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ELECTRIC RADIO

celebrating a bygone era

Number 20 December 1990

ELECTRIC RADIO

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The Purpose of Electric Radio

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

Electric Radio Solicits Material

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

EDITOR'S COMMENTS Barry Wiseman, N6CSW/Ø

Going into the New Year....

We still have the AM power issue to deal with - see KW1I's report on page 3. Dale has filed a Petition for Reconsideration with the FCC in response to their denial of RM-7402 and RM-7404. Personally I'm getting a little 'weary' of this 'AM power issue' but I know we must struggle on. For me, outlawing the 'classic' AM kilowatt - for no reason at all - is a tragedy. One last round... let's all get involved.

This month I decided to lower the number of words in the free subscriber ads from 30 to 25 and to increase the price of additional words from 10 cents to 15 cents. The reason for doing this is two-fold; first of all it raises the revenue from classifieds slightly (we can use the money) and secondly it will tend to make the ads less 'wordy' which will allow placing more ads in the same amount of space. Both the increased revenue and the more efficient use of magazine space is important at this time. I hope everyone understands.

An idea for the holidays.... Jim Musgrove, K5BZH, reminded me the other day that there are very many old-timers in hospitals and resthomes around the country. At this time of year, particularly, they would welcome a visit from another ham. Most of the 'oldtimers' like to reminisce and who better to reminisce with than us 'vintage enthusiasts'. It could be a rewarding experience; please consider it.

Merry Christmas and a happy new year to all... on to #21

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100% Recycled Paper

Cover: Throughout the year Robert Beasley's cartoons enrich, enliven and add 'class' (as in classic) to the pages of ER and then at Christmas (this is the second Christmas cover he's doné) we are treated to some great graphic art. Thanks Bob.

Reflections Down the Feedline

by Fred Huntley, W6RNC
POB 478
Nevada City, CA 95959

A lot has been said about acquiring old AM radio equipment by attending ham swap-meets, as well as by responding to ads in amateur publications. But not much has been heard about 'prospecting' through local non-ham channels.

Out here, in rural Northern California, by 'beating the bushes' I have accumulated a fair amount of old radio gear without ever having attended a hamfest. Almost all of this has been found through local newspaper advertisements - either by ones that I have inserted or by reading ads put by others in the miscellaneous section; in the daily paper or the weekly give-away shopping news.

My first attempt was 8 years ago, when I invested one dollar for an ad in "The Swapper" - a 3 sheet shopping paper - looking for Johnson amateur equipment. A local realtor who was a novice ham phoned me that he had two Viking Valiants. They had been in CB use and were inoperative. I took a chance and forked over $75 apiece for them. The problems were minor and both were repaired and placed back in operation.

A year later, I placed another want ad in "The Swapper" and received a phone call from an ex-ham who had some radio parts. I went out to his location five miles out of town. He was in the process of building a home, and there out in the middle of the woods, were several large piles of radio transmitter components sitting on the ground, underneath black plastic tarps. It turned out that he was an ex-surplus dealer and had kept some of his inventory for a possible ham station. I traded a new Coleman lantern and a few other non-ham items for a large Cardwell split stator capacitor, several Johnson transmitting variable capacitors, a BC-306A antenna tuner and some receiving type variable capacitors.

That wasn't the end of it. Four years later this fellow called me on the phone and asked me if I wanted all the rest of his stuff - or it was going to the dump. So I went over and loaded up my Jeep Wagoneer stationwagon to the gills. There were several large HV plate transformers, 2 military rack mount HV power supplies, various other large chokes and transformers and many HV filter capacitors of various sizes. There were some cabinets and other stuff as well. The rear end of my car was really sagging under the load, even though I had heavy duty springs. Amongst the stuff was a never used UTC VRM-5 600 watt varimatch modulation transformer. Later on, I traded it to K2LYC in New Jersey for a GPR-90-RXD military receiver which I repaired and restored to operation.

Another time, there was an ad in the local newspaper about a garage sale. I went over and it turned out the fellow was a technician class ham with a few 'boat anchors' he wanted to get rid of. I asked him why he didn't fix the equipment and use it himself. He replied that he wanted a modern solid state radio. So I gladly gave him the $5 that he asked for an original HRO with power supply, a Hallicrafters SX-100, a Hammarlund rack mount power supply and 2 power transformers. The SX-100 didn't need anything but a clean-up. On the HRO, I had to replace all the old tubular paper capacitors and it now works fine.

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AM Power Issue Update

by Dale Gagnon, KW1I
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Bow, NH 03304

Petition for Reconsideration submitted

A petition for reconsideration of the FCC denial of petitions RM-7402 and RM-7404 was submitted by KW1I during the month of November. The reconsideration request was based on these issues:

1) The petitions have been incorrectly characterized as petitions to promote AM use by allowing two to four times the power allowed other emissions.

2) The evidence for increased AM emission use since the early 1980's has been minimized.

3) The commission has not acted consistent with it's previous statements concerning special consideration based on interest in the AM mode.

4) The commission has ignored the economic impact on amateurs who have high power AM transmitters made obsolete by the expiration of the Part 97. 313 grandfather clause.

5) Alternative commission actions are available that are harmless to operators of high power AM equipment and to the Commission, other amateurs and the general public as well.

The reconsideration request detailed these problems and others on a paragraph by paragraph basis. It's suggested that one of the petition's proposed power rules be adopted. Failing that, I suggest that the Commission should establish another grandfather period while they reconsider the matter and continue to test the interest in AM.

The petition for reconsideration will probably be sent to the same people in the Personal Radio Branch who denied the earlier petitions. It is not likely that they will change their minds unless they are directed to by higher authorities.

Concerned AM operators should contact anyone they know with influence in the Federal government. For most of us this means contacting our Congressman. Up to this time congressional inquiries to the FCC on this issue have received the standard answer from personel radio branch staffers, that they are dutifully following administrative rulemaking procedures. Now we actually have a situation that has been mishandled by the FCC and we can ask our Congressman to intervene. Use the following points when you ask for their help.

1) Over one thousand amateurs who operate the familiar mode of amplitude modulation - AM - are having their earned privileges reduced in order to "tidy up the amateur service rules on power measurement". Petitions requesting these historic power privileges have recently been denied by the FCC. One of these petitions was filed by the ARRL, the largest amateur radio organization in the United States representing over 150,000 licensed amateurs. These petitions received overwhelming positive support during the public comment period.

2) This 50% reduction of maximum allowed power changes the power limit that has been in place for over half a century. The burden falls hardest on senior citizen amateurs some of whom have operated their transmitters for decades. This is especially unfair because many of these senior citizens do have the means to modify their transmitters to comply with the reduced power limits.

3) In contrast to many FCC actions where there are two opposing parties AM enthusiasts seeking continuation of

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ELECTRIC RADIO IN UNIFORM

by Walt Hutchens, KJ4KV
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Arlington, VA 22207

"The R-392/URR"

The one or two watt Army portable radios covered in previous columns (the PRC-25, E.R., September 1990 and BC-222, E.R., November 1990) have effective ranges of at most a few miles. For somewhat longer ranges, higher power VHF FM sets are used -- such as the SCR-508/608 and the current VRC-12 series. However, larger Army units (such as a division, 15,000+ men) and rapidly moving forces (such as tanks and mechanized infantry) can be spread over distances which are beyond the range of such equipment. Sets for these applications must be still more powerful, and since towns, mountains and jungles can get in the way of VHF signals, HF must be used.

Army medium power (50 to 100 watt) HF radios can be divided into four groups:

Prewar sets -- SCR-177, 188, and 193 (BC-191 transmitters with accessories) -- Master Oscillator Power Amplifier technology.

WW-II sets -- SCR-506 (BC-653 transmitter and BC-652 receiver) which includes a buffer amplifier.

Postwar sets -- GRC-19 and 46 (T-195 transmitter, R-392 receiver) having very stable conventional VFO's.

Modern sets -- GRC-106 and later sets having crystal stabilized oscillators. These sets are designed primarily for SSB and FSK operation.

