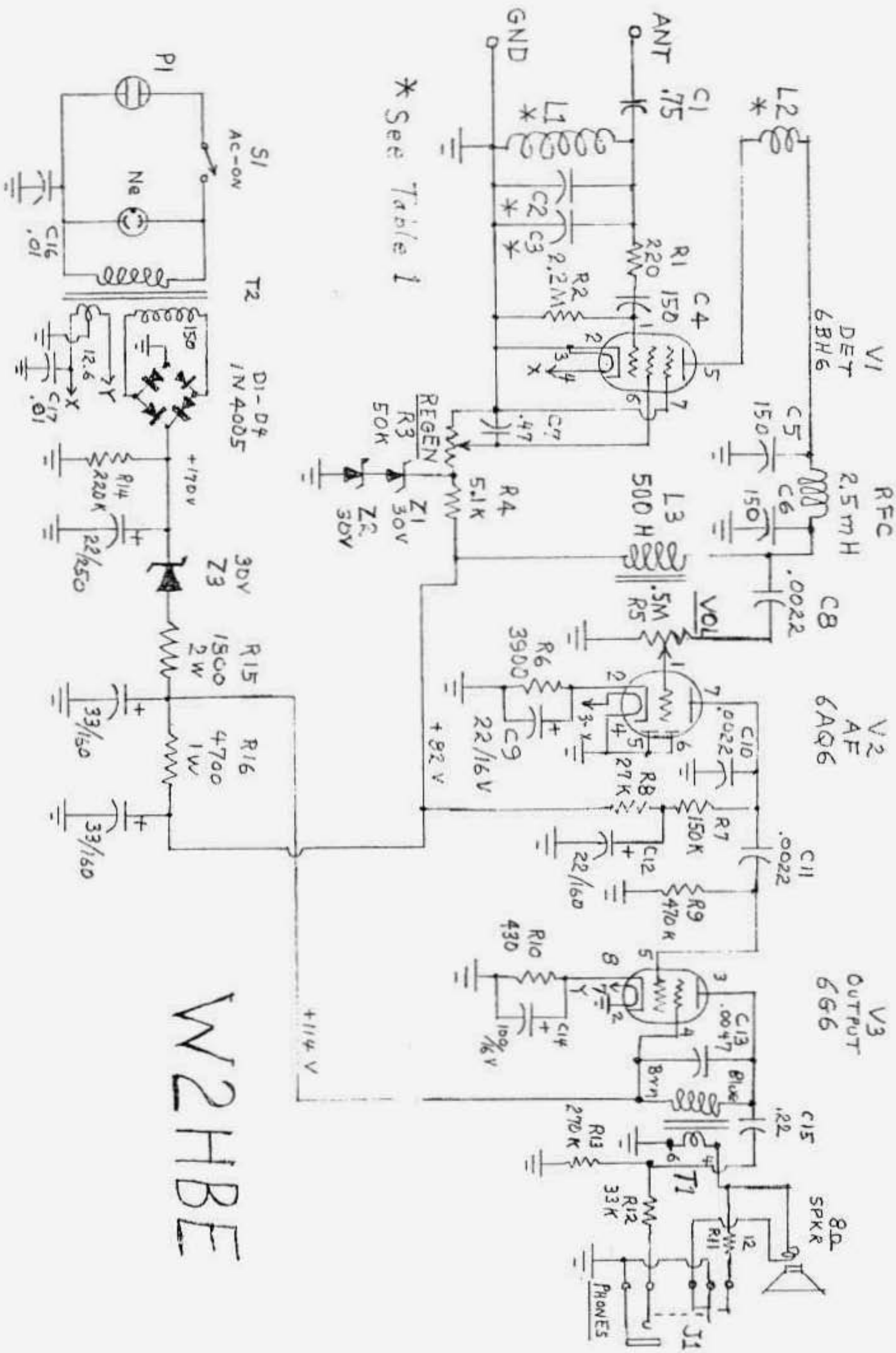

Fig. 2. Wiring diagram of the regen. Bandswitch details are omitted. See Table 1.

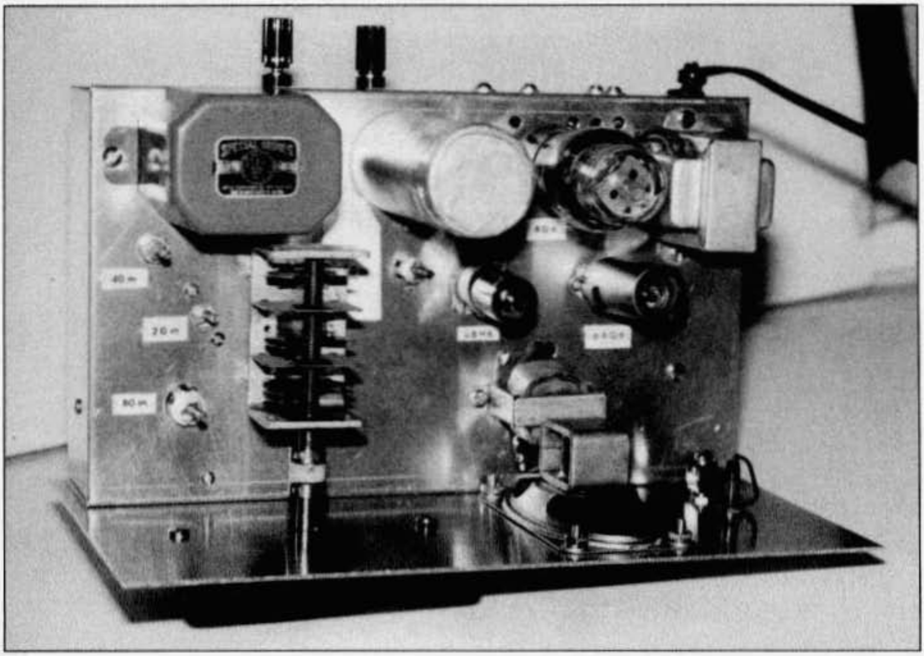

Fig. 3. Top view of the regen. See text for details.

Allowing for the tuning capacitor's Cmin of 6 pF, stray wiring capacitance of 2 pF, the coils distributed capacitance of 2 pF and V1's input capacitance of 5.4 pF (total = 15.4 pF) we need an additional capacitance at C2 of about 110 pF. I used 100 pF. Similar calculations were made for each band. The tickler windings were experimentally adjusted to make the detector oscillate just as the detector's screen voltage reaches 30 volts.

The 6BH6 tube has nearly three times the g_m of a 6J7 and its plate can handle four times more power input. The higher g_m tends to compensate for the lower Q of the smaller coils. The 6BH6 runs cooler than the older tubes and this reduces warm-up drift. On the other hand, the higher g_m makes the tube more susceptible to microphonics. Thus it is advisable to test several tubes to find one that is acceptable. A lead-covered tube shield is recommended.

A top view of the receiver is shown in Fig. 3. The aluminum chassis measures 10 x 6 x 2 and the bottom cover is 10 x 6 and has four rubber mounting feet. The tuning capacitor is coupled to the dial by a miniature flexible coupling that allows for any slight mismatch of shaft alignment. The tuning capacitor is mounted on three hex pillars one inch above the chassis and 1.5 inches behind the panel. Three .375 inch holes below the tuning capacitor permit connections to the stators.

Behind the tuning capacitor is L3, the 500 Henry detector plate choke. A friend gave me this choke and that's what really started this project. The choke was so handsome it just had to be used and it deserved to find a home in a really good regen.

The electrolytic capacitors, C18,19 and 20 are concealed inside the aluminum can salvaged from an old-style electrolytic (Aerovox) with the leads being brought out the bottom. I cut the height of the can down to 3.5 inches to improve the radio's appearance. Epoxy

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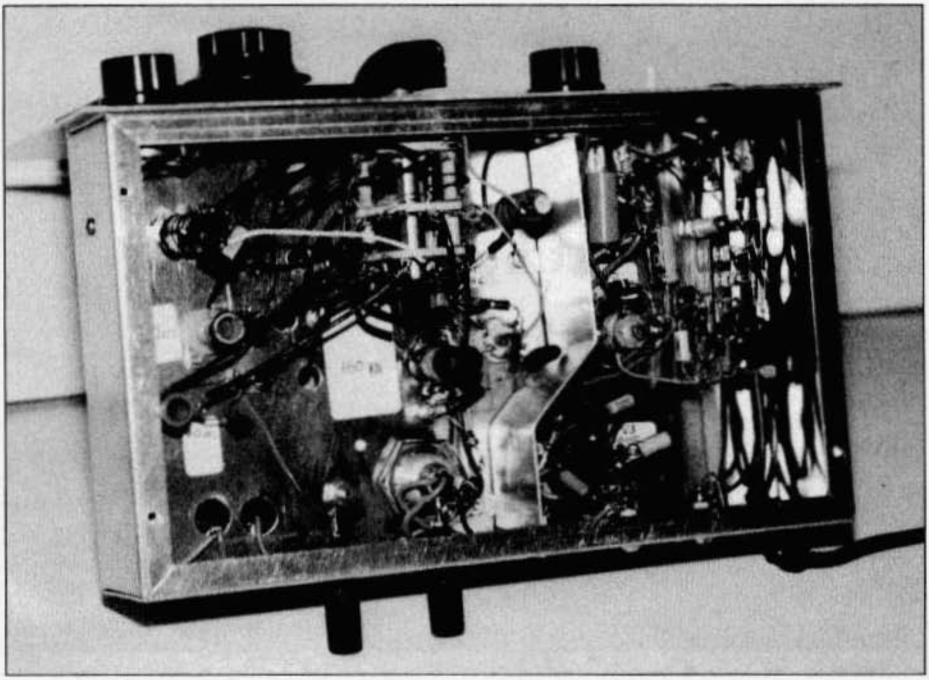

Fig. 4. Bottom view of the regen. Detector section, bandswitch and coils, are at left of shield.

the top of the can back in place and conceal the joint with a narrow strip of aluminum foil.

To the right of the electrolytic can is the 6G6 output tube. What a Godsend this tube is. I could hardly believe my good fortune in finding a genuine audio power output tube that requires only .15 A heater current. I'll wager that my next receiver will employ a 6G6!

At the far right is the power transformer, T2. Just the right size for this compact regen. Silicon diodes are employed to eliminate the heat that a tube would entail. A zener diode, Z3, protects the electrolytics from over voltage while the tubes are warming up. This is probably an unnecessary precaution but when I worked at RCA the design review group would have insisted on it.

The output transformer, T1, is located just behind the loudspeaker. It is a Hammond 125A and provides the high impedance (12,000 ohms) called for by the 6G6 tube. Just in front of the output transformer is the 8 ohm loudspeaker measuring 2 x 3.75 inches. The detector tube, V1, is located near the center of the chassis and the 6AQ6 audio amplifier is to its right.

Fig.4 shows a bottom view of the regen. Near the center is the three section bandswitch. The 160 meter coil is behind the switch and at the left, starting near the front, are the 80, 20 and 40 meter coils. Just to the right is the RFC mounted vertically.

The detector section is separated from the remainder of the audio and power supply circuits by a shield made from .040 aluminum. The long section is 2.75 inches long, the next section is 1.375 inches long and the last section is 1.5 inches long. A small notch in the center section permits passage of the filament lead to V1.

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BOOK REVIEW

"Tube Testers and Classic Electronic Test Gear"

by Allan Douglas

Reviewed by Ludwell Sibley, KB2EVN

This tasty book is from Alan Douglas, who long ago built a reputation as a first-rate historian of early radio (via articles in antique-radio publications and the book series Radio Manufacturers of the 1920's). More recently, he has published a group of 16 articles on test equipment for equipment restorers. These, greatly extended, form the nucleus of the new volume.

About 60% of the book is devoted to tube testers, which have become a "hot" topic as restoration of tube gear has become an important activity. Douglas covers test methods, comparing the values and failings of mutual- conductance versus emission measurement. He includes variants of the basic techniques, including "dynamic" testers and the once-patented Barnhart/Hickok circuit. He gives straightforward methods for getting actual calibration of a mutual-conductance tester and for making automated curve-plots. In a style like that of the Radio Manufacturers series, concise histories of industry leaders and their companies are given, along with summaries of tester product lines. A sampling of old-time ads gives insight into the tester industry. Specific coverage goes to 23 major tester brands: Hickok, Jackson, Simpson, Supreme, Triplett, Weston, and the rest, plus the military (TV-x/U) models. Photographic coverage comprises about 250 high-quality shots.

The remainder of the book goes into general test equipment useful to today's restorer: bridges, grid-dip meters, oscilloscopes, Q-meters, signal tracers, VOMs, and VTVMs. The author emphasizes that vast quantities of older professional-grade analog testgear are available at quite reasonable prices through hamfests and similar sales, and that a modest amount of restoration work can yield gear that is thoroughly satisfying to use. He gives several "case histories" of turning neglected equipment into reliable instruments.

This book is a "classic in the making." It's a pleasure to read, it's utterly reliable technically and historically, and it's seasoned with hands-on experience.

For housekeeping details, Tube Testers and Classic Electronic Test Gear is a 166-page, 8-1/2" x 11" paperback from Sonoran Publishing of Chandler, Arizona. Its list price is $25.95, available from the Electric Radio Bookstore. ER

A Valiant for the 21st Century

by Tom Marcellino, W3BYM
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This article is about the modification of my Johnson Viking Valiant 1. The goals of the project were several. First and foremost was reduction of the tremendous amount of heat using as many solidstate devices as practical. Second was improvement of the audio response by expanding the frequency range and fidelity within the capabilities of the stock modulation transformer.Third was to correct a very unstable VFO having a downward drift after a substantial warm-up period.

The modifications were neither complicated nor difficult to install but did require several hours of bench time. Much use was made of solidstate devices such as: high voltage Zeners, hi-voltage rectifier "sticks", 1 amp-1KV rectifier diodes, and a hi-voltage transistor. Yes, some old parts were used such as tube bases obtained from junk tubes and a few high-wattage resistors. To avoid problems in the final stages of check out, all parts, new and old, were pre-measured before installation.

The speech amplifier, driver, and modulator circuitry were designed by Tim Smith, WA1HLR . This circuit was so successful in my Ranger 1 that I just had to try it in the Valiant. Bear in mind the AM RF output difference of 55 watts vs 140 watts between these two transmitters. The feedback was changed due to the absence of a feedback winding on the modulation transformer secondary. To my amazement, and several others, the modulator has more than enough gain to do the job. One hundred percent modulation is obtained with the gain setting at the 8 o'clock position! I did choose to use a matched pair of Sovtek KT88s as modulators obtained from Antique Electronic Supply.

I will attempt to describe exactly what I did and how I did it to achieve the above goals. You may elect to incorporate all or just use some of the mods in your rig. I believe that I have met the stated goals as demonstrated with on-the-air and much bench testing. The completed transmitter now runs much cooler *with the absence of eight tubes*, is extremely stable to less then 100 Hz after warm-up and has an expanded, flat audio frequency response of 80 to 8 kHz. This can be further improved with the use of a better modulation transformer.

The following modifications will require the chassis to be inverted for most of the time. This beast is heavy and after a while you will develop your own method of handling it. One caution that I would like to pass on is to protect the final tank coil when in this position. It will "bottom out" if the transformers are allowed to directly contact the bench top. I found the use of two empty inverted tuna cans will solve this problem. The cans are the right height and rigidity to place under each corner transformer.

Rectifiers

Refer to Figure 1 for the proper base pin connections. This method of mounting the rectifiers is extremely easy and when completed, you simply plug them into the corresponding tube position. The 866A HV rectifiers were replaced with rectifier sticks, each stick having a value of 1.5 amp at 6 KV PIV. Each stick

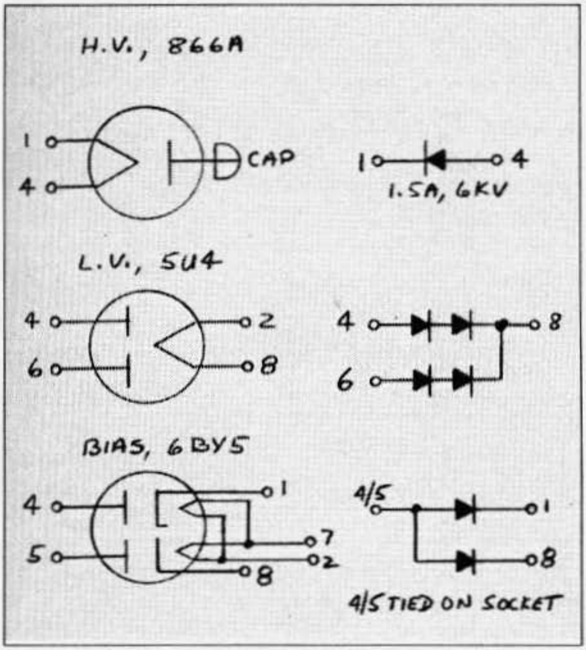

Figure 1. Solid State Rectifiers

was mounted into a 4-pin tube base and held in place with RTV. These sticks use spade lug contacts and simply replacing the old plate cap with the mating spade lug provided the anode connections. The 5U4G LV rectifier was replaced with four 1N4007 diodes. Two diodes per leg will provide adequate PIV protection and these were mounted into a 8-pin tube base. The 6BY5 bias rectifier was replaced using two diodes and a 8-pin tube base.

Modulator Screen Regulator

Refer to Figure 2 for this description. To incorporate this circuit remove resistor R15, 12K at 25 watts. The input of the regulator connects to the HV side of the old R15 and the output connects to the low voltage side. Do not discard this resistor, it will be used later in the modifications.

The total Zener value of 300 volts is a requirement for the KT88s. I've shown the minimum quantity necessary to do the job but any quantity/combination can be used as long as the total voltage equals 300 volts. The Zener current is controlled by the 47k and 68k series resistors. This level must be kept low enough to avoid Zener heating which if allowed to rise will increase the regulated output above the requirement.

The transistor in this circuit is an NPN Motorola MJW-16018. It is rated at Ic=10 amperes with a Vce of 800 volts. This is a large overkill but the high values give a sizeable safety margin. In this application, a current of 2 amperes and Vce of 500 volts would be very suitable. The transistor selected has a power dissipation of 150 watts from a small plastic case. To ensure long life, it was mounted to a small heat sink as it does get warm under sustained modulation. Don't mount this transistor directly to the chassis without insulating washers! It can be mounted to the small PC board with the other parts.

When compared to the stock pair of OC3 gas regulators, this circuit will hold the regulated voltage to about 3 percent under peak modulation. The stock circuit dropped over 22 percent at peak modulation with the new modulator circuit. One final thing to remember when the OC3 tubes are pulled from their sockets, the PTT relay coil circuit is now open. This is because the builtin bypass connection from pins 3 to 7 in each tube is now open. You must provide this path by wiring these pins together on the sockets. In the stock unit this was a nice safety feature which prevented a damaging voltage from reaching the modulator screens if either of the OC3 tubes was removed.

This is no longer an issue with the solid state regulator.

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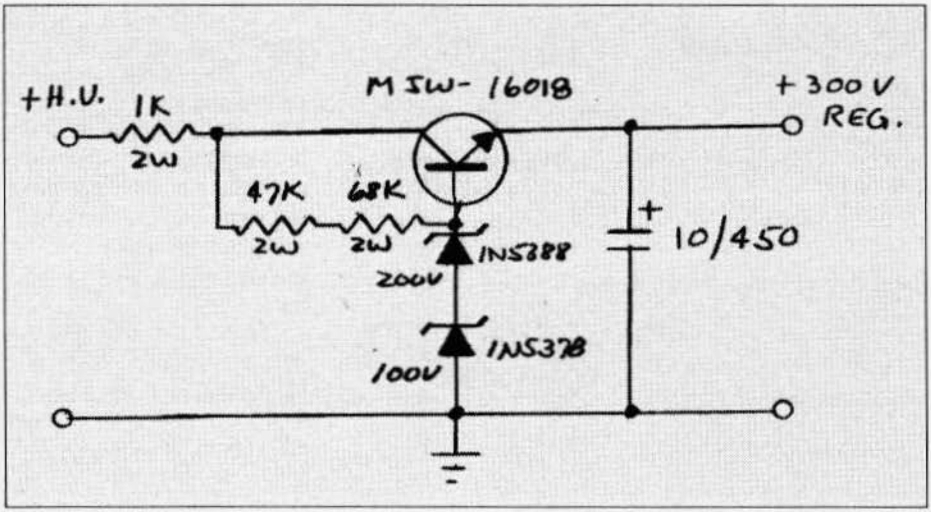


Figure 2. Modulator Screen Regulator

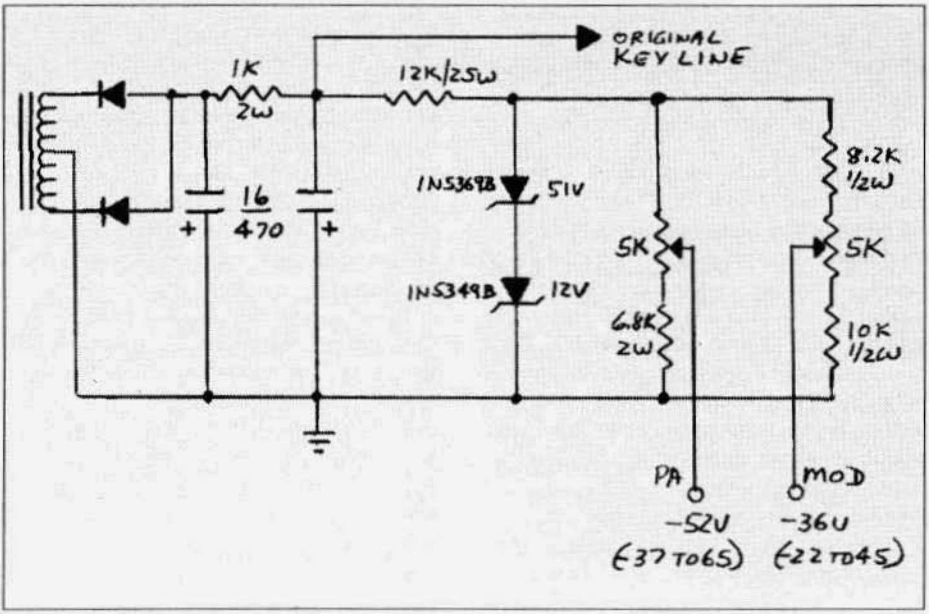
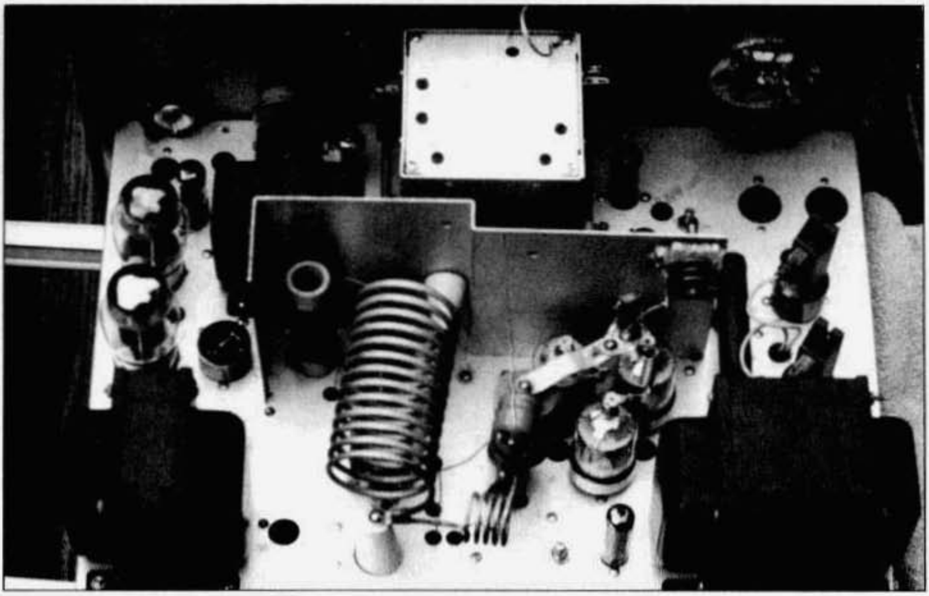


Figure 3. Bias Power Supply

Adjustable Bias

Refer to Figure 3 for this description. Remember the R15 that was removed? Well here is where it is reused. It's the correct value for the series dropping resistor for the two Zeners. This circuit uses the original two chassis-mounted adjustment pots as well as the filters and 1k resistor but with the use of new divider resistors, much better control of the two bias voltages is achieved.

In the original circuit these pots required high-wattage series resistors because the source voltage was the full -265 volts. In this circuit the source voltage has been reduced to -63 volts thus



A topside view of the modified chassis. Note the KT-88 modulators on the left and the solid state rectifiers on the right.

the pots are under much less stress and run very cool. The value of -63 volts was selected because of the -52 volt PA requirement. The resistor dividers were selected giving a range of -37 to -65 volts for the PA and -25 to -45 volts for the modulators. The KT88s, with regulated 300 volts on the screens, will require about -36 volts of bias for an idle plate current of 90 mA. Both bias voltages can be preset after completion of this mod.

Modulator Tube Socket Rewiring

To accomplish this procedure, the LV filter choke L44 mounted over the modulator tube sockets must be temporarily removed. Just unbolt the choke and lay it out of the way. Its lead length will allow this to happen.