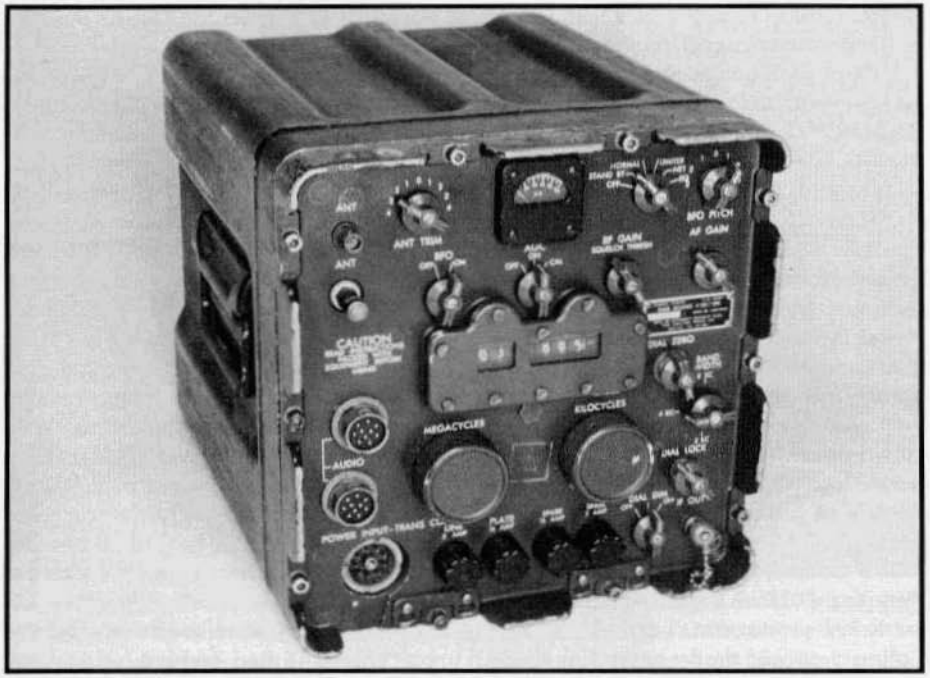
The postwar sets are especially interesting because they represent the highest point of VFO and AM development in U.S. military radios and because they were the first to show what was learned during the war about the conditions in which such radios had to operate. This month we'll study the R-392, which was the first high-quality receiver I used as a reactivated AM'er and which has been a part of KJ4KV ever since. In preparing this article, I was fortunate to be able to interview George Stevens, WOATA, who was an engineer for Collins Radio with responsibility for testing of the R-392 during the later years of its production.

Overview

The R-392 is the receiver part of the GRC-19. It is essentially a small (and somewhat simplified) R-390. The description in the preliminary technical manual says:

"Radio Receiver R-392/URR is a high performance, compact, rugged receiver designed primarily for vehicular use. The receiver provides reception of radiotelegraph, voice and single-channel FSK radioteletype signals within a continuous frequency range from 500 kc to 32 Mcs. The receiver is immersionproof and sufficiently rugged to withstand parachute delivery when mounted in a 1/4 ton 4x4 truck prepared for parachute drop..."

The receiver is 11.25" x 11.5" x 14" (H x W x D) and weighs 52 pounds. It is a 26 tube superhet and covers the frequency range in 32 one-megacycle bands; the lowest band goes down only to 500 kcs. The frequency is shown on a mechanical



The R-392/URR from the front. Sturdy handles on the sides make it possible to lift what would otherwise be a 52 pound greased pig.

digital counter which is marked at intervals of 200 cps throughout the tuning range. The accuracy of the indicated frequency is specified as +/- 300 cps when the set is calibrated at the nearest 100 kcs crystal check point. This is considerably better than the BC-221 frequency meter, which was still in use in the 1950's!

The R-392 uses triple conversion on the 500 kc to 8 Mcs bands and double conversion on the higher frequencies. It can be connected directly to the T-195 transmitter which then provides power, muting and antenna switching, but it can also be operated alone. There is no provision for remote tuning of the R-392 or for presetting frequencies for quick selection.

History

I don't have written history for the R-392. If one follows the story of multiband military communications receivers, one finds a series of sets – the BC-189, BC-342 and 348, the Army Super-Pro's (BC-779, 794, and 1004) and GRR-5, the Navy HRO's (RAS, RCE), the ARB, the ARR-7 (a repackaged SX-28) – spanning about 1935-1950, which are more alike than different. All use bandswitched (or coil-changed) capacitor-tuned local oscillators; none have sealed oscillator assemblies. As a result, dial calibration and resetability is of the order of a few kcs at 75 meters and more than proportionately worse at higher frequencies.

The mid WW-II development of the PTO (the name applied to the Collins sealed unit permeability tuned oscillator) pointed the way to an entirely new approach which was exploited in a series of radios beginning with the ARC-2 liaison transceiver in 1944. By the late 1940's, the PTO had appeared in several Collins products (among them the early models of the 75A series of receivers and 32V series of transmitters) and a second generation design was in use. The stage was

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set for a group of receivers which would (with minor changes) remain the standard for calibration accuracy until quartz crystal stabilized oscillators appeared in the late 50's.

The new receivers were the R-381 (commercial 51J-2), R-388 (51J-3), R-389, R-390, R-391, and R-392. All are continuous coverage sets of similar electronic design and except for the R-392, all are designed for rack mounting in a protected environment. The R-390 (and its mechanical filter brother, the R-390A) are surely first among these equals; they were the best of the Navy shipboard receivers from 1950 into the '60's and served with the famous T-368 in the later models of the Army's GRC-26 field radio central.

The Collins history book ("The First Fifty Years") gives a starting date of 1950 for R-392 production. It is likely that Collins proposed the set to the U.S. Army as a replacement for the much less capable SCR-506 which had been introduced near the end of WW-II.

I have seen serial numbers in the thousands on several contracts so production was probably in the tens of thousands. The R-392 was built by Collins, Stewart Warner, Western Electric and others. Production ended sometime after 1958; the radio served in Korea and Vietnam. As SSB became the standard, use of the R-392 for voice fell off, but it continued to be used for FSK at least into the early 1980's in some reserve units.

Design

In order to build an R-390 in less than half the space, the mechanical design of the R-392 is unique. The chassis is an open box consisting of a heavy cast front panel, 1/8" aluminum sides, and a 1/16" rear plate. A 3/16" sub-panel holds the many gears associated with the tuning mechanism; the RF subchassis which holds the tunable coils and RF and first and second mixer stages is permanently mounted on this sub panel. A 1/4" horizontal plate divides the chassis box into upper and lower sections.

The RF and crystal oscillator subchassis fill the space above this plate; calibration oscillator, VFO, IF and audio subchassis mount on it from below, giving you a radio which is 'solid' from top to bottom. The calibration oscillator, IF and audio subchassis are removed as a unit but can be separated for replacement; they can be operated on an extender cable for servicing.

Electronically, the one remarkable feature of the R-392 is the plate voltage. Absolutely alone among communications receivers, it uses the 28 volt primary supply as the 'high voltage' for the tubes. This low plate voltage gives lower stage gains, so the R-392 has six IF stages, rather than the three or four which are typical of receivers of this type. But conventional circuits are used throughout -- you just don't find large value plate or cathode bias resistors!

George Stevens says Collins believed that the use of 28 volts on the plates improved reliability by reducing the stress on parts and eliminating the high voltage power supply.

The R-390 series of receivers is the first to cover a wide frequency range with constant bandspread; doing so required a new approach. Typical of the group, the R-392 is a 2 to 3 Mcs receiver (this is called the second tunable IF) with a 32-band crystal-controlled converter ahead of it.

The receiver has two RF stages. Frequencies in the range 8 to 32 Mcs are then converted directly (by a crystal controlled converter) to the second tunable IF frequency. Directly converting the frequencies below 8 Mcs, however, would lead to problems. For frequencies below the second tunable IF, harmonics of the signal frequency would be generated in the mixer and would appear as spurious responses. Signal frequencies above this IF could mix with harmonics of the local

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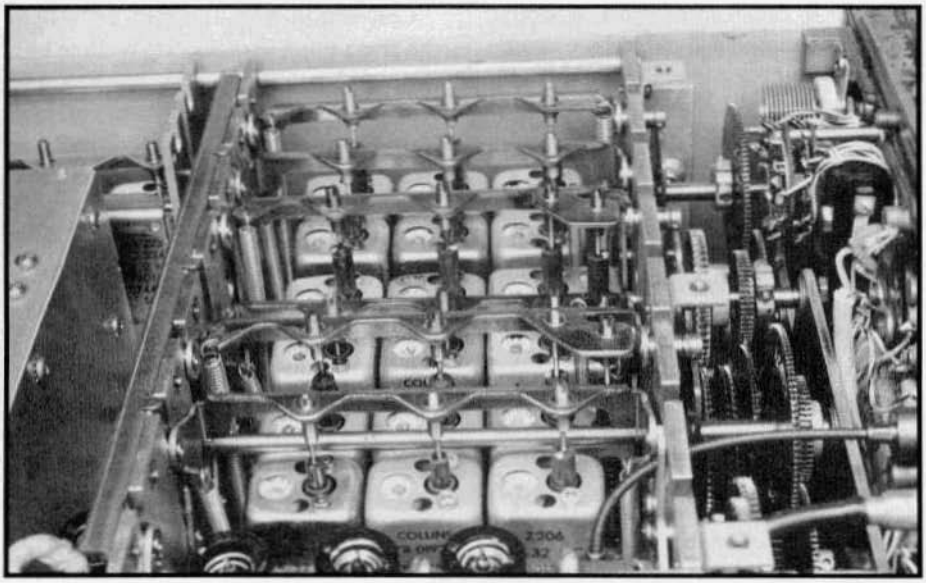
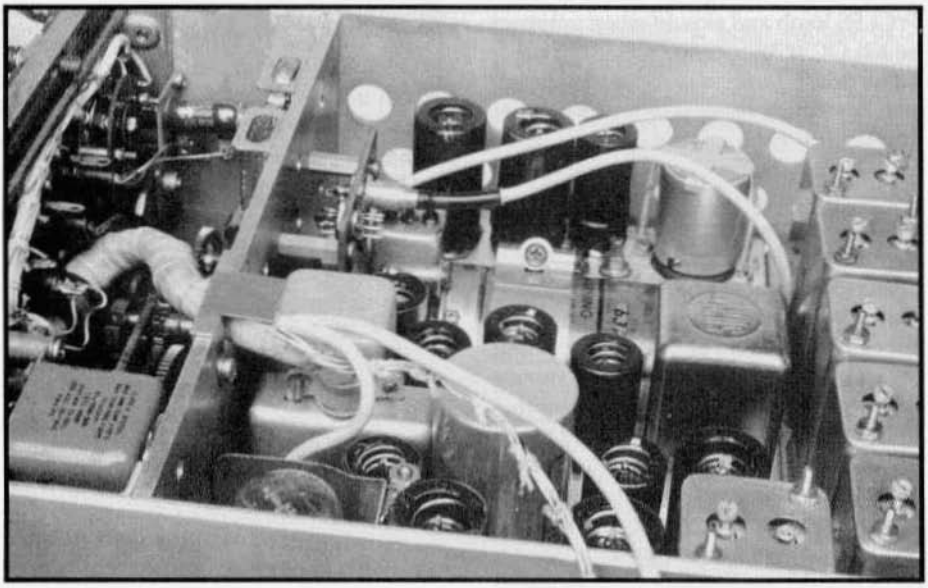


Top view of the R-392 with the case removed. Front panel is at right. Just behind panel wiring is the top of the forest of tuning gears. The two RF stages are in the center section foreground, behind them are the six sets of RF coils and tuning slugs. The first tunable IF coils are behind the side plate in the foreground, the second tunable IF coils are at far left.