The stock 6146 tube sockets are rewired to the KT88 pin out. At first this may sound like a bear of a task but after studying the tube base pinouts for each tube, it becomes easy and is done is about two hours. Actually there are only five pins involved on each tube socket, and the two mod current meter wires. Failure to reverse the meter wires will yield zero current in the mod current position of the meter switch. In reality the meter needle is pushed downward against the peg trying to read the proper current. Finally, remove the original plate caps and pull the wires back down through the chassis.

The tube socket conversion is as follows: (A)=6146 and (B)=KT88. Move (A)3 to (B)4. Move (A)1 to (B)8. Connect (A) plate lead to (B)3. Repeat for both sockets. Reverse the white and yellow mod current meter wires at the one socket.

Speech Amp, Driver, and Modulator

The single point ground and rerouting of the filament returns wasn't installed resulting in no ill effects. Negative feedback is taken from the PA end of the modulation transformer secondary through a .01/1.5KV capacitor in series with a 500k resistor to the driver cathode. The driver, a 12AU7, was replaced with a 12BH7 because it has a higher plate voltage rating.

Installing this circuit isn't a trivial procedure. I recommend the removal of

continued next page

'all stock speech amp and driver parts. To accomplish this get a supply of solder wick and start wicking all the tube socket pins and associated parts. Discard all the parts and get new ones. Resistors and capacitors are inexpensive these days and much better quality. For the two tube sockets that are no longer needed, I kept the filament wires intact for maybe a later project. You can now remove the driver transformer and place it into the nearest trash can. At the completion of this phase it's a good idea to verify that 300 volts is on the screen grids measured at the tube base. The bias voltage can be adjusted to yield a mod idle current of 90 mA.

VFO

This is the final modification made and probably gives the most bang for the buck. Everyone who has ever owned a Johnson transmitter knows about the infamous R3 in the VFO box and how it can single handily wipe out the VFO. So the first thing to do is remove the side cover and cut out this resistor and route two wires from its connections down to a new terminal strip mounted under the chassis. The stock value of this resistor was 18k at 2 watts. In my case it had degraded to 14k and all color bands were gone. Two 10k resistors at 10 watts each were connected in series and attached to the terminal strip. The extra 2k isn't a factor as the OA2 voltage remains stable under peak modulation condition.

The next problem to address in the VFO is electrical/mechanical in nature. This idea is used in the Ranger 1 VFO and was installed into the Valiant. Connect a short wire braid from a front top cover screw to the front panel flange. There's no provision such as a threaded hole on the flange so simply solder the braid at that point.

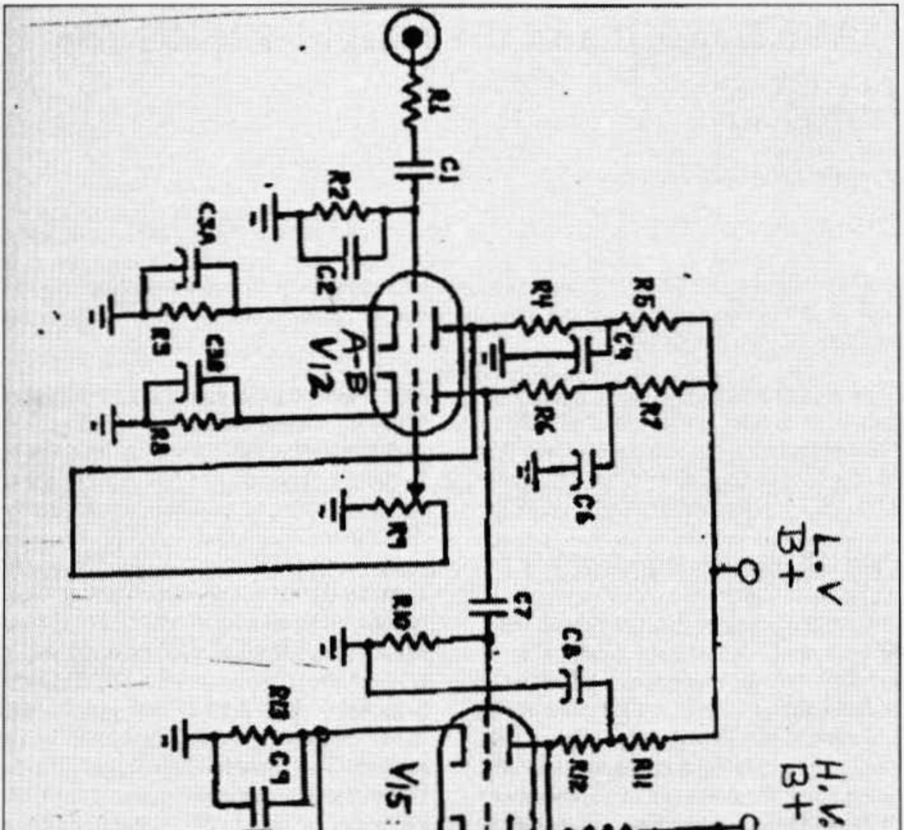
The final step in improving the VFO's performance is to make sure all the little box mounting sheet metal screws have internal tooth lock washers and are tight. Yes even check the ones under the chassis that hold the VFO sides to the chassis. I know this is a pain but just think you only have to do it once and then forget about it.

Now having done all the above you are ready to calibrate the VFO assuming there's no other problem within that little aluminum box. I used a frequency counter sitting right next to the rig with a short whip and proceeded after a

continued on page 42

Modulator Parts List

R1, 4.7K	C1, .005uf
R2, 4.7Meg	C2, 100pf
R3, 1.8K	C3A/B, 47uf/35V each
R4, 470K	C4, 10uf/450V
R5, 33K	C6, 10uf/450V
R6, 220K	C7, .1uf/600V
R7, 33K	C8, 22uf/450V
R8, 2.7K	C9, .001
R9, 1.8K	C11/12, .1uf/1200V
R10, 470K	
R11, 15K	V12A/B, 12AX7
R12, 220K	V15, 12BH7
R13, 4.7K	V16/17, KT88
R16/17, 68K - 2W	
R18/19, 150K matched	Note: All resistors one half watt except as noted.



Speech amplifier and modulator modifications by Tim Smith, WA1HLR.

Van der Bijl and the Knight-Kit KG-686

by Art Hogrefe, N3FEB
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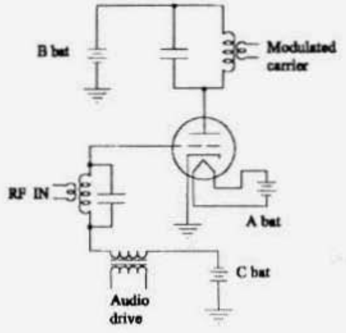
Wherein we'll wander from about 1914 to the present and reconsider a very early type of AM modulator and its implementation in modern circuitry. The KG-686 is shown to be easily upgraded to act as a flea power AM station for demonstration and easy listening. All of which is built on the innovations of a most excellent individual, Afrikaner van der Bijl (pronounced: fun der bail).

The Knight-Kit KG-686 RF generator on my bench had a successful rebuild of its attenuator section (see Electric Radio No. 131, March 2000, p10 "dB or Not dB"). Checking the rest of the circuitry suggested an external audio source might produce clean enough AM for music. A cassette recorder drive with Golden Oldies or radio programs from the '40s and '50s would make a nifty demo. However there was a good bit of RF distortion and uncertainty about the modulation method.

Knight says the kit has a van der Bijl modulator. This was innovated early in the development of radio and used continuously by the Bell system through much of the 20th century. Van der Bijl and his remarkable contributions to radio are discussed in the attached sidebar, the rest of this article describes the modulator and useful modifications to the Knight-Kit.

Fig. 1 shows the basic modulator in both vacuum tube and bipolar transistor implementation. A large audio signal varies the gain of the amplifier and a small RF voltage produces a current in the output proportional to the gain. The tube circuit sums the two input signals using an audio transformer in series with a tuned RF transformer. The transistor circuit differs in using a current drive to set the gain and the smaller RF voltage signal to produce the carrier and modulation currents. The output DC stays at the power supply voltage as low frequency current is shorted through the inductor.

Amplifier small signal gain must be linear (a straight line) with respect to the audio amplitude for good fidelity. AC transconductance "gm" (output current change for input voltage change) is commonly used to characterize both tubes and transistors. It is obtained from the slope of the DC plot of output current vs input voltage (the DC Transfer Function). Fig. 2 provides graphics of the DC characteristics for tubes and transistors. The transfer functions plot the DC output current at given input DC volts for a fixed DC output voltage. "gm" is shown in Fig.2 A & B for perfect square law and three halves law transfer functions. Actual vacuum tubes do not fit either equation exactly although the 3/2 power is now used to model and discuss circuitry. Van der Bijl hoped he could build a square law tube since it has minimum distortion, he couldn't. A square law device (FETs should work well) produces only second harmonics of the input frequencies in addition to the fundamentals and modulation products, its output is filtered to produce only the carrier and sidebands. For a vacuum tube modulator select a triode or pentode with a large linear gm range as shown by its characteristic curves. The deviation from linearity as the current approaches cutoff is inherent, at the limit the grid voltage no longer controls current from all parts of the cath-



A: Classic van der Bijl triode AM modulator

Triode is biased for linear class A operation.

A large audio signal at the grid varies the plate current and transconductance.

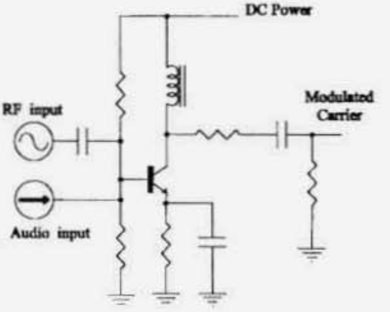
A small constant RF drive voltage produces a modulated output carrier as the transconductance changes.

Tube type and operating point are chosen for best linearity of transconductance change with grid voltage.

50% modulation limit is typical along with poor power efficiency and the need for following amplifiers to be linear.

Later designs used pentodes.

Was used by Bell Telephone during much of the 20th century to generate subcarriers for frequency multiplex cable and microwave.



B: Knight version of bipolar van der Bijl AM modulator

Transistor transconductance is approximately equal to I_c /26. (I_c in mA.)

Transistor transconductance is varied by the input audio current driver to obtain good linearity. Beta is fairly constant.

RF drive must be small for minimum harmonic generation as the transconductance is exponential.

10mV increases I_c by 1.5X	-10mV decreases to 0.67X
18mV increases I_c by 2.0X	-18mV decreases to 0.50X
60mV increases I_c by 10X	-60mV decreases to 0.10X

Fig.1 Basic van der Bijl modulators.

ode equally. Some tubes have a second major deviation as the grid voltage approaches zero, this occurs whenever the maximum current is thermally limited by the cathode.

So we see a square law current vs voltage characteristic produces a linear gm curve and can find vacuum tubes capable of at least 50% AM without excessive distortion. The Fig.2B curve would probably work well for a grid swing of 0 to -7 volts, we'd bias it at - 3.5V. But a bipolar transistor has a very different characteristic and must be considered separately. With its exponential response of output current to input voltage a menagerie of frequencies are created—harmonic, intermods, crossmods and all.

Many references show a transistor transfer function similar to Fig.2F. Seems reasonable and looks a lot like a vacuum tube plot. This is misleading as it suggests operation is possible over a limited current range. The Fig.2C log plot is a much more powerful way to characterize transistor DC properties. In fact, the "ideal bipolar transistor" plot can be used for any silicon transistor, the slope at room temperature is the same for all bipolars, just slide the linear plot up or down to intersect the device under consideration. *All transistors are alike!* This is confirmed by the plot of measured characteristics for a 2N2369A, it parallels the ideal curve until base voltage goes above about 750 mV. Then if we take the transfer function and plot the base current on the same graph as in Fig. 2D we can also check the region where beta (current gain) is useful. Beta is measured as the distance between the two curves for any given I emitter. *All transistors are not only alike but many can he used over large ranges of bias current.* There must be a drawback to all this good news.