Bottom view with the case removed. The front panel is on the left. The IF stages are at the right. The audio chassis is in the center section foreground, with the VFO (PTO) behind it. The crystal calibrator is at the rear. The two cables in the foreground were disconnected for this photo.

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oscillator to cause another set of 'spurs'. These problems are avoided by converting the frequency range 0.5 to 8 Mcs up to the range 9.5 to 18 Mcs -- a first tunable IF which is used only below 8 Mcs. This is even more complicated than it might seem: to keep as far as possible from strong 'spurs', the one megacycle bands are not simply moved up by a fixed amount. 0.5-1 Mcs goes up 9 to 9.5-10, but 7-8 Mcs goes up 10, to 17-18 Mcs and 3-4 Mcs goes up 12.6 to 15.6-16.6!

Obviously a lot of tuning goes on when you turn one of those two inch diameter knurled knobs. There are three RF coils for each of the six ranges 0.5-1 Mcs, 1-2 Mcs ... 16-32 Mcs, plus three—coils for each of the two variable IF's; a total of 8 sets of coils. Each set is mounted on a bridge moved by a cam. The cam for the second variable IF is driven only by the KILOCYCLES knob; all the others are driven through a differential gear by both knobs -- for example the RF coils are tuned rapidly when you turn the MEGACYCLES knob and slowly when you turn the KILOCYCLES knob.

The MCS knob also operates bandswitches which select different RF tuned circuits for each of the ranges listed above, select the necessary crystals in the two crystal controlled converter stages, and bypass the first converter (for the first tunable IF) above 8 Mcs.

There were some production problems with this system. While each tuned circuit can be adjusted at both the high and low frequency end points, what happens in between depends on the coil winding, tuning slug and cam being exactly as the designer intended. According to George Stevens, even slugs from the same manufacturer and batch were not identical and Collins often resorted to selecting a slug which would work with a given coil and cam.

Conversion from the 2 to 3 Mc IF to the fixed third IF of 455 kcs is done by a pentagrid converter with the first grid serving in a PTO tuning 2.455 to 3.455 Mcs; because the second conversion oscillator is above the frequency being converted, 3.455 Mcs is the low end of each one Mc band, and 2.455 is the high end.

The 455 kc IF stages have switch-selectable bandwidths of 2, 4, and 8 kcs. Five of the IF transformers have three extra windings. These are connected in various combinations by the bandwidth switch to vary the effective coupling between the primary and secondary windings of these transformers. In the CCW switch position, the effect is to make the transformers critically coupled, thus giving the narrowest bandwidth of which they are capable; the Q of the coils and number used are such that an IF bandwidth of 2 kcs results. With the switch in the mid position, the transformers are slightly overcoupled, giving 4 kcs bandwidth; in the last position the coupling is further increased to give 8 kcs bandwidth.

This is not the only receiver to use this technique, but it is a good one for a military set, since it is easier to operate than a crystal filter and requires less power, volume and weight than mechanical filters.

Amplified AVC is used and the set has all the usual accessory circuits -- a series noise limiter, a very stable BFO, and a 100 kc crystal calibrator. IF output (through a cathode follower) is available on the panel for an FSK adapter. There's also a carrier operated squelch relay; you set the function switch to SQ, turn the RF gain down 'til the set goes dead, and when 3885 comes alive in the afternoon, you'll know it!

On The Air With The R-392

The R-392 is just about the simplest of all military radios to get working. Just connect +28 VDC to pins A (plate power) and D (filaments) and ground pin E of the POWER INPUT - TRANS CONTROL connector on the front panel. Rated power consumption is 3 amps. 600 ohm audio output is available on pin H of the same connector or between pin L and (ground) pins B, E, or H of the Audio connectors. Fair Radio Sales has the receivers, 'part repro' manuals, accessories and just about any part you might need.

Unless there are mechanical problems (missing gears, broken servo clamps, etc.) most R-392 troubles are easy to fix. If you drop me an SASE marked 'R-392', I'll send a page or so of notes from my experience repairing and using the set.

Conclusions

One's first impression of the R-392 is of ruggedness; this radio would probably hold up not just one wheel, but your entire jeep. The lip around the edge of the panel gives considerable protection to the knobs, S-meter, etc. Those wonderful big tuning knobs are the only ones I can think of (on a ground communications receiver) which you could operate without removing your cold weather gloves.

'Ruggedness' isn't just resistance to damage, either. When I got my first R-392 working, I was astonished to find that I could (with the receiver out of the case) tune in WWV, set the BFO for a beat note, and turn the set on its side, back, etc. -- with no change in the beat note! I don't know another receiver (until the days of crystal-stabilized oscillators) which will pass that test.

The R-392 was probably the first ground communications receiver to be operable while under water. (George Stevens says that Collins actually did test the R-392 for operation while fully submerged!) One application was with a T-195 on the back of a jeep equipped with a snorkel and sealed engine; this rig was expected to be able to ford any stream which didn't rise above the driver's neck.

A big problem with equipment in the Saudi desert is the sand --which is actually an abrasive dust about the consistency of flour. A radio which is really watertight won't leak dust, either.

The use of 28 volts on the plates can be questioned just for the increased distortion and reduced dynamic range which must come from operating tubes designed for use at higher voltages in this corner of their characteristics. This really is a problem: Arlington has strong local broadcast stations on 1390 kcs and 570 kcs and my R-392 (but not other receivers here) picks up a strong signal on 1960 kcs having the modulation of both. But this isn't the only bad result of this design choice.

In general, the specifications and acceptance tests for a tube 'control' the characteristics required for good performance as the tube is most often used; it is very poor practice to apply a tube in a manner which depends on characteristics (such as 'gain at a plate voltage of 28 volts')which are not 'controlled'.

MIL-HDBK-211 (Electron Tubes, Techniques For Application Of in Military Equipment) says:

"There is no assurance of characteristic uniformity when the plate is operated at a low voltage, as for example, from 28-volt d-c aircraft supplies. With a very low plate voltage, the cutoff value of bias approaches the value of the 'contact potential' effects. Operation in this area must be regarded as extremely unpredictable."

This too is more than a theoretical problem: Mr. Stevens recalls chronic problems with brand new 26A7 output tubes having low gain, also with meeting the overall gain specification for the receiver. In the one or two hundred hours of operation since I put my R-392 in operation (and tested all the tubes) I have replaced at least two of the 26A6 IF and RF tubes which had lost all gain.

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One way a manufacturer can handle a situation like this is to get a new type designation covering a version of the tube which includes specs and testing for characteristics actually used in the application. It's expensive, but cheaper (over the life of the set) than the extra failures.

(This why there are often several numbers for what seems to be the same tube – because new applications demanded control of new characteristics. The most common case is the military need for tubes meeting shock and vibration specs. A 12AU7 may work fine at a high level of vibration – or it may not; the manufacturer doesn't say it was designed to do so, and he doesn't test a sample of the tubes to make sure it will. A 5814, however, is so designed and tested. Other characteristics frequently controlled in new versions of existing tubes are heater-cathode and other interelectrode leakage, microphonics, and operation following a long period of zero plate current.)

Another (and probably better) way to use low plate voltage in the R-392, would have been to use battery operated tubes – the 1U4, 1R5, 1S5, 3S4, etc. Power consumption would have been even less and I suspect that these tubes at 90 volts would have given higher per stage gains; the space saved by eliminating two or three tubes would have been enough for a small vibrator supply. The PTO and some other circuits would have had to be redesigned because of the lack of an independent cathode.

Reliability would have been better, with fewer problems from using tubes in a way they were not designed for and with even less heat. The problems introduced by adding a small vibrator supply would not have been enough to offset these gains.

My guess about the reason battery tubes were not used: Collins wanted to do as little re-engineering of the R-390 as possible.

A radio which requires individually selecting parts (such as the slugs in the RF coils) can hardly be repaired at a depot, let alone in the field. Current military standards prohibit this but it was poor practice even in the 50's and should not have been allowed.

Hindsight is so much easier than the alternative. Even such basic principles of quality control as looking at the controlled characteristics of a tube (rather than just the average characteristics given in most handbooks) were not generally known in 1950; it took the development of missiles and computers to get those textbooks written. (The HDBK-211 quoted above is dated December 1958 and draws on a 1955 Wright Air Development Center report.) As in so many other cases, Collins pushed the state of the art and ran into problems not seen by the more cautious.

Overall, the R-392 is a remarkable achievement. One could wish that someone had insisted that the design work with off-the-shelf tubes and tuning slugs but when you look at other 'mud soldier' communications receivers of the 40's and early 50's, it is hard to get very upset about this.

Want To Test Your Alarm Clock?

For the last several weeks, Chris, AJ1G, Mike, N4FS, (and often one or two others) and I have been getting together somewhere in the range 3870-3885 kcs at about 0500 Eastern Time each Saturday to discuss (and usually to operate) old military sets. All are welcome, whether using military radios or not, but military sets are especially welcomed, no matter how low powered or unstable. Just prop those eyelids open, and look for an AM signal – often one with the whine of a dynamotor in the background.

Next month we'll return to Navy aircraft sets, to look at a transmitter which was a contemporary of the ATA and ARC-5 command sets but which was bigger, cost more and put out less power. But at least, it was harder to operate...

The TBS-50
and an interview with Dick Mahler, W1DQH, former President of Harvey Wells Electronics

by Dave Olsen, W6PSS
310 Maple Court
Chula Vista, CA 92011

Editor's Note:

About a month ago I received a letter from Parker Heinemann,W1YG. I quote:

"In my quest for pre-WWII amateur history, hardware and memorabilia I crossed paths with Dick Mahler, W1DQH. I knew that Dick had worked at Harvey Wells during and after WWII but had no idea he was the leading technical man and was instrumental in bringing about the famous TBS-50! I told him about ER and asked him if he would be willing to be interviewed. I would like to do the interview but I have zero experience in that area. Perhaps you or someone else could do it. Off the record, Dick is ill with cancer and the prognosis is not good".

Although I own a TBS-50 (inoperable and in need of restoration) I did not feel qualified to do this story. I called my good friend (everybody's good friend) David Olsen, W6PSS, and asked him if he would undertake the project. David said that he would. Anyone who knows David, knows that he is a great fan of the TBS-50. We have all heard him from his home station and mobile using the TBS-50 and singing it's praises.

Introduction

One of the neatest, compact and functional transmitters coming out of the post WWII era was the venerable Harvey-Wells TBS-50 "Bandmaster" transmitter.

An ad appearing in the 1947 issue of QST magazine introduced this new product with the following announcement: "The sensation of the Boston Hamfest, the Harvey-Wells TBS-50 transmitter has 50 watts; Phone or CW; No plug in coils; 8 bands with bandswitch; Crystal control on all bands; No oscillator or multiplier tuning; and operates fixed or mobile. Covers 80 meters, 40, 20, 15, 11, 10, 6 and 2. Only $99.50. See it, try it! Manufactured by Harvey Wells Electronics, Southbridge, Massachusetts." It was indeed unique for any transmitter covering this broad of a spectrum, to do so without the use of plug-in coils. Other small transmitters such as the Allied T60-1 and the WRL Globe Trotter , cover the HF bands adequately but none were bandswitching. Some years later,the Globe Scout and Johnson Ranger , among others, emerged with bandswitching but none of these were capable of operating in the 2 meter band.

Aesthetically, the Harvey-Wells TBS-50 series transmitter is a real show-case rig. Unlike similar transmitters in it's class, it's operating controls are symmetrically arranged around a single meter. The impressive Harvey-Wells emblem separates the meter above it from the logging chart below it. The chart is used to record appropriate settings for the most common operating frequencies. The early models had a substantial black wrinkle finish - the later models were finished in a hammer-tone grey. A matching VFO was introduced which featured a slide-rule dial. It was unusual in that it also functioned as a base on which to set the transmitter. Together, they are an impressive and complementary amalgamation.

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The Interview

David: Could you tell us about yourself and any historical recollections about the company and the TBS-50, in any order you prefer?

Dick: I'd be delighted to. Please realize, however, that the whole story about the company is rather complicated. Let me begin by telling your readers how I got started in this thing.

Cliff Harvey, W1RF, and I were friends in Brookline Massachusetts back in the early '30s. In 1936, Cliff started a small company called Harvey Radio Laboratories. When Cliff married, I was in his wedding party as he had been in mine some years earlier. As we were close and trusted friends, Cliff asked me to take a leave of absence from my job and run his company for a couple of weeks while he was away on his honeymoon. I did so, and my entire life was changed!

A few days after Cliff's honeymoon departure, an old friend contacted me indicating that he had joined up with Admiral Richard Byrd's Antartic expedition. Naturally I told him about our 1-tube 5-meter transceiver product and it's diverse uses. Shortly thereafter, I sold him a bunch of these for use on the expedition dog sleds. When Cliff returned from his honeymoon you can imagine his surprise at hearing about the huge order. He had never received an order for $10,000! As a result, Cliff asked me to come aboard as his sales manager. I accepted and terminated my position at General Food Corporation.

In 1939, we were contacted by a very wealthy gentleman and fellow radio amateur - John Wells, W1ZD, of Southbridge, Massachusetts. Although his family owned the American Optical Company, John's interests were not in optics - but in ham radio and flying. John expressed great pleasure with two 204 triode amplifiers we had built for him. And, being pleased, John asked if we would come to Southbridge and join him in the formation of a new company. We accepted and the new company was incorporated under the name, "Harvey Wells Electronics". For us this meant leaving Boston.

Just before the outbreak of WWII I was elevated from Sales Manager to General Manager and later I became Executive Vice President and finally President - a position I held for about 20 years.

David: Tell us about your product line at the new company.

Dick: Harvey-Wells Electronics began with the manufacturing of various amplitude modulated police radios. This was before Motorola got involved in this communications line. Enter, Dan Noble of the University of Conneticut. Dr. Noble distinguished himself here as quite an expert in the field of frequency modulation by developing various FM communications techniques. Hearing of his successes, we attempted to bring him onboard at Harvey Wells but, he elected instead to join with Motorola. The rest is history for it was Dan Noble who developed the tremendous Motorola product line which found it's way into the police radio service and a myriad of other uses. Thus, it is only natural to ponder what might have been if Dr. Noble had accepted our offer instead of theirs.

Getting back to our product line. We had a requirement for quartz crystals in our police radios. Word reached us that a couple of fellows up in Springfield were hand grinding quartz crystals. We succeeded in recruiting them to do the same for us. However, their combined effort yielded only two crystals per day. Hearing about our effort in manufacturing crystals for our own radios, a young engineer from Motorola named Elmer Wavering, dropped by to place a crystal order. I said,"great". Then he presented me with an order for 10,000 units with a

minimum requirement of 500 per week. My retort was, "You are out of your mind!" I explained that the manufacturing of quartz crystals was highly complex and very time consuming. But, we did accept the order indicating that we would make a concerted effort to tool-up for the task and agreed to work with Elmer in developing new crystal production processes. We consulted with the leading authorities of the day in grinding technology. Collectively, we did develop a process for turning out 25,000 units per month to meet the war effort. These were the familiar FT 243 crystals. As a result, the company experienced phenomenal growth - growing from 6 persons in 1940 to over 900 by the ending of hostilities. During this period, Elmer Wavering remained with Motorola and later aspired to become it's President and CEO. The crystal business cotinued until shortly after the war.

Before war's end, we learned that the FCC's postwar plans included ham radio. We thus set out to capitalize on this news by designing a practical and moderately priced transmitter to meet this postwar need as well as meeting the needs of police and other state and federal agencies. This effort culminated in a design to meet all of these requirements. The new transmitter was to be called the Harvey-Wells Bandmaster, Model TBS-50.

Although I can't take full credit for the entire TBS-50, the design was my conception. I wanted something practical - but different. I desired an upright cabinet with a vertical chassis design and a unit capable of running about 50 watts input. Also, it should be capable of operating on as many of the new ham bands as possible and include a crystal option. With a crystal option, we could continue to capitalize on our own crystal manu-

continued next page

facturing prowess. One of the factors that influenced this latter option was the fact that we had bushel baskets full of the FT 243 crystals. Again, I did the conceptual design and Cliff Harvey did most of the electronic design based on our mutual feelings about using an 807 in the final of a multi-band configured rig. We were also fortunate to have a wonderful draftsman who was capable of interpreting our sketches into the proper sheet metal design for the form we desired. This same individual was responsible for the simultaneous switching arrangement of oscillator, multiplier and final tank circuits with only one bandswitch control.

David: Why was the 807 selected as the final amplifier noting that other excellent beam power tetrodes like the 815, 829B and HY 1269 were also available?

Dick: Good question. That choice for us was an easy one because we discovered that a certain Boston parts distributor had several thousand surplus 807s that were brand-new and available at a price we couldn't refuse. This selection also met with my desire to manufacture a transmitter which could be sold for under $100, and still yield a reasonable return for the company. I'm quite proud that it was a good decision.