The exponential characteristic for the bipolars means they are ferocious distortion generators. The distortion is determined by the AC amplitude at the base and independent of the operating current. This is illustrated by Fig. 2E,

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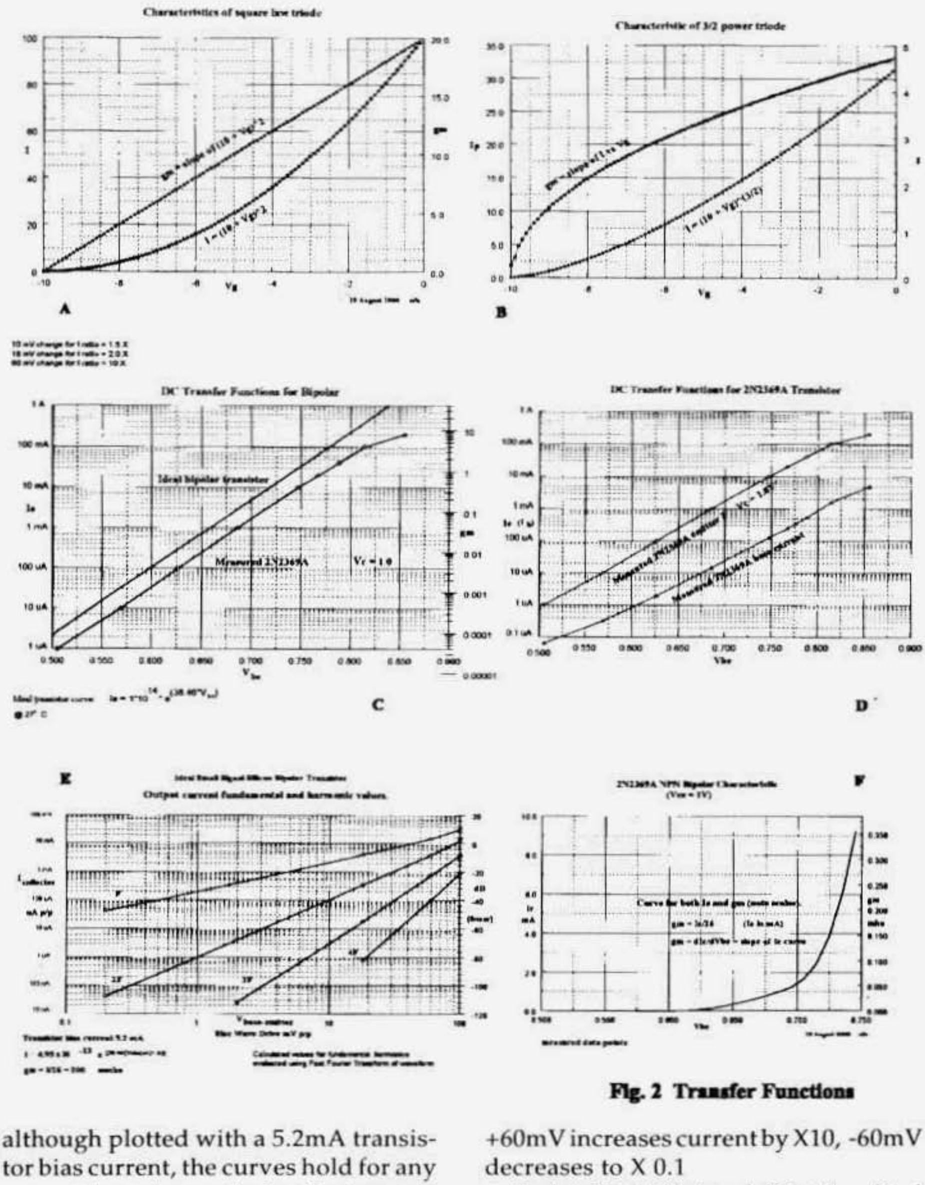


Fig. 2 Transfer Functions

although plotted with a 5.2mA transistor bias current, the curves hold for any current, just change the I collector scale values. A few operating points provide a feel for the characteristic. As the base to emitter voltage changes around the bias value:

+10mV change increases current by X1.5, -10mV decreases to X 0.6667

+18mV doubles the current, -18mV halves the current

+60mV increases current by X10, -60mV decreases to X 0.1

For less than 5% signal distortion (2nd harmonic 26 dB below fundamental) the base to emitter AC voltage must remain smaller than about 10 mVp/p. For example: a 36 mVp/p signal with a bias current of 1 mA increases to 2 mA at the positive peak but only drops to 0.5 mA on the negative peak, severely nonlinear.

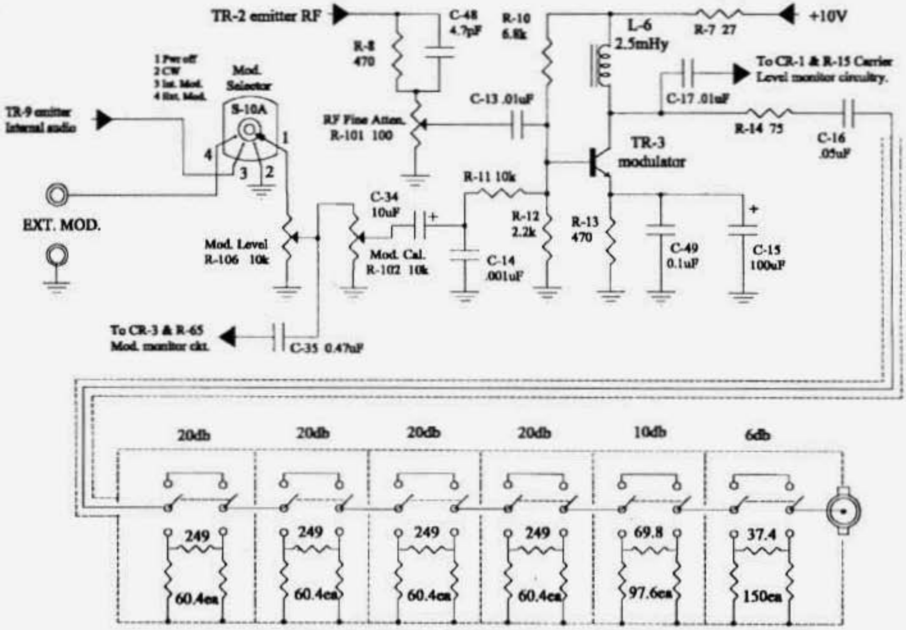


Fig. 3
Knight Kit van der Bijl Modulator Schematic

Fig.2 provides considerable information on DC characteristics for any bipolar transistor (PNPs just have negative currents and voltages). Frequency characteristics are not considered here, they can often be ignored if the beta cutoff frequency (which varies with bias current) is several hundred times the highest required in operation. If we check the graphs or ideal transistor equation another major constant for all parts is revealed.

For any bipolar silicon transistor at room temperature:
gm = Ie/26
where Ie is in mA, gm in mhos

The gm is linear with bias current, the exact requirement for a perfect van der Bijl modulator. We need to drive the transistor so that its current varies with the input modulation voltage. If beta stays constant over the operating region the input voltage can be converted to current drive with a resistor and we have a simple circuit with perfect characteristics. Actual implementation isn't ideal and some residual distortion products occur. Further, the RF drive is a voltage and distortion is dependent on amplitude. The original circuit has an RF 2nd harmonic only 16 dB down at 0 dB out. The audio distortion isn't too bad, the 2nd harmonic is down about 28 dB for 50% modulation.

Fig.3 shows the Knight modulator stage, input controls and output attenuators. TR-3 is biased at about 3 mA so has a nominal gm of around 0. 12 mhos. One millivolt change at the base causes a 120 microampere change in the collector current. Under CW conditions S-10A is at position 2 and there is no modulation current. The RF drive at the TR-3 base is around 70 mVp/p for 0 dB output (282 mVp/p at the output BNC with a 50 ohm load and no attenuators switched in). The problem with harmonic distortion is obvious looking at Fig. 2E. Knight recommends working at -10 dB meter or lower (adjust the RF

continued on next page

Fine Attenuator) to improve things. The curve agrees, expect the 2nd harmonic to track the drive amplitude, a 10 dB reduction in drive reduces the output by 10 dB and the 2nd harmonic by 20 dB, a distortion reduction of 10 dB. Note, reducing the signal using any of the attenuator stages has no effect on distortion.

The DC bias current and audio modulation currents are bypassed by L-6 but all the RF currents drive the 125 ohms (50 ohm load plus R-14) and produce RF voltages. If we were working at a single frequency L-6 could be resonated and the 2nd harmonic practically eliminated. The actual hi-pass used (L-6 and C-16 along with the load) allows operation between 100 kHz and 50 MHz with little circuit adjustment. The output amplitude varies with band and frequency, this is normalized by a monitor meter circuit and manual adjustment at the RF Fine Attenuator.

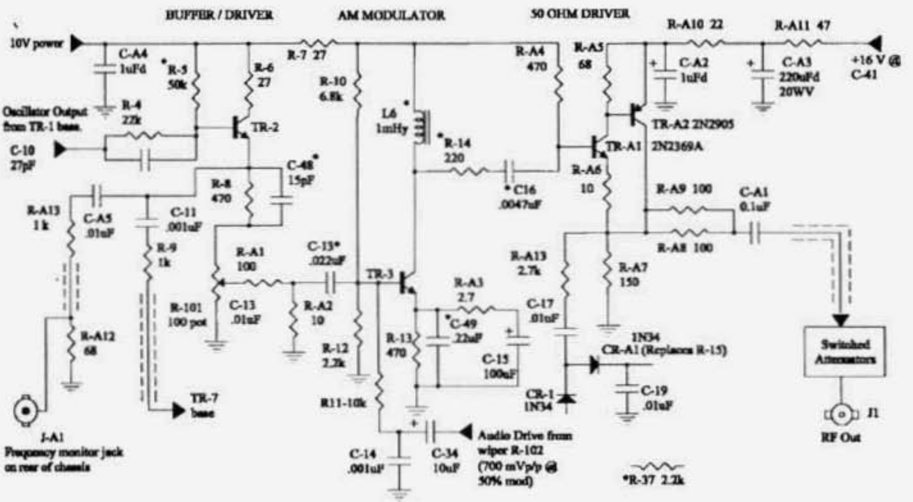
Switching to either position 3 or 4 on S-10 connects the modulation input to an internal fixed audio oscillator or to the external modulator GR connector on the front panel. The audio amplitude at the wiper of R-106 is monitored to provide percent modulation. Internal pot R-102 is adjusted to make the meter reading agree with the actual modulation (check with oscilloscope). R-106 is the front panel modulation level adjustment. C-14 bypasses any RF from the audio circuitry and rolls off the audio input above 10 kHz or so.

Six hundred and eighty three millivolts peak to peak at the wiper of R-102 modulates the stage 50%. There is about 43 mVp/p of distorted audio at the base of TR-3. Therefore the input current modulating the transistor is about 640 mV divided by 10k (R-11) or 64 uAp/p some of which is lost driving the bias resistors. This level will vary as there is a wide beta range for any given type transistor, 3/1 being common in the specifications. The user calibrates operation using the modulation level meter and decent accuracy is achieved at minimum cost. The harmonic distortion for 50% modulation is about the limit standard for broadcast stations, 5% below 85% modulation or 2nd harmonic sideband 26 dB below the desired sideband.

This is a very good inexpensive kit generator, well built, smooth tuning, no 60 Hz hum on the signals and built in 96 dB switched attenuation. A cassette recorder earphone output produces decent music and can be used for demonstrations. Can any easy improvements be incorporated?

The attenuators should be overhauled first as the resistors have drifted a lot since new. See the previous article. The next most useful modification is a frequency counter monitor output. Fig. 4 shows the modified unit, the counter output is at J-A1 as connected by R-A12, R-A13 and C-A5 to the TR2 emitter. A coax shielded is used from R-A13 which is mounted inside the oscillator shield, through the main chassis to R-A12 which is mounted directly across J-A1. Now the small frequency changes with Fine Amplitude or Switched Attenuator adjustment are visible to the user as well as any proximity effect (placing a hand on the unit) and small temperature drifts. Generator stability is pretty good, more than required for AM work. It is possible to do characterization of filters, at least at the lower output frequencies. This configuration will satisfy most users.

If you are really fussy and don't mind a non-original unit, the RF harmonic distortion, audio distortion and output impedance characteristics can be improved. Knight pushed versatility, when the last of the switched attenuators is switched out the circuit becomes a current generator and output voltage jumps up considerably if the load is greater than 50 ohms. This was considered advantageous in providing a



Added parts shown as "A#" i.e. C-A1
Value changes marked with * i.e. *C-49

RF 2nd harmonic at 2MHz & 0dB........................ -26 dB
Audio 2nd harmonic at 2kHz & 50% mod......... -34 dB

TR-2 & TR-3 may be replaced with 2N2369A
0 dB out is 100 mVrms (282 mVp/p) into external 50 ohm load.
0 dB out TR-3 collector swing about 830 mVp/p.

12 mVp/p RF at TR-3 base for 0 dB.
43 mVp/p audio at TR-3 base for 50% modulation.
64 uAp/p audio into TR-3 base for 50% modulation.

Fig. 4
VAN DER BIJL MODULATOR
Modification for Knight KG-686 RF Generator

higher voltage range but can also fool the operator since the meter loses calibration. A laboratory generator has a 50 ohm output under all conditions. We can fix that property along with improving the distortion using the circuitry of Fig.4.

A buffer amplifier, TR-A1 and TR-A2 along with the associated passive parts, is built on a small board and mounted in the oscillator shielded housing near the front panel and close to the modulator circuit. The board should have a maximum ground plane tied to chassis with a length of braid or very short wire. R-A11 and C-A3 are mounted under the chassis near the power supply.

New components are indicated by an A preceding the part number (i.e. R-A1) while revised values of original components are marked with an asterisk (*).

TR-3 now drives a 470 ohm load instead of 125 ohms allowing the RF drive to be reduced to about 12 mVp/p. This reduces the carrier 2nd harmonic for 0 dB output to -26 dB, a 10 dB improvement. The modulation distortion is reduced by R-A3 which inserts a bit of negative feedback in the emitter at audio frequencies. Originally the RF amplitude monitor circuit (CR-1) increased modulation distortion when switched in, this is eliminated by monitoring the RF at the buffer amplifier. Modulation 2nd harmonic distortion is -34 dB for 50% modulation.

Improvement to the modulation linearity was not easy, the original designer did a superb job of finding an optimum operating point for the transistor.

The meter monitoring circuits are modified to work with the new signal levels and provide a bit more sensitivity to the audio input. Output impedance is 50 ohms under all conditions, the meter is truthful under all conditions and attenuator switching always produces the indicated level change. For no output load or any load much larger than 50 ohms the output voltage is twice the indicated meter reading.

continued next page

The generator here is presently transmitting "After the Ball", a prerecorded Advent chrome dioxide tape produced when they introduced the first truly high fidelity Dolby-B cassette recorder back in 1975. Bill Bolcom on piano with Joan Morris singing songs from the turn of the century is crystal clear and a treat from a Sony AM mini hifi receiver. Much nicer than any AM (and most FM) stations as there is no compression on the signal, no 60 Hz whatever, and no commercials. The transmitting antenna is a few turns of wire making a two foot diameter loop. It's untuned, resonating it will increase the range if desired.

Station KG-686 makes a nice demonstration of an old idea and is valued here as a tribute to van der Bijl and the other great engineers at Western Electric who got it all started. **ER**

Dr. Hendrik van der Bijl (1887 - 1948)

Van der Bijl (pronounced: fun der bail) was born in Pretoria, South African Republic (better known as Transvaal). His family had immigrated from Holland in 1668. He was young enough to miss serving in the Anglo-Boer War which created The Union Of South Africa as a British colony.

He was awarded a B.A. degree with honors in mathematics and physics from Victoria College then went to Germany for his Ph-D. Post graduate work on the photo-electric effect and the improvement and characterization of photo detector tubes gave him a head start when the audion arrived at Western Electric in 1912.

His work with the photo detector tube was noticed by R. A. Millikan, Professor of Physics at Chicago University. Millikan visited Dresden and reviewed van der Bijl's work. This allowed him to correct the errors in his own research and complete an experimental proof of Einstein's equation for the photo effect. Millikan admired van der Bijl and was instrumental in getting Colpitts (of oscillator fame) at Western Electric to offer him a position. This was quickly accepted as WW I was only months away and it was time to leave Germany. Van der Bijl signed on with Western Electric Laboratories with an initial income of $36 a week and began work in September 1913.

Western Electric Laboratories was the research and development arm of the Bell telephone system and in the process of deciding how to build amplifiers for long distance wire communication. The audion tube (triode) was under test and required some major effort as no one was quite sure how it worked. Van der Bijl joined the effort about the time they had improved prototype tubes with oxide coated filaments, larger elements and better vacuum. He designed the Type M or 101A tube which clearly won the transcontinent amplifier application when compared to the Edison carbon button amplifier and Arnold mercury vapor discharge tube. The filament design was then improved resulting in tube life of about 4500 hours. DeForest's original audion tubes used incandescent filaments with a life of 30 to 100 hours, Western Electric Lab improvements turned them from curiosities to useful devices.

The previous work on photo-electric tubes suggested the field relationslips between the three tube elements and van der Bijl worked out both the mathematics of triode design and the characterization of the finished product. He designed a number of early tubes (the VT-1 and VT-2) which were used by both the Army and Flying Corps after the US entered the conflict. This was followed by a much smaller "peanut" tube (the VT-3) that was developed too late for the war. The VT-3 was licensed to a number of manufacturers, its low power filament (.2A @ 2V) much appreciated in the commercial market to enhance battery life.

In 1915 Western Electric wanted a transatlantic radio communication system using AM. The team used a van der Bijl linear modulator (see main article) driving 500 parallel output tubes! They succeeded in contacting Paris and Honolulu from the Navy Signaling Station in Arlington, Va.

The concepts of voltage amplification (μ) and plate resistance (R) were reported in the classic paper, "Theory and Operating Characteristics of the Thermonic Amplifier" of 1919 and became the basis of the textbook, "The Thermonic Vacuum Tube and its Applications" of 1920. This text remained an industry standard up until WW II.

General Smuts became Prime Minister of the Union of South Africa in 1919 and made a personal appeal for van der Bijl to return as Scientific Advisor to the government. He left Western Electric in late 1920 following a "whale of a party" by well wishers. The Bell system pays him tribute by their description of his work:

He was largely responsible for analyzing tube performance in terms of simple parameters and establishing techniques for designing circuits with performance predictable from these parameters.

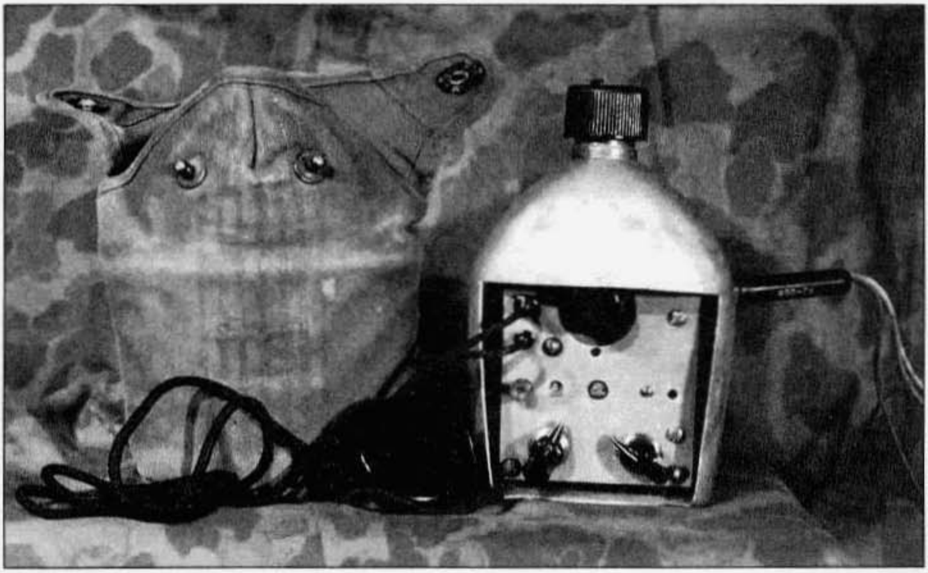
Most radio handbooks and vacuum tube circuit design references mention the van der Bijl AM modulator since the circuit was long used for subcarrier generation in the Bell System long haul cable and microwave multiplexers.

Van der Bijl played a major role in bringing South Africa up to first world standards for technology and production. He started by insisting on a steel industry to support national rail and never looked back. During WW II he was Director General of War Supplies, afterwards resumed the expansion of the nation's industries.

The English language Encyclopedias have lost van der Bijl and even the South African records are slim. We are all indebted to Dirk J. Vermeulen who researched his biography and to the IEEE for inviting Vermeulen to do an English translation as an invited paper. The IEEE also reproduced the 1919 classic "Theory and Operating Characteristics of the Thermionic Amplifier" in the same issue. This printed record with photographs of the early tubes and the test equipment used to characterize them may be accessed in the *Proceedings of the IEEE, Vol 86, No. 12, December 1998.* I located the material with the help of the IEEE Historical Dept., and the friendly librarians of The Penn State Engineering Library. Many thanks.

Additional MRCA Meet Photos

Paul Bernhardt, KF4FOR's Telefunken "Rainbow" set.



Al Klase, N3FRQ, covered clandestine radios. These included a reproduction of a regenerative receiver in a GI canteen that was used for years in a Japanese prison camp, an example of the mysterious CMS agent(?) set.

Band-Switching Regen from page 24

The silicon rectifier diodes, D1-D4, are mounted on a terminal strip near the end of the chassis and don't show up in the photo. Avoid excessive heat when soldering the diodes.

RF alignment will be explained by illustrating the procedure I used on the 80 meter band. Set the dial at 95% of full scale, tuning capacitor almost at minimum capacitance. Set the signal generator at 4000 kHz. Adjust the 80 meter coil's ferrite core for maximum signal. Now turn the dial to about 5%, tuning capacitor near 95% of maximum capacitance. Tune the signal generator until the signal is heard. If the frequency is 3500 kHz, you are finished. The set now tunes the entire 80 meter band with a little extra at each end. But suppose the signal generator indicates not 3500 kHz, but, let's say 3580 kHz. This tells us that we need more inductance. Turn the slug slightly further into the coil and repeat the steps given above. Repeat this process until the entire 80 meter band is tuned as the dial goes from 5% to 95%.

When all the coils are properly adjusted as outlined above, the dial may be calibrated. For most accurate results, use a signal generator and a frequency counter. Make light pencil marks every 10 kHz. Do this on each band. It helps to make the 50 kHz and 100 kHz marks slightly longer than the in-between marks. Remove the dial scale and ink in the marks. Then print the key frequencies: e.g., 3.5, 3.6, etc. Finally, glue the dial scale into place on the dial body.

Now that your receiver is finished, you can do either of two things. You can carry it into your hamshack and give it an on-the-air test. Or, if you are like me, you can get a fresh notebook and start designing your next great receiver! And be sure to share it with ER. ER

References:

1. Modernizing the Simple Regenerative Receiver, Vernon Chambers, W1JEQ, QST, Oct. 1937. Chambers describes a two-tube bandswitching regen for four bands -1.7 Mc to 14 Mc. Uncalibrated dial and unshielded construction. Separate power supply and no built-in speaker. The desire for bandswitching goes way back.

2. A deLuxe Amateur-Band Receiver, R.C.Dennison, W2HBE, QST, Oct. 1955.

Power Adjustment Device from page 17

I constructed a simple AC control device which allows me to apply power in stages as well as to have full power with a fuse. The entire project can be done for less than $20 if you buy all the parts new and may be constructed in an afternoon.

The diagram shows three light bulbs in parallel and a separate switch for a fused line. I did not put switches in all the light bulb lines but instead just screw in the bulbs as needed. For example, my unit has a 25, 100 and 200 watt bulb in the sockets. By screwing in one bulb at a time applied power is limited to 25, 125 and 325 watts. This power is also applied in sequence so power is applied without having power surges to the equipment. After the old radio is up to speed a flip of the switch applies full power through a fused line. Turning off the switch for the lights at this point gives a fused full power source.

Be certain to use a three prong power plug in the feed and keep the power socket at ground potential the same as the source power. A parts list would be four ceramic light sockets, two switches, and one power socket. I found the easiest way to acquire a good power plug was to buy an extension cord and cut off one end. ER

A complete index of the entire 11 years of ER is available for viewing or downloading at the following website: http://www.qsl.net/n9oo

Valiant from page 30

twenty minute warmup. Just follow the instructions in the manual and you are finished. One additional point. If you have to remove and install the VFO cover, don't assume the calibration will hold. The mechanical configuration of the box is critical to the frequency and reinstalling the cover usually requires re-calibration.

If you are still with me at this point and have followed what my approach has been, you may be wondering why I didn't change out the OA2 that sits inside the VFO box. Well, now that you asked I did address this issue hoping to make it minus nine tubes. In fact two different regulator circuits were tried and the VFO just wouldn't cooperate, refusing to act like a normal VFO. Therefore this idea was abandoned. The OA2 voltage was measured under maximum power out with peak modulation and remained within 200 mV deviation.

Final notes

To increase the performance of this old boat anchor and avoid some headaches, some of the following may be of interest. Check the PTT relay. After some 40 odd years of operation the contacts can be in pretty bad shape. In fact this one had contacts that were black and pitted. Install a new relay, one with a 120 VDC coil.

Another area that is often overlooked is all the grounds that are made using solder terminals and small screws and nuts. These do become loose with time. Check them all, you may be surprised. Also check all the connections in the PA tank circuit. The large ceramic insulators will need a turn or two on the mounting screws and the screws that hold the 20 KV coupling capacitor will need attention also.