As one of the first postwar bandswitching transmitters, the TBS-50 found great favor with government agencies in both point to point and mobile service. We sold hundreds of them to police departments. This market also included numerous countries in Central and South America. Actually, only one third of the units manufactured reached the amateur radio service. This transmitter also became popular among companies in the lumber industry.

An important factor in the gaining of wide acceptance by many agencies and services, was the fact that only minor alignment adjustments were necessary in placing the transmitter in service anywhere in it's operating spectral range. With the basic design of a 6AQ5 oscillator, a 6AQ5 buffer/multiplier and 807 final with push-pull 6L6 modulators, there was very little that could go wrong. During the years of the TBS-50 manufacturing cycle, very few troubles were reported or documented. It was a darn good design!

David: It was a unique pleasure to meet a person of Dick Mahler's stature. I found him to be a very open, modest man and lucky for me (and the readers of ER) he just naturally provided a progression of interesting facts about the company and himself. Few corrections and embellishments were required with this well spoken man. We hope to hear more from Dick Mahler in the future. He would like to share some interesting tales of mystery and intrique... including a true spy thriller involving foreign agents and their Harvey Wells TBS-50 transmitters.

Editor's Note:

It's very sad for me to report that Dick Mahler passed away November 24. I placed a call to Dick shortly after I received Dave's manuscript for some additional information and learned the news from his wife. I asked her about someone else that I might talk to about Dick but she couldn't think of anyone. She said that Cliff Harvey and John Wells and everyone that she could think of from the Harvey-Wells company had passed away. I asked her about photographs and she said that she would supply me with some for a later issue.

Shortly after I talked with Mrs. Mahler, I received a call from Ken Bolin, W1NG, a friend of the family. He told me that Dick had been given six months to live almost exactly six months prior to his death. He said that Dick was never really sick until the very end. He was 76 years old.

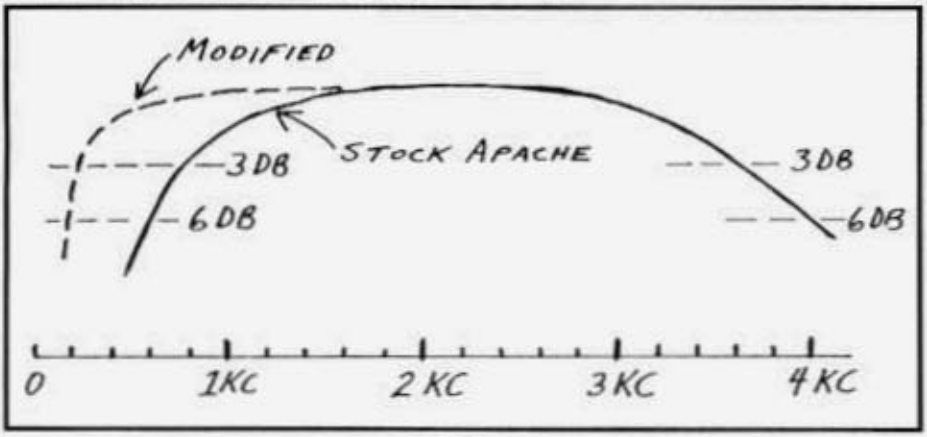
Low Frequency Response in the Heath Apache

by Ken Morgan, KC5DW
9000 Trumbull Ave. SE 76
Albuquerque, NM 87123

Most amateurs who acquire an old AM transmitter change the small interstage coupling capacitors in the audio amplifier to larger values in order to improve audio quality. There are a few holdouts, however, who believe that speech power in the frequencies below 400 to 500 cps causes unnecessary power loss in the modulator and final amplifier. While this is true to a certain extent, what some amateurs may not realize is how poor the low frequency audio response in their transmitter really is. When I came into possession of a Heath TX-1 (Apache) one of the first things I did was to check out the response characteristics of the audio amplifier. In the Apache the first two audio amplifiers use 510 pf interstage coupling capacitors. Further along the audio chain is a low-pass filter to limit the high frequencies and a clipper to eliminate the peaks. The Apache manual claims a response of 300 to 3000 cps.

I tested my Apache by connecting an audio oscillator at the mic input and measuring the voltage at the modulator tube control grids. I used an oscilloscope to measure the peak-to-peak values and to make certain I was below the level that would activate the clipper. The response curve of the stock Apache is shown in the figure. The low frequency response begins to roll off at about 1600 cps and is down 6 dB (half voltage) at 600 cps. Most SSB rigs can do better than this and I'm sure my telephone receiver would give it close competition. Increasing the mic gain to the point where clipping occurs widens the response a little due to mid-frequency attenuation, but this will introduce harmonic distortion. The response curve in the figure also shows the effects of the low-pass filter. The 3 dB point is about 3600 cps, which is much higher than most SSB rigs.

Changing the two small coupling capacitors to .0047 ufd improve the low frequency response as shown by the modified curve. Now the 3 dB point is about 200 cps. Changing these capacitors is the simplest improvement you can make to these old rigs considering the dramatic improvement in audio quality. If you're still worried about low frequency power losses you can stay with tiny coupling capacitors and make your listeners suffer.



LETTERS

Dear ER

[A letter from the U.K.]

Please find enclosed my log for the 10m AM contest. I hope it is in order, as I didn't know the rules until my 21st contact told me.

I enjoyed the contest - such as it was experienced over here. I went to some trouble to get my DX-100U going properly for the event and I was really looking forward to good conditions. Mostly I was not disappointed. I have been licensed since 1967 and enjoyed the '69ish cycle very much using a homebrew single 6146 plus home brew 807x2 modulators (this is still somewhere in my garage!)

I like AM because you can see (on the S-meter) what is happening to propagation, not to mention what's happening. The QSOs are usually more relaxed. It's just like then though; we all talk too long on each over.

You may know that the only AM activity on 10 metres evident in the U.K. is from the USA. We only rarely hear short skip European AM (in my experience only once fleetingly during the last year of fairly extensive monitoring). Therefore we rely totally on USA -over the pond- contacts to sustain our interest in AM. I think many of your readers will not be aware of this fact.

It is true that there is still some AM activity on 160 metres but this is usually constrained to Sunday afternoons and very local nets - which are generally awful, because one's turn comes around once in 2 hours. Remember we are limited here (still) to 10 watts power on 160 metres.

I have heard that 40 metre activity is good in the U.S. Here, as you know we have only 100 Khz on 40 metres, needless to say there is no room for AM at all. Similarly on 80 metres, we have only 3.5 -3.8 Mhz and there is little room for AM. I have called CQ several times on 15 metres, 21.385 when 10 metres is dead. However I have not had any success. I have never heard any USA stations when I have listened.

However I find 10 metre AM great fun and rarely tire of long rag chew contacts. Practically speaking, we here in the Southern U.K. are constrained to 10 metre AM contacts from your dawn, corresponding to a local time here of about 12 a.m. - 1p.m., up until the band closes. This is mostly around 1800 - 1900 local and, as you know, exceptionally up to anything around 21 - 2200 local in this sunspot cycle. The pity is that quite a lot of the time East Coast USA stations do not have their beams eastward. The west coast stations are beaming in the right direction for us, but the operation 'window' for the Westcoast is so short it's tough going.

I have a few comments regarding the contest. Firstly it very quickly became apparent that few stations were interested in an actual contest. The general tenure I perceived was this is a 'festival' rather than a contest. I happily went along with long rag-chew QSOs but was a bit disappointed that we couldn't actually operate in at least a 'quasi-contest' mode. After a few contacts I resigned myself to this operation and had many lengthy (enjoyable) QSOs just like usual. By the way I have never entered a contest in my 23 years of operating. This one was, I thought different. I do hope you'll be issuing a commemorative certificate to hang on the shack wall showing 10 metres, 1990 and AM. I'd like to close with a thanks to all you boys over there for some great 'atmospheric contacts' on AM, may they continue.

Dr. Ian Dilworth, G3WRT

Dear ER

The November "Electric Radio in Uniform" article about the BC-222 gave me a rush of 44 year old memories. My interest in listening to shortwave radio and ham chatter began in the late 1930's when my father brought home a multi-band Zenith console with a big round black airplane dial.

In 1946 as a high school sophomore, I had a friend also interested in radio that worked part time for his uncle who sold military surplus radio equipment from a large warehouse in Chicago. Having a key to the warehouse, my friend invited me to look at all this fascinating equipment when the warehouse was closed on a Sunday. He assured me that most of the equipment came in in large uninventoried quantities. So, we decided to "borrow" a couple of transceivers from among the many different two-way radios piled up.

Because of their small size, excellent condition and schematic on the their inside covers, we took home three BC-222's to talk (illegally) between our houses about a block apart. We quickly wired up some batteries and the radios worked like a charm. Exciting for a 15 year old interested in radio. We checked the latest amateur radio call book at Allied Radio and made up call signs that weren't in the book.

My father died about that time and since I had a driver license, I got to use his 1941 Buick Century whenever I wanted. I couldn't wait to get that BC-222 into the car as a mobile unit. On the back of the car I installed a 96" whip attached to a large heavy ball and spring base and I was mobile.

My friend used a roof antenna at home and we could talk reliably for a mile or sometimes two. Since the BC-222 used a standard looking telephone headset, I of course told my dates that I had a telephone in my car.... very, very rare in those days. On many occasions I made "phone calls" to my friend at a pre-arranged time and let my dates talk to him. That made me quite a hero with the young ladies. Since the range was so limited, I never worried about getting caught by the FCC.

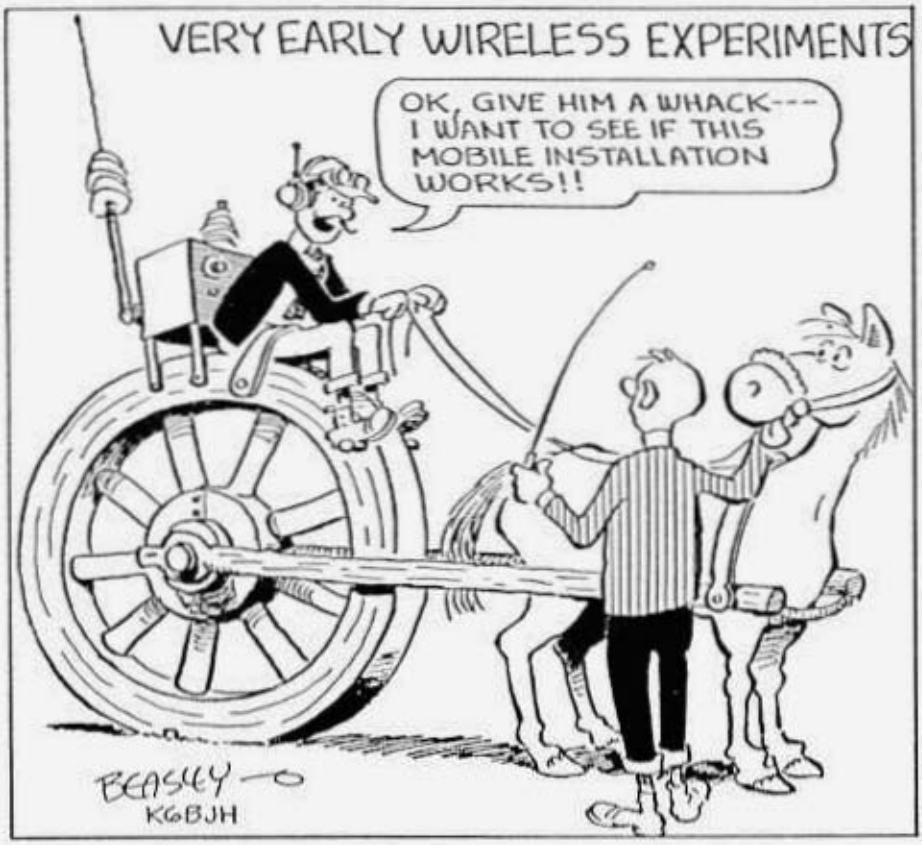
At about 7 a.m. on one bitter cold winter morning while waiting for my car to warm up, I decided to call CQ, CQ, using my bogus call sign. Within minutes, I was astonished to hear a ham in Texas answer my call. We talked for 10 to 15 minutes and I began to get nervous about getting caught by the FCC. Nevertheless, I made a couple of other fairly distant contacts that morning including a ham on a boat in the Gulf of Mexico. Wow!!

For the next few days I continued to make contacts with hams from several states and was constantly amazed that they could hear my two tube signal. I was pretty good at 'ham talk' having listened to them for a few years, but sometimes when asked questions I couldn't answer, I abruptly ended the contact. I continued making contacts for a week or so until apparently the skip disappeared and I went back to talking to my friend. Even then, once in a while a local ham would try to make contact with us.

Eventually I lost interest in the transmitting part and became (still am) an avid SWL. I replaced the BC-222 in my car with a Gonset 3-30 Mc converter and bought a Hallicrafters S-38 for the house, eventually followed by an S-40 and SX-42 and more. I don't remember what became of the BC-222's. Probably used the tubes for something else and threw the units away. Every once in a while I feel sorry I never went after the ham ticket.

Ken Greenberg, Skokie, Illinois

Collecting/Repair/Restoration...Tips



I'm certain we have all had dial glass lettering damaged during cleaning and my 75A-1 was no exception. I solved the problem by making a photocopy of a good dial glass and then making a transparent photocopy of the first copy. The transparency was then cut to size and placed behind the original dial glass; the finished appearance cannot be told from new. This scheme would also work for the Collins 32V series. I'll be glad to supply a 75A-1 dial glass overlay for $1 plus postage.

Joe Sloss, K7MKS, 4732 119th St., Bellevue, WA 98006

Want an almost perfect replacement knob for the Collins S-Line? A firm called Caltronics in Canoga Park, CA 91304 sells a bar knob, part number 50-133 that is the exact diameter and almost a dead ringer for the original article. And it's even made of genuine bakelite! They also sell the same type of knob in larger or smaller sizes - the smaller one is useable for the crystal pack selector on the 75S-3A. At a cost of less than $2 each, these 'ringers' are a heck of a better deal than the 'factory replacement' jobs being sold for $20 each.

KDØHG

AM FREQUENCIES

2 Meters - 144.4, calling freq., activity in most cities; **6 meters** - 50.4 calling freq. **10 meters** - 29.0-29.2 operating window; **12 meters** - 24.985 calling freq.; **15 meters** - 21.385 calling freq.; **17 meters** - 18.150 calling freq.; **20 meters** - 14.286 for the nightly SPAM net starting at 5:00 CA time; **40 meters** - 7160, 7195, 7290 are the main freqs. Westcoast SPAM net every Sunday afternoon ,4:00 PM on 7160; **80 meters** - 3825, 3850, 3870 and 3890 are the main freqs. Westcoast SPAM net Wednesdays nights, 9:00 PM on 3870. Northeast SPAM net Thursday nights, 7:30 PM on 3885; **160 meters** - sporadic summer-time activity but during the winter signals can be heard anywhere on this band.

More on the 160 Meter Contest December 28-29

I've received quite a response from last month's announcement of the 160 meter contest. Most letters requested additional information; particularly regarding rules and logging requirements.

The contest will begin the evening of the 28th and end on the evening of the 29th or more exactly in the wee hours of the 30th. It is for AM operation only; that is a station operating AM working another station operating AM. The initial contact can be made with a station operating SSB but for the point to count you must have the operator switch to AM for the exchange of information.

Here are the logging requirements: the stations callsign, QTH, name of operator, transmitter (Viking II, homebrew 813s, Yaesu 1999, etc.), receiver, time of the contact and it would be helpful to number the contacts. There will be one point for each station worked. Send me a copy of the log and that's it. There are no other rules. As in the other contests, certificates will be awarded to the first, second and third place prize winners.

I'm really quite surprised with the amount of interest that is being shown in this first 160 meter contest. I've received more letters and calls regarding this contest than I have for any other. And some operators are really 'gearing up' in some serious ways. At least two stations will be using broadcast towers and one fellow (he wishes to remain anonymous for now) says he'll be using a helium balloon. It should be a lot of fun. N6CSW/Ø

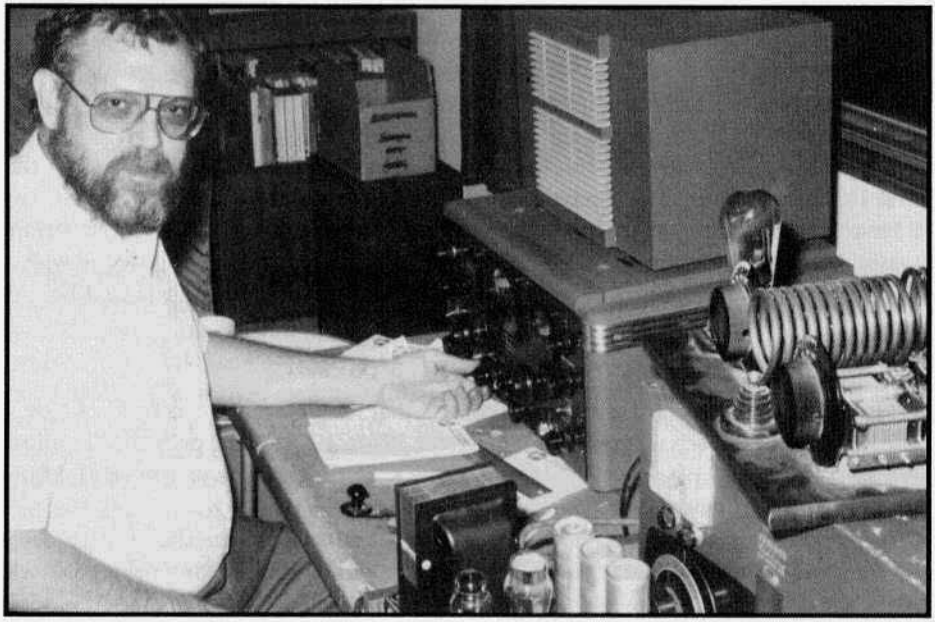
Ten Meter Contest Results

Here are the results of the ten meter contest that took place the weekend of Nov. 3 and 4th. The first place winner is John Barcroft, WA6ZJC with 120 points (120 stations worked). In second place is Bill Kipping, KE7KK, with 68 points and in third, Marty Drift, WB2FOU/5 with 53 points.

I'm considering another ten meter contest for later in the season that will probably be a one day event with extra points for DX. I think the incentive for working DX will make the contest more interesting. I think there's lots of DX available on ten; Europe, South America, Japan, Australia, New Zealand etc.