Well that's the end of the story. Apologies for some of the boring details but hopefully this will reduce the return E-mails and phone calls. If there are any questions or suggestions, please don't hesitate to contact me. The project presented a good challenge especially for maximizing the heat reduction. It is used almost daily and can be heard in the 40 meter AM window during the day.

The author would like to thank several great ham friends whose continued support was greatly appreciated during the past several months to see both this and the Ranger project to a successful conclusion. The many E-mails, on-the-air testing and QSOs, and eyeball QSOs provided immense support and encouragement. They are: Mike McElhinny, WN3B; Dee Almquist, W4PNT and Bill Breshears (Bowie Bill) WC3K. **ER**

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10 Meters Lives from page 18

what kind of radios I was using or what a vacuum tube was! Really!!!

WA2PJP convinced me to rebuild my Viking II instead of turning it into an organ donor. Also gonna rebuild the modulator in my favorite, my DX-100. It is to me like Charlie Brown is to kites—can't keep the thing on the air.

I will be monitoring 29.0 most every day. This is going to be a bang up hot 5 months on 10 AM.

I am finding that the lost art of conversation is being resurrected on 10 AM. I love those long,"old buzzard" QSO's. **ER**

P.S. Insanity reins on ebay. A pristine KnightKit T-150A and R-100A sold on ebay for $900!!! There is no T-150A/R-100A (a dog of a receiver) that is worth that kind of $$$. Actually I may have cornered the market on T-150's. I have 3. I have the one in the garage that is plate modulated, a pristine, almost collector quality one in my den with a restored R-100A and a 3rd is an organ donor. Another project I'm involved in now is restoring a Heath Tener for 29.0.

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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 02857-2805. aq253@osfn.org

FOR SALE: KWM-2 fan bracket - $12 ppd. Dave Ishmael, WA6VVL, 2222 Sycamore Ave., Tustin CA 92780. (714) 573-0901.

FOR SALE: Small parts, transformers for projects and repairs of tube gear Let me know your needs. Van Field, W2OQI, 17 Inwood Rd. Center, Moriches, NY 11934. (516) 878-1591 or wreck_and_rescue@juno.com

FOR SALE: NOS,UTC # F-7101 matching (600-8 ohms) xfmrs (2 W) - $13 ppd/dom/USA. ABEN, POB 4118, Jersey City, NJ 07304-0118,Avidov@aol.com

FOR SALE: Hammarlund SP-600 parts, transformers; tubes; tube shields; and more. Make offer. John, TX, topshack@hotmal.com

FOR SALE: NOS TCS baseplates - 2/$15.00; a very limited supply of good used TCS shockmounts - 8/$20. Plus shpg. Carl, KN6AL, POB 3531, Laramie, WY 82071. (307) 742-0711 kn6al@uwyo.edu

FOR SALE: Collins S-Line aluminum knob inlays: small (exciter/PA tuning) - $1; 30L-1 - $2; spinner/plain (main tuning) - $3. Charlie, K3ICH, 13192 Pinnacle Lane, Leesburg, VA 20176. (540) 822-5643

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: Meters for WW II military radios, have some connectors. Henry Engstrom, KD6KWH, CA. (707) 544-5179. pacifica@sonic.net

FOR SALE: MFJ-249 SWR analyzer w/manual, exc condx - $150 shpd. Money back guarantee. John, W9MHS, TX, (956) 584-7840.

FOR SALE: Drake R4-A rcvr, VGC w/manual - $175 + shpg. Burt, MI, (517) 736-8020, kc8fbr@kwcom.net

FOR SALE: S40A, vg - $80; Ranger, vg - $200; S-38C, fair - $30; SX-25, good - $50. Chuck, NZ5M, (806) 698-8767

FOR SALE: National HRO PW dial & gear box, exc - $75 + shpg. Richard Cohen, 11802 Willow Pt Way, Tampa, FL 33624. (813) 962-2460

FOR SALE: Short-wave rcvr in good condx, Icom R-70 - $300; preselector MFJ1046, mint - $50. Alex, NY, (718) 648-7370.

FOR SALE: Military and commercial communications items: http://www.maxpages.com/murphyjunk. Murphy's Surplus, 401 N. Johnson Ave., El Cajon, CA 92020. (619) 444-7717

FOR SALE: Over 600 electronics magazines, mostly 1960's & '90's - 99¢ ea + shpg; also available: electronics books, parts, etc. List for stamp. Bob Eckert, 133 E. 7th St., Clifton, NJ 07011.

FOR SALE: Tube list, new & used, wide variety audio, ham. Recently expanded. SASE 52¢. Bill McCombs, WBØWNQ, 10532 Bartlett Ct., Wichita, KS 67212-1212.

NOTICE: T-368 Registry. For info w2zr@aol.com or W2ZR callbook address. Subscribe to T-368 reflector: www.onelist.com/t-368_bc-610

NOTICE: A website dedicated to traditional ham radio & classical radio resources. Visit Ham Radio USA, http://www.hamradiousa.com

FOR SALE: Hallicrafters xmtr HT-40 - $45 + shpg. Henry Mohr, W3NCX, 1005 W. Wyoming St., Allentown, PA 18103.

FOR SALE: HQ110A, very good - $160; S-20, worlds prettiest - $200; high voltage sply, 7000 watts - BO. Ron, MI, (517) 374-1107.

FOR SALE: Heavy turntables: Fairchild 311, 312, etc. in various configurations by former employee. Charles Graham, 4 Fieldwood Dr., Bedford Hills, NY 10507. (914) 666-4523

FOR SALE: Books, all electronics related; 300 titles; SASE. Paul Washa, 4916 Three Points Blvd, Mound, MN 55364. wotok@email.msn.com

FOR SALE: Build your own "Midget" bug replication by KØYQX, ca 1918, featured by K4TWJ in CQ Magazine, May, '98. 10 detailed blueprints. FAX (507) 345-8626 or e-mail<bugs@mnic.net>

FOR SALE: RBM pair, hi-low band, new condx, matching serial numbers - $750. Carl Bloom, (714) 639-1679, 3778111@MCIMAIL.COM

FOR SALE: Parts, tubes, books, ect. Send two stamp SASE or email for list. Wayne LeTourneau, POB 62, Wannaska, MN 56761. wb0cte@arrl.net

BUY, SELL, TRADE: Classic ham equipment at the K8CX Ham Gallery http://hamgallery.com

FOR SALE: Connectors (AN/MS, rack/panel, Blue Ribbon, Jones, etc); meters, relays, parts, list - $1. Joe Orgnero, VE7LBI, 1349 Leask Rd., Nanaimo BC V9X 1P8 Canada joseph@pacificcoast.net

FOR SALE: 115-230 volt round emblem 516F-2 serial 20636 serviced to the standard, pg 10, Electric Radio, February 1998, scratch free cabinet, US parts, test report, manual furnished - $300. Ed, 8245 Garden Oaks Dr., San Antonio, TX 78266. (210) 651-9348

FOR SALE: HQ170/180 AC/ON/OFF switch - $25; Drake mic plug R/A - $9; tubes pair 811 - $50; (3) 6CA7 - $70; all shpd. John, W8VBQ, 6015 Scotch Pine Dr., Milford, OH 45150.

FOR SALE: OEM Heath belts - $2.50 each shpd; or 10+ for $2 each shpd. Send check or money order. Roberta Hummel, 202 Midvale Dr., Marshall, WI 53559

FOR SALE: Radio, TV tubes NOS, send want list & SASE. Dan Hill, POB 49, Dixmont, ME 04932. (207) 234-2315

FOR SALE: Manuals for old ham gear of the '30s to the '70s. Check WEB Catalog www.hi-manuals.com

FOR SALE: T-Shirts 4 Color 807 Tube - $18.07ppd Priorty Mail (CA-$19.43), S, M, L, XL (XXL-+$3) See ER#128 pg 52. http://members.aol.com/tcsopr/ mouspads, buttons, hats, etc. Greg Greenwood, WB6FZH, POB 1325, Weaverville, CA 96093. msg# (707) 523-9122. wb6fzh@arrl.net

FOR SALE: Swan 500CX w/matching 117XC sply/spkr, 8950 finals - $250. Bob, KD9GI, Rockford,IL (815) 332-9520, KD9GI@aol.com

FOR SALE: Collins 75A2, exc; 75A3, 3.1kc & 800hz filters, good to exc; 32V2, ruff, manual copies, extra 4D32's, extra new K301 relay; 10" Collins spkr. Prefer sell as a package. Lys, KØPGM, 13495 W Center Dr., Lakewood CO 80228. (303) 986-5420, K0PGM@ARRL.net

FOR SALE: Book: Audel Diesel Engine Manual-$11 ppd. R.J.Eastwick, W2RJE, 400 N. Haddon Ave., Unit 109, Haddonfield NJ 08033. (856)429-2477

FOR SALE: Viking 500 manual - $40; crystal radios - $40; Heath VTVM - $30; signal tracers/generators - $20. Carter Elliott, (804) 979 7383, CElliott14@aol.com

FOR SALE: National vernier dials N, AM, MCN - $22 each postpaid in lower 48. David W. Burns, 5709 Dun Horse Ln., Derwood, MD 20855. (301) 963-0122, daburns926@aol.com

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

FOR SALE: E. F. Johnson small black fluted knob w/o white dot - $3. **WANTED:** 1947-70 Johnson amateur catalogs. Bruce Hering, 41120 State Highway 13, Waseca, MN 56093. bhering@efjohnson.com, (507) 835-5619

FOR SALE: Transformers for Collins 32V3, Hallicrafters HT9, BC610 & RF xfmrs for Hammarlund SP600. Roland V. Matson, POB 956, Lake Panasoffkee, FL 33538

FOR SALE: Older type electronic parts & hardware; free vintage flyer. Mail order since 1954. Bigelow Electronics, POB 125, Bluffton, OH 45817

FOR SALE: Meters, mostly new, all sizes & shapes. SASE for list. Bill Riley, 863 W 38th Ave., Eugene, OR 97405. (541) 345-2169

FOR SALE: VM parts, new boxed electron tubes, new Heathkit parts, new panel meters. Norm, 1440 Milton St., Benton Harbor, MI 49022

FOR SALE: Mostly complete years QST from 1960 or so. Moving and don't want to move. Make offer. Dennis Olmstead, WB9EMD, 431 Ridgewood, Glen Ellyn, IL 60137. (630) 469 0531, wb9emd@aol.com

FOR SALE: Thordarson C.H.T. TMIIM78 Multi-Match 500 watt mod xfmr in great condx - $195; special - Stancor A-3896 KW plus multi-match mod xfmr, pair of 810's and sockets and matching driver xfmr - $249. Also have complete, unmodified T-368 pwr sply deck, a great buy at $195, but pickup at my QTH necessary. For detailed info, call Mike Ruggiero, W2NVR, Saylorsburg, PA, at (610) 381-3211, w2nvr@ptd.net

FOR SALE: 40's Radio 1920-1930 period: horn spkrs, headphones, tubes, parts, etc. Like to sell entire collection to one person, SASE for listings. Lawrence Gross, 11040 70th St., S. Cottage Grove, MN 55016. (651) 459-3233.

FOR SALE: National NC300 - $150; Hallicrafters SX101 MK III - $175. Jim, 13549 Morse Rd., Pataskala, OH 43062. (740) 927-2592

FOR SALE: Tecraft model CCS-220 converter, (1) tube missing, untested, complete - $20 inclds shpg. Louis L. D'Antuono, 8802 Ridge Blvd., Brooklyn, NY 11209. (718) 748-9612 after 6 pm

FOR SALE: Philmore home made xtal sets; mint Knight 600 series tube tester. Bill Coolahan, 1450 Miami Dr. NE, Cedar Rapids, IA 52402. (319) 393-8075

FOR SALE: National NC-183D w/spkr; Hallicrafters SX-71. Both wrkg - make offer. Ed Van Vleet, CA, (530) 529-4875.

WANTED: Collins - Amateur catalogs, sales literature, manuals, promotional items & Signals. Richard Coyne, POB 2000-200, Mission Viejo, CA 92690.

WANTED: Howard radios of any type. Andy Howard, WA4KCY, 105 Sweet Bay Ln, Carrollton, GA 30116. wa4kcy@usa.net

WANTED: For purchase. Equipment & technical information related to AN/ARN-6 Radio Compass. Jim Cavan, 6 Timberline, Norfolk, MA 02056. (508) 528-0908, jcavan56@aol.com

WANTED: SW3 #33A and #35 coils. I will trade my extra coils SW3 coils. Hank Bredehorst, 2440 Adrian St., Newbury Park, CA 91320. (805) 498-8907

WANTED: Parts for a TMC GPT-750 xmtr. I need the AM modulator deck and other parts to restore this unit. John, KF2JQ (716) 873-0524 jprusso@acsu.buffalo.edu

WANTED: Long wire ants AT101, AT102, GRC-9; DY88/105; PP327GRC9; counterpoise CP12 & 13 GRC9; BC348 pwr conn PLQ102/103. KA1ZQR, 348 N. Main St., Stonington, CT 06378.

WANTED: Globe King 500 B/C; Viking Valiant I/II; Viking 500; Heathkit Mohawk. Frank, (916) 635-4994, frankdellechaie@sprintmail.com

WANTED: National Company emblems, escutcheons, WW II era equipment. Will trade HRO coils or purchase. Don Barsema, 1458 Byron SE, Grand Rapids, MI 49506. DBARSEMA@prodigy.net

WANTED: WW-2 Japanese military radio of any kind. Yokohama WW-2 Japanese Military Radio Museum, Takashi Doi, 1-21-4, Minamidai, Seyaku, Yokohama 246 Japan. Fax 011-8145-301-8069. takadoi@carrot.ocn.ne.jp

WANTED: Noise silencer for Hammarlund HQ-170/180 receiver. Ed, N5BFW, (817) 222-5355, ecuevas@juno.com

WANTED: T / R switch for use with Johnson Ranger. 115 VAC coil required. With or without auxiliary contacts. Bill Evans, VE4UD, (204) 489-7467 or bevans@ebsys.mb.ca

WANTED: SAMS auto radio series numbers AR-9, 10, and 12. Jack Iverson, 1110 N Old Mill Rd., Palatine IL 60067. Jackiv@juno.com

WANTED: Westinghouse MW-2 pwr sply; BC-221; BC-603; DX-100; DX-60; Teletypes Models 15 and 28; SP-200. Gary, WA4ODY, POB 58506, Houston, TX 77258. (281)-291-7701, pycckuu@gateway.net

WANTED: B&W 5 pin plug in coils, models: JCL, JVL, MEL, MCL; any low band, any condx. Trying to get my old rig working again. Jim Riff, K7SC, 9411 E. Happy Valley Rd., Scottsdale, AZ 85255. (480) 473-1093, k7sc@cybertrails.com

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

WANTED: Heath Gear, unassembled kits, catalogs and manuals. Bill Robbins, 5339 Chickadee Dr., Kalamazoo, MI 49009. (616) 375-7978, billrobb@net-link.net

WANTED: I wish to correspond with owners of National FB7/FBXA/AGS coil sets. Jim, KE4DSP, 108 Bayfield Dr., Brandon, FL 33511. j.c.clifford@juno.com

WANTED: British, Commonwealth W.S. 62, W.S. 22, W.S. 18, W.S. 48, W.S. 46. George Rancourt, K1ANX, MA, (413) 527-4304

WANTED: Contact w/Bendix fans, especially those working on the TA-12 xmtr & the RA-10 or similar rcvrs. Sam Kelly, W6JTT, CA, (714) 893-2092 or skellycp@aol.com

WANTED: PreWW-II Iowa QSL cards; materials of 1920s Iowa Radio Relay League. Will trade or purchase. Bill Smith, W5USM, w5usm@aol.com

WANTED: HF-300 tubes. Don Chester, K4KYV, 2116 Oldover Rd., Woodlawn, TN 37191. (931) 647-2179, k4kyv@hotmail.com

WANTED: Hallicrafters SX88 or SX115. Larry Redmond, 413 Bedfort Dr., Duluth, GA 30096. (770) 495-7196

WANTED: Oddball old 1930s military radio control and junction boxes. BC-177, BC-214, BC-235, etc.. William Donzelli, 15 Gen MacArthur Dr., Carmel, NY 10512, (914)225-2547, aw288@osfn.org

WANTED: National NC-240D, NC-183D, NC-400; Multi-Elmac PMR 8 and AF 68, Frank, KBØW, (916) 635-4994, frankdellechaie@sprintmail.com

WANTED: Galaxy LA-550 amp, any condx. All cards answered. Kelley, W8GFG, 9010 Marquette, St. John, IN 46373. (219) 365-4730

WANTED: Manual for Collins 20V-2 AM 1 KW broadcast xmtr. H.P. Boone, W4YVX, FL, (904) 471-0812.

WANTED: Johnson Ranger II in exc condx for personal use. Richard N. Pann, 2447 Yates Dr., Augusta, GA 30906. (706) 798-7279

WANTED: National SW-3 model1, version 3. Uses 32-32 30 tubes. Dean Showalter, W5PJR, 72 Buckboard Rd., Tijeras, NM 87059. (505) 286-1370

FOR SALE: Hallicrafter's manuals, copies starting at $5, some Johnson, WRL, others. SASE for list. DSM Diversified, 909 Walnut St., Erie, PA 16502.

FOR SALE: Military radio TM's, origs & reprints. New list. Send $1 & address label to Robert Downs, WA5CAB, 2027 Mapleton Dr., Houston, TX 77043-2410. (713) 467-5614

FOR SALE: I repair all tube type amplifiers. Licensed in 1955. Steve Gross, N4PZ/W9OJI, IL. (815) 734-4255

FOR SALE: 51J-4 filter replacements, direct plugin—6.0 kc Collins mech. filter, 500 cycle xtal latice - $215 each. Chuck Felton, KDØZS, WY, (307) 322-5858, feltoned@coffey.com

FOR SALE: Collins 51J series drum overlay - $10 ea, specify which. Ron Hankins, KK4PK, 555 Seminole Woods Blvd., Geneva, FL 32732. (407) 349-9150

FOR SALE: Homemade galena xtal radios, SW or BC. Pix available, also parts. Len Gardner, 458 Two Mile Creek Rd., Tonawanda, NY 14150.

FOR SALE/TRADE: Transmitting/rcvr'g tubes, new & used - 55¢. LSASE for list. I collect old & unique tubes of any type. **WANTED:** Taylor & Heintz-Kaufman types & large 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, johnh.walker@honeywell.com

FOR SALE: New Release. For details send 2-stamp LSASE to: Olde Tyme Radio Co, 2445 Lyttonsville Rd. Ste 317, Silver Spring, MD 20910

FOR SALE: New WD-11 replacement tubes - $15 ea + $3.20 priority shpg for 2 or more. James Fred, 5355 S 275 W, Cutler, IN 46920.

FOR SALE: Drake 2BQ - $75; Heath HS-24 - $20; 6005 (6AQ5W tubes 5 for - $10; xfmrs NOS 5 VCT 15A secondary, 220V PRI, 2.5V out at 110V in - $8 ea; BC442 ant relay unit w/meter NIB - $30; Hammarlund spkr for HQ-170 etc exc + - $95; Brush BA-106 mic NIB - $60. William Ernst, 16300 Campbell Rd., Commins, MI 48619. (517) 848-5002

FOR SALE/TRADE: BC-654 wrong case, otherwise complete - $250; BC-611F, very good condx trade for S-39 in same condx; BC-1000 nice shape w/ ACC - $250; SX-25 w/matching spkr - $250; scrap BC-348 - $20 ea; Waterman scope - $25; misc telegraph, equip - $125; RU-19 equip w/coils - $275; British T-115 4 xmtr, fair condx - $350; RA-120 pwr sply - $150. Steve Bartkowski, 4923 W 28 St., Cicero, IL 60804

FOR SALE: 10-101 Heath vectorscope w/manual - $75; 1938 Webber signal generator, nice, w/ manual - $75; Rider Trouble Shooting manuals. Bruce Beckeney, 5472 Timberway, Presque Isle, MI 49777. (517) 595-6483

FOR SALE: WACO-5NWX telephone filters. Just plug in. 1/$13.95, 2/$25, 3/$34. Money back. Cecil Palmer, 4500 Timbercrest Ln., Waco, TX 76705. (254) 799-5931, w5nwx@juno.com

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: "Complete Guide To WWII Military Communications Equipment", 117 pg info on almost all WWII equip. - $15 + $2 domestic mail. Sam Hevener, W8KBF, 3583 Everett Rd., Richfield, OH 44286-9723. (330) 659-3244

FOR SALE: Convert any wattmeter to read PEP! Perfect for AM/SSB - $19.99 ppd for complete kit! HI-RES, 8232 Woodview, Clarkston, MI 48348. (248) 391-6660, hires@rust.net

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

FOR SALE: Repair, upgrade, performance modification of tube communications & test equip. Accepting most military, all Collins & Drake designs, & the better efforts from others. Laboratory performance documentation on request. Work guaranteed. Chuck Felton, KDØZS, Felton Electronic Design, Box 187, Wheatland, WY 82201. (307) 322-5858, feltoned@coffey.com

FOR TRADE: Two good RCA 833A's for one Taylor 833A; also looking for Taylor 204A, 813, 866B. John H. Walker Jr., 13406 W. 128th Terr., Overland Park, KS 66213. (913) 782-6455, johnh.walker@honeywell.com

FOR SALE: Old rcv'g tubes: 36 unboxed, 37 good - BO. Send/list. Bierley, 61 Massey, Westerville, OH 43081. (614) 794-0834

FOR SALE: Measurements model 59 grid dip osc, as new - $150; National RBL-2 & NC 120 - $175; Clegg 22er, working, clean - $75. Stuart T. Carter II, W4NHC, 680 Fernwood Dr., Melbourne, FL 32904. (321) 727-3015

FOR SALE: Full yr QST 1936 - $30 shpd USA. Tom Berry, W5LTR, 1617 W. Highland, Chicago, IL 60660. (773) 262-5360, 262-0016

FOR SALE: CVM-5 modulation xfmr, good condx - $225. Joel, W4SLH, 337 Compass Point Dr., Oriental, NC 28571. (252) 249-2344

FOR SALE: BC-342N; Swan 270B; Dumont Fairco Mark III (freq meter); Yaesu FT901DM; Pegasus 550. Make offer. Roger, OH. (513) 451-1096.

FOR SALE: Heath VTVM model V7A; Paco 12VDC pwr sply - $25 ea + shpg. Robert Martin, 111 Bancroft, Rochester, NY 14616. (716) 663-4182

FOR SALE: Raytheon RA-1000 1 kw, spare parts - $500 or BO; Collins 32-V3 w/manual, mint - BO. Rich, CA. (960) 739-1835.

WANTED: Hallicrafters Village/Hamlet radios TR-5/TR-20 & Gonset Civil Defense 6m radios/ accessories, manuals also. Daniel Cahn, 3444 Greenwood Ave., Los Angeles, CA 90066. Fx/msg (310) 398-7159 or danielc411@aol.com

WANTED: Cash for Collins: SM-1, 2, 3; 312A-1, 2; 55G-1; 399C-1; 62S-1; KWM-1; 302C-3; 51S-1; 75S-3C; 32S-3A. I buy any Collins equip. Leo, KJ6HI, CA, Ph/Fx (310) 670-6969. radioleo@earthlink.net

WANTED: QSL cards from old/pre WW II Ham DX countries; old regen kits. Hajime Suzuki, Nishikuniyoshi 1644-24, Ichihara-Shi, Chiba-Ken, 290-0231 Japan

WANTED: Western Electric horns, spkrs, amps, mics, theater equipment. Barry Nadel, POB 29303, San Francisco, CA 94129. bnadel@ccnet.com

WANTED: Mics: Astatic JT 30/40; UT-48; Shure CR80/81/41; 707A; Turner VT-73; CD/BD, parts for same. Tom Ellis, Box 140093, Dallas, TX 75214. (214) 328-3225. tomsmics@flexcomp.com

WANTED: Stancor/Chicago PCC200, PCO/P50150, RC8150; Triad A-9-J, A-10-J, A-11-J, A-12-J. **FOR SALE:** Books, send SASE. Richard Robinson, POB 1425, Wallingford, CT 06492. (203) 949-0871, richmix@erols.com

WANTED: National FRR-59, Hallicrafters SX73; Scott Special Communications rcvr. EA4JL, please call, Kurt Keller, CT, (203) 431-6850

WANTED: Small 1" panel meters, especially DC ammeters. Send price info. Chris Cross, POB 94, McConnell, IL 61050

WANTED: Bug with a 3 inch wide black or grey base. MacElroy bug. Brian Roberts, K9VKY, 130 Tara Dr., Fombell,PA 16123. (724)758-2688 K9vky@stargate.net

WANTED: Zenith 121-872 or 121-00950 transistors. No longer available. (no sub please) Jack, AZ, (520) 634-2028

WANTED: Kleinschmidt teleprinter models: 311, 321, (AN/FGC-40, AN/GGC-16, AN/UGC-39...) Tom Kleinschmidt, 506 N. Maple St., Prospect Hts., IL 60070-1321. (847) 255-8128

WANTED: Military survival communications equip: radios, beacons, manuals, books, historical info/photos. Daniel Cahn, 3444 Greenwood Ave., Los Angeles, CA 90066. (310) 398-7159. danielc411@aol.com

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

WANTED: RCA 140, 141, AVR5A. GE K80, K80X, K85. Any condx. James Treherne, 11909 Chapel Rd., Clifton, VA 20124. treherne@erols.com

WANTED: Tube-type Hi-Fi & guitar amplifiers by ACRO, EICO, Fender, Marantz, McIntosh, Pilot, Triad, UTC. Rob, CA, (510) 845-2625.