I'll try to announce this contest well in advance so that the level of participation may be higher. Stay tuned.

Charlie Carpenter, W5TOP, operating his 813 homebrew rig. Note the T-368 exciter unit built into the RF deck. Also shown (above and to the left of the 813 rig) is a 3-500Z homebrew amp for SSB.



Harry MacLean, VE3GRO, operating in the AWA contest. Shown is a 1929 Hartley transmitter (UX-245 - 9 watts) and a Hallicrafters SX-28 receiver. Harry is Vice-President of the Canadian Radio Relay League and the Editor of QST, Canada.

Jerry Chandler, K6PKO, at the operating position in his vintage station. Some of the gear shown (it all looks mint) is Johnson Viking II, a KW matchbox, 122 vfo, NC-300, Johnson Ranger, HRO-50T1 and SX-71.

Dave Mills, AJ7O, in his shack. From the left we see Dave's 813 homebrew CW transmitter, HG-10 vfo, Viking II and R-388. Above the R-388 is a T-368 exciter unit, mounted in a cabinet, that Dave uses with his homebrew rig as well as the Viking II.

The TV-7/U Tube Tester

by John Staples, W6BM
732 Cragmont Ave.
Berkeley, CA 94708

Introduction

Our radios that "glow in the dark" use vacuum tubes that need to be tested to insure that our equipment continues to operate at peak efficiency. Tube testers such as the TV-7/U are widely available at flea market sales and from surplus dealers. I will describe it's operation and discuss some considerations for tube testing.

Vacuum Tube Characteristics

In gridded vacuum tubes, electrons emitted from a hot cathode pass through one or more negatively biased grids which control their flow to the plate. The cathode in a healthy tube provides far more emission than is used. The plate current in vacuum tubes is controlled by the negative control grid bias.

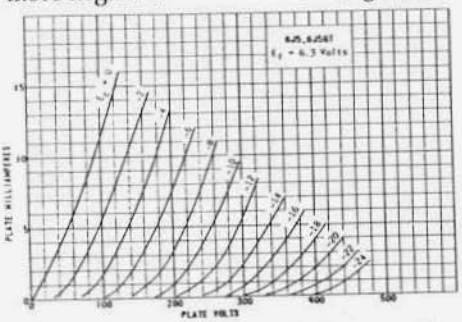
One measure of the gain of a tube is the change of plate current that is produced by a change of grid voltage with the plate voltage held constant - dI/dV the transconductance. We can understand transconductance by writing ohm's law upside-down: G=1/R=I/V. The units of I/V are inverse ohms, or mhos, and the inverse of resistance R is conductance G. A voltage change dV in the grid circuit produces a current change dI in the plate circuit and this ratio dI/dV is referred to as mutual conductance or transconductance, with the symbol g_m.

Figure 1 shows the characteristic curves for a 6J5 triode. The plate current is plotted as a function of plate voltage for several values of negative grid voltage. The transconductance can be estimated by noting the change of plate current produced by a change in grid voltage for a constant plate voltage. For example, with 200 volts on the plate, a change of grid potential from -6 to -8 volts lowers the plate current from 7.6 to 3.3 mA. The transconductance is:

$$g_M = \frac{0.0076 - 0.0033 \text{ Amps}}{8 - 6 \text{ Volts}} = 2150 \times 16^{-6} \text{ mhos}$$

or 2150 micromhos. The transconductance depends on the operating point: the transconductance, as well as the plate current, decreases as the bias is made more negative.

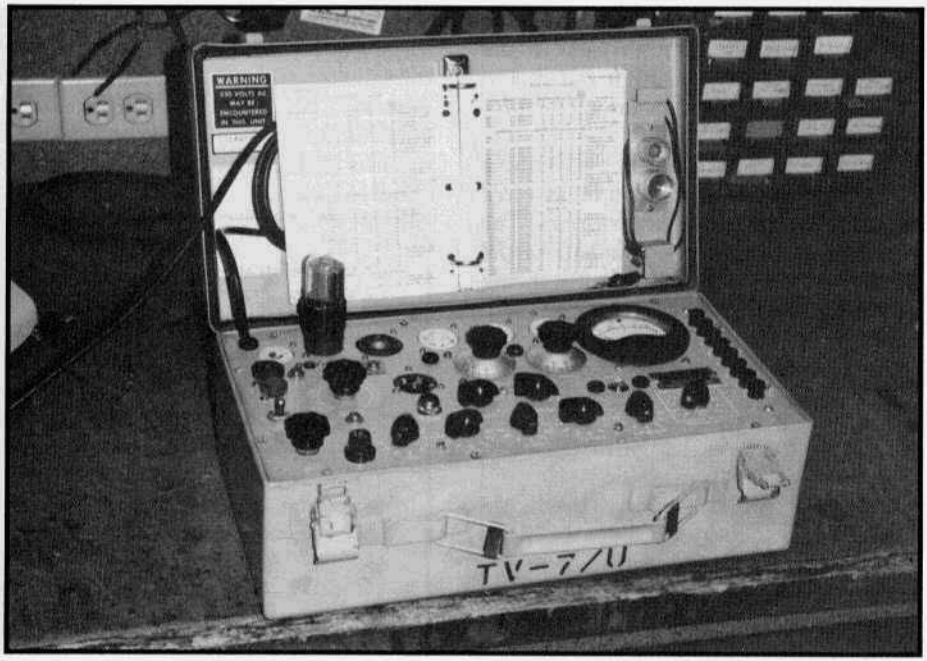
Figure 1



A healthy cathode's emission capacity far exceeds normal operating requirements. The cathode emission in weak tubes limits the plate current along with the control grid and therefore becomes a limit to the gain.

Diodes, or diode-connected gridded tubes show a non-ohmic behavior of the plate current with changes in the plate voltage. In tubes with high cathode emission capability, the electron cloud around the cathode drives most electrons back into the cathode which results in the plate current varying with the 3/2 power of the plate voltage $I_p = P\ V^{3/2}$, where P is the perveance of the tube - the space charge regime. When the cathode emission is impaired, the peak current saturates and becomes independent of plate voltage above some limiting value - the emission limited regime. Emission- limited diodes are sometimes used as current regulators.

Oxide cathodes, found in almost all receiving tubes and most low power transmitting tubes, will eventually lose their peak emission capability through ion bombardment poisoning or other mechanisms.



Tube Testers

Tube testers measure the gain and condition of a tube and can be divided into two classes: emission testers and transconductance testers. The less elaborate emission testers configure all tubes as diodes and measure the plate current at some fairly low plate voltage. This is a useful test, and can be made even more useful by measuring the change of emission while raising and lowering the filament voltage. The filament voltage for a good tube can be reduced by 10% or so without much change in emission. The falloff in a weak tube will be dramatic and rapid.

Transconductance testers measure the gain of a tube under conditions similar to actual operation. This gives a more accurate assessment and better predictor of the tubes's condition. Changing the filament voltage during a transconductance measurement gives additional information about the cathode condition.

Tube testers often provide several additional tests: inter-electrode shorts, noise and gas tests, for example.

The TV-7/U Tester

The TV-7/U tester (and it's siblings, the TV-7A/U, TV-TB/U and TV-7D/U) is a widely available unit dating from the early 1960's, using almost the same circuit developed in the early 1940's for the I-177. It is an excellent unit, offering transconductance as well as shorts, gas, noise and cathode emission tests. The current flea market price is around $25, with the data charts frequently missing and somewhat higher from retail surplus distributors, presumably with charts.

As with many transconductance testers, the TV-7/U doesn't apply filtered d.c. to the tube, but uses 120 Hz full-wave rectified a.c. on the elements, with a 60 Hz grid signal provided by an additional winding on the power transformer.

Figure 2 shows the basic bridge circuit configuration. Two windings on the power transformer, together with a type 83 vapor rectifier, provide a 120 Hz, 230 peak volt excitation to the plate of the tube under test. The cathode is connected to the center tap of a resistor across the

continued next page

meter. The current through the tube passes alternately through each of the two windings and through the meter. The a.c. current through the meter produces no deflection.

The bridge is unbalanced by adding a 60 Hz component to the grid bias from a winding on the power transformer. The tube conducts more on one-half of the a.c. cycle than on the other, unbalancing the bridge and producing a d.c. current through the meter. The meter deflection is proportional to the transconductance.

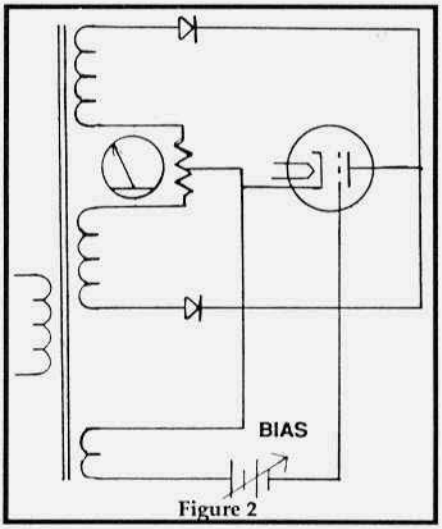


Figure 2

Figure 3 is a more detailed diagram of the tester showing how the grid bias and screen voltages are generated. The bias and screen voltages are 120 Hz full-wave rectified waveforms with the sinusoidal 60 Hz signal added in series. The d.c. bias voltage is set by the bias potentiometer. Switchable meter shunts set the transconductance scale on the meter. For diodes, the meter sensitivity is adjusted by the ganged shunt potentiometers across the meter. In the low voltage ranges the filament transformer is center-tapped by a resistor which connects to the cathode circuit.