WANTED: Seeking unbuilt Heathkits, Knightkits. Gene Peroni, POB 7164, St. Davids, PA 19087. (610) 293-2421

WANTED: Ampex tube type decks, mixers, amps. George, OH, (216) 486-6489, blksub480@yahoo.com

WANTED: Watkins-Johnson or Communications Electronics Inc. info, catalogs, manuals or equipment. Terry O'Laughlin, WB9GVB, P.O. Box 3461, Madison, WI, 53704-0461, 608-244-3135

WANTED: AM1088 VHF Amp; P/O MT1088; Ant. AS-2887/UR; Pack CW-1005/UR; MK-1517/UR for R1518/URR-71. Steve, milspec22@aol.com or (480) 962-0220

WANTED: QST's before 1936 and various years ARRL Handbook for personal collection. Gary Yantis, WØTM, 800-844-9860, gary@w0tm.com

WANTED: Drake 1A rcvr; 399C1 Collins VFO; JRC 505 twins. K5YY, AR, (501) 756-5010. k5yy@arrl.net

WANTED: GF-11 & GF-12 aircraft xmtr equip. Mike, WØBVA, 305 N. Keith St., Scammon, KS 66773. (316) 479-2756

WANTED: Top $ for Philmore CR5A RX, international xtal 80/40 xmtr, WRL, CW7, xmtr. Gary Wagner, K3OMI, TN, work # (865) 690-4217

WANTED: RBB/RBC rcvrs, pwr splys, cables & RAK/RAL equip. Andy Miller, KD6TKX, CA, (831) 484-2389, amillertkx@aol.com

WANTED: BC-375/BC-191 xmtr; BC-611. Pete Hamersma, WB2JWU, POB 467, Holderness, NH 03245

WANTED: Restoration parts for an SX-28, HQ-129X, Morrow MB-4, SBE-34, & National NC100A. Robert, rboyceh@gte.net

FOR SALE: Various parts for homebrewing. List at: http://home.earthlink.net/~af4k/trade.htm FREE: Buy/Sell crystals at: http://pluto.beseen.com/boardroom/b/21532/ Brian Carling, AF4K, af4k@earthlink.net

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

FOR SALE: Repro Nameplates, R-390A generic - $9; 51J-3 and 51J-4 exact replicas - $12. Tom Marcotte, N5OFF, 242 Chestnut Oak Dr., Mandeville, LA 70448. marcotte@iamerica.net

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FOR SALE: HQ-110 AC-VHF - $325; SX-11 - $400; Morrow CM-1 - $30; Lionel J-36 - $125; Vibroplex J-36 - $140; Johnson Signal Sentry - $50; Johnson SWR - $60; Ameco VFO - $55; Gonset VFO - $75; LaFayette HA-410 - $150; Subraco 10 meter xmtr - $95; coax relays - $35; R-175A plate chokes, new - $33. Free list. Richard Prester, 131 Ridge Rd., W. Milford, NJ 07480. (973) 728-2454, rprester@warwick.net

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FOR SALE: Signal Corps rack FT-244A, type 5009A radio equip., a gold mine of beautiful radio parts & tubes - $30 + shpg. Bill Riley, W7EXB, 863 W. 38th Ave., Eugene, OR 97405.

FOR SALE: ARRL Handbooks, all thru 1995, except ed's 4, 5, 8, 14, 15 & 16. Most in good to exc conds. Jim McCobb, W1LLU, 65 Coffin St., W. Newbury, MA 01985. (978) 363-1619. w1llu@worldnet.att.net

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FOR SALE: Repair! Radio repair, tube or solid state. Reasonable charges. J. Dan Rupe, W7DDF, 998 Whipple, POB 697, Grayland, WA 98547. (360) 267-4011, w7ddf@yahoo.com

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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

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FOR SALE: Collins drum overlays. 75A-2, 3, 51J#. For 75A-4 & KWS-1, specify new/old - $8.50 ea. 2/$15 ppd. Correct colors. Charlie Talbott, K3ICH, 13192 Pinnacle Ln., Leesburg, VA 20176-6146. (540) 822-5643.

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

FOR SALE: Strong steatite antenna insulators. Lengths from two to fifteen inches. SASE for list. John Etter, W2ER, 16 Fairline Dr., East Quogue, NY 11942. (516) 653-5350

FOR SALE: Dial/clock covers. Send bezel, old or drawing, make/model, guaranteed satisfaction - $10 ppd. William P. Turner, WAØABI, 1117 Pike St., St. Charles, MO 63301. (314) 949-2210

FOR SALE: T-Shirts w/Johnson Viking logo - $15, state size. Viking Radio Amateur Radio Society, POB 3, Waseca, MN 56093.

WANTED: National HRO black wrinkle spkrs, oak coil boxes, coils; Western Electric horns, spkrs, amps, mics. Barry Nadel, POB 29303, San Francisco, CA 94129. bnadel@ccnet.com

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

WANTED: Mohican; SB-200; SB-220; SB-100; SB-101; SB-102; Knightkit Band Spanner II; Heath GW-12A; GW22A; GW42. Debbie, AR, (870) 857-3366.

WANTED: New or used unmodified BC459A, BC696, T18/ARC/5, T19/ARC/5, CBY52232. Louis Lytch, K2DET, 117-33 230th St., Cambria Heights, Jamaica, NY 11411-1806. (718) 528-5065

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

WANTED: Collecting military electronics including radio, radar, RDF and test, manuals & literature. William Van Lennep, POB 211, Pepperell, MA 01463. (978) 433-6031

WANTED: Tube type shortwave converters, preferably pre-war. David L. Muse, 510 Minturn Ave., Hamlet, NC 28345

WANTED: WW II Japanese xmtrs & rcvrs (parts, plug-in coils) for restoration & ER articles. Ken Lakin, KD6B, 63140 Britta St., Ste. C106, Bend, OR 97701. (541) 923-1013. klakin@aol.com

WANTED: Postcards of old wireless stations; QSL cards showing pre-WWII ham shacks/equip. George, W2KRM, NY, (631) 360-9011, george2f@aol.com

WANTED: Owners manual, schematic, etc for Hughes Mitchell, X-EC frequency control (VFO); bottom cover for SX-25 Super Defiant. John Micsak, 1549 Shoecraft Rd., Penfield, NY 14526

WANTED: Navy xmtrs: MQ, TCA, TCE, TCN, TCX, TDE; rcvrs: RAW, RAX, RBD, RBJ. Steve Finelli, 37 Stonecroft Dr., Easton, PA 18045. (610) 252-8211. navrad@enter.net

WANTED: Tektronix memorabilia & promotional literature or catalogs from 1946-1980. James True, N5ARW, POB 820, Hot Springs, AR 71902. (501) 318-1844, Fx 623-8783, james.true@ibm.net

WANTED: Cash for Collins: SM-1, 2, 3; 55G-1; 62S-1; 399C-1, 51S-1; 75S-3A, C 32S-3A; any Collins equip. Leo, KJ6HI, CA, ph/fx (310) 670-6969, radioleo@earthlink.net

WANTED: TMC GPT-750, TAC Tuner, GPR-90/92 & GSB-1. Alan Gray, W3BV, PA, (215) 795-0943.

WANTED: Hallicrafters S-39 rcvr Skyranger. Bob, K1YJK, CO, (303) 768-9200, k1yjk@arrl.net

WANTED: Hallicrafters HT-1, HT-9, HT-31, 5-T, SX-11, SX-17, SX-25; Howard rcvrs; Harvey xmtrs. Ken Seymour, KA7OSM, 9115 SW 176th Ave., Beaverton, OR 97007. (503) 306-7439 24 hrs. ken.seymour@attws.com

WANTED: 80 & 40 meter xtals in FT243 holders. Howard Weinstein, K3HW, 4041 Ridge Ave. Apt 4-405, Philadelphia, PA 19129. (215) 843-1180. k3hw@arrl.net

WANTED: Merchant ship radio memorabilia, radios, keys, parts, clocks, documentation. Tom Mackie, W2ILA, 14 Washington St., Jamestown, RI 02835. (401) 846-1200

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

WANTED: Electric Radio; Antique Radio Classifieds; Old Timers Bulletin. Alan Mark, POB 372, Pembroke, MA 02359.

WANTED: Mallory Sta-Loc controls, plug-in shafts & AC switches. One or 100. James Fred, 5355 S 275 W, Cutler, IN 46920. (765) 268-2214

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

FOR SALE: Johnson panel, cabs, refinishing. Done in same finish as new cars. Valiant-1 - $285. Ranger-1 - $250. + shpg. Visa/MC/Am-Xp Dee, W4PNT, Virginia, (540)249-3161 or cel pho:(540)471-7023,http://home.rica.net/soundmind/ for pics

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

FOR SALE: Marine Radio RCA MI type CRM P2A-5 - $50; hetrodyne frequency meter type CRR—74028, added eye w/book - $45; Mallory retro pwr sply mod 12RS6D 6&12V -$40; Heath (Canterna) mod HN-3 gallon can, color A-10 - $25. Bernie Samek, 113 Old Palmer Rd., Brimfield, MA 01010. (413) 245-7174, fx -0441

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

FOR SALE: Military Radios, etc. E-mail N1UDH@IDT.NET for a List or SASE. Ronnie Parker, 1357 Bridgeport, CT 06601-1357

FUNDRAISER: Museum expansion. Needed: Old dud tubes you can spare. Tax deduction documentation provided. National Atomic Museum, R. Barry King, KB5KCG, Docent, Kirtland AFB, PO Box 5800, Albuquerque, NM 87185. (505) 836-6044

FOR SALE: Copies: Hard to find schematics for radios, also kit radios 1922-1950; manuals: test equip. ham gear. Contact me for prices, availability. Duane Ballew, KB7QZK, 6813 152nd St. Ct., NW, Gig Harbor, WA 98332. (206) 851-4505

FOR SALE: Books, radio parts, galenas, galena xtal radios. Free lists. Len Gardner, 458 Two Mile Creek Rd., Tonawanda, NY 14150

FOR SALE: NOS mica caps; Cornell dubilier; Sanamos 8-pin octal ceramic; ceramic switch; relys 120-230V, lots more. Joe, CA, W6CAS, (916) 731-8261.

WANTED: RF & detector coils for any model National SW-3. Leland Smith, W5KL, 10 Hawthorne Dr., Harrison, AR 72601. w5kl@alltel.net

WANTED: BC-375/BC-191 xmtr; BC-611. Pete Hamersma, WB2JWU, POB 467, Holderness, NH 03245.

WANTED: Electronics, radio (cables for TCS), nav, SO radar for WW II PT boat. Roger, PA, (610) 998-0380

WANTED: RF amplifier module 2A2A4 for T827F/URT; also AM3007 amplifier. Don, WA2ELD, 1653 Wyatt Parkway, Lexington, KY 40505. (859) 254-1886

WANTED: Manual or schematic for McMurdo-Silver signal generator model 906. Bob Carlton, K8RTV, 14030 Nash Rd., Burton, OH 44021. (440) 834-8047

WANTED: Oddball old 1930s Army and Navy dynamotors. Any condition, any weight! William Donzelli, 15 Gen MacArthur Drive, Carmel, NY 10512, (914)225-2547, aw288@osfn.org

WANTED: Test equipment & tube audio amplifiers. Mike Nowlen, WB4UKB, 2212 Burgee Ct., Reston, VA 20191. mike@3dnet.com

WANTED: Collins 70K-2 PTOs working or not; IN82A diodes; Bretting 14/14AX manual. Clark, W0BT, KS, (785) 286-2132

WANTED: Manuals for ASB-5; OE-4/GR; TRN-25; PPS-15B; Ferris 32-D; Sienna 305A; RCA 308A. Wm Van Lennep, POB 211, Pepperell, MA 01463. (978) 433-6031, anaps4@aol.com

WANTED: Collins 310B, basket case OK - welcomed; & Chicago 500W CMS-2 high-level modulation xfmr; Taylor T21. Jerry, W8ECD, CO, (303) 979-2323

WANTED: Ex-Sparks looking for WW II Merchant Marine radio room 2400 hour clock. George Marts, W9TDH, 5022 Pennsylvania, St. louis, MO 63111. (314) 353-7669

WANTED: Transmitters: GO-9 ; TBW; GF11; BC-AR-430; rcvrs: R-1004 part of GRC-109; RR-2B, goes w/xmtr RT-3. Bob Lackey, W4QBE, 1252 Worley Creek Rd., Lakemont, GA 30552

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