A peak plate voltage of 230 volts is used for transconductance tests. The peak screen voltage is 180, but can be reduced to 80 volts by simultaneously pressing the transconductance and diode buttons, described below. The 60 Hz grid signal amplitude is 14 volts peak-to-peak and the bias voltage is variable from zero to about -63 volts.

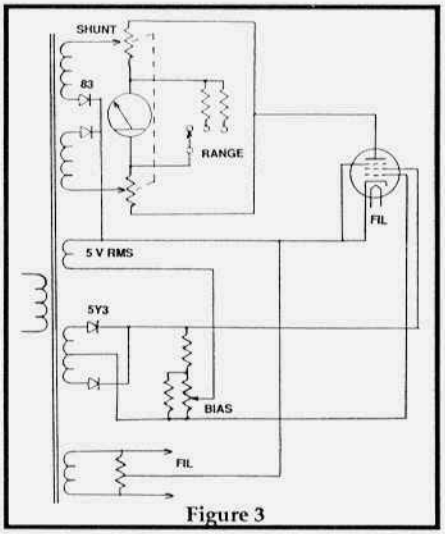


Figure 3

Eleven tubes sockets are provided, including acorn, 8-pin subminiature and 7-pin in-line hearing-aid. Seven indicator switches configure the sockets. The chart listings for the seven selector switches have an old-style telephone number format such as HS4-8653 for the 6SK7 pentode. The filament switch setting A-K and P-Z (I and Q missing) correspond to pins 0-9. A setting of zero is a disconnect, otherwise the setting designates the tube pin number.

Switch	Electrode Positions
1 Filament	ABCDEFGHJK
2 Filament	PRSTUVWXYZ
3 Control Grid	0123456789
4 Plate	0123456789
5 Screen Grid	0123456789
6 Cathode	0123456789
7 Suppressor Grid	0123456789

Don't worry about setting more than one switch to the same pin and shorting out the power supplies. The switches are wired so that the first switch dialed to a particular pin disables the following switches from being connected to the same pin.

Eighteen filament voltages are available, from 0.6 to 117. A ten-position short/range function switch is provided. Five positions of this switch (1 to 5) provide a shorts test between tube elements, lighting a neon glow-lamp if a short is detected. Five meter ranges are provided (A to E) for diode and transconductance tests. Position "A" is used for diode and rectifier tests. The other four switch positions provide the following transconductance sensitivities in micromhos corresponding to 100 on the meter scale.

Position	Scale
B	3000
C	6000
D	15000
E	30000

Eight push buttons down the right side select the measurement function:

Buttton	Function
8	Meter reverse
7	Rectifier
6	OZ4
5	Gas 2
4	Gas 1
3	Transconductance
2	Diode
1	Line Adjust

The Line Adjust button is used to adjust a rheostat for variations in line voltage. The Rectifier, Diode and 0Z4 buttons place 24, 44 or 90 peaks volts of sinusoidal a.c. on the tube under test and the meter range switch should be in position "A". The shunt control is preset to a value listed in the charts and the meter reading is compared to the listed value.

To measure transconductance, a meter sensitivity scale and bias are selected (the shunt control is not used for transconductance tests), button 3 is depressed and the meter reading compared with the listing. The listing gives the minimum acceptable transconductance (in terms of a meter deflection of 0 to 120) as 75% of the nominal tube transconductance.

The gas test measures the change in plate current when a large-value resistance is switched in series with the control grid. The Gas 1 button is held down while adjusting the bias control to set the meter on scale. The Gas 2 button is depressed, placing the resistor in series with the grid. If gas is present, ion bombardment will change the grid voltage and the meter deflection. Good tubes will not show a change in meter deflection.

The noise test is really a sensitive short-circuit test. The neon bulb will light if shorts are present. If the noise test terminals are connected to a radio receiver, wideband noise generated by firing the neon bulb will be detected in the receiver.

As mentioned earlier, it is useful to lower the heater voltage and observe how quickly and far the transconductance falls. Weak tubes, besides having a low transconductance, will also exhibit a rapid fall-off when the filament voltage is reduced. Good tubes will not change much.

Troubleshooting

I bought my TV-7/U at the renowned Foothill College flea market last summer, replacing a grand old wood-box Weston OQ-3 transconductance tester I restored a number of years ago. The TV-7/U had a few problems that needed fixing.

Several precision wire-wound resistors in the bridge and meter circuit had corroded and opened. The resistance value is clearly marked on the resistor body and an ohmmeter check showed two resistors to be open. Corrosion had also attacked the contacts of the push button

continued on page 30

Update That Super-Pro

by Bill Kleronomos, KDØHG
POB 1456
Lyons, CO 80540

I have observed that there are two main categories of classic radio enthusiasts. There are the collectors/restorers, who might put hundreds of hours into making an old boat anchor into a mint, factory stock restoration. Then the unit goes on display, little used for fear of ruining it's pristine condition. Then there are the radio 'hackers' who would just as soon strip the entire chassis of an older rig to replace the circuitry with some 'home design' that ought to give better performance for daily on the air operation.

My own personal station consists of a number of '50s and '60s vintage units for AM, CW, and SSB that are kept in a reasonable state of restoration and used regularly. My own philosophy is that I don't get upset due to dust collecting in or minor cosmetic problems with my equipment, but I do expect reasonable performance so I can enjoy, rather than getting aggravated with my on the air activities.

My primary general coverage receiver that I used in my shack is a '60s vintage Hammarlund SP-600JX-17 'Super Pro' and as time went on, I became increasingly annoyed with a few problems that seriously detracted from my enjoyment of this receiver. Let me summarize the design flaws that I decided to address. Perhaps your 'Pro' or other similar vintage receiver has some of the same annoying features...yes, they are fixable. Read on for details!

1. Unable to receive SSB transmissions without constant playing with tuning, RF gain and audio level. This is 1990 not 1955 and the ability to receive SSB is essential.
2. Frequency changes when the RF gain is varied.
3. Unexplainable drifty of a hundred or so Hz, even after a long warm-up.
4. Crossmodulation noticeable when trying to receive a weak one when extremely strong adjacent signals are present.
5. Slight, but annoying audio distortion present on very strong AM signals.

The changes I employed to fix these problems were designed not to require serious internal modification of the SP-600. There's enough collector/restorer in me that I hate to change the innards of an old classic unless absolutely necessary. Lets look into the stability problems first. Unless a receiver is extremely stable, it is pointless to even try to use it for serious SSB reception and even operating CW can be a chore.

My 'Pro' exhibited an annoying change in pitch of a CW or SSB signal as the AGC operated or when the RF gain was changed. After some checking, I found that the regulated B+ that feeds the oscillators and BFO was changing several volts due to AGC action, changing the amount of current drawn by the IF amplifiers and this was in spite of the fact that this voltage was regulated by an OA2 VR tube. I metered the B+ at the VR tube socket and tried several different VR tubes. Sure enough, several would let the B+ change several volts as the RF gain pot was varied and others would be rock stable. This was a simple enough problem to solve and it should

show that just because a VR tube is lit up, it doesn't guarantee proper operation! I noticed that the OA2 became quite warm during operation and became outrageously hot when operated within the bright nickel plated tube shield. I would recommend that this tube shield be spray painted flat black inside and/or out, or it's replacement with one of the black heat dissipating tube shields often used in military gear. My suspicion is that this heat caused a degradation of the operating characteristics of this tube since it had only been in service some six months.

The cause of the slow drift I noticed was a bit tougher to identify. The symptoms were that when a sideband or CW signal was tuned in, there was an occasional slow change in pitch of some 50 to 100 Hz in either direction. I realized what was happening when I used the Pro on CW one night with a full kilowatt on transmit. It turns out that line voltage changes of a volt or two were affecting the heaters of the oscillator tubes. This problem was not always evident; but the municipal electric system in this small town doesn't have the best line regulation in itself, and the KW made the problem obvious. Apparently, this type of problem wasn't unknown to the receiver designers of the '50s, as receivers such as the R-390 and HRO-60 have a ballast tube incorporated in the filament circuits of critical stages to regulate the current. I can't understand why Hammarlund never put heater regulation in a receiver of this quality unless it's because it was designed to be used with an external VFO in critical applications.

Hammarlund made it relatively easy to incorporate regulation of the first L.O. The entire front end consisting of the two RF amplifiers, 1st mixer and 1st oscillator is fed from its own winding on the power transformer. This winding is 7.5 and not 6.3 volts due to there being RF isolation chokes in the heater circuit of the front end which have a substantial voltage drop. I decided to rectify and filter this filament voltage and use a solid state regulator, but what of regulation - voltage or current?

As I mentioned, there is an RF choke in series with the filaments in the front end that contributes about 1 volt of drop in the voltage at the filaments. As the resistance of the tube filaments changes due to temperature, the current will change and this series resistance in the RF choke would theoretically cause the voltage at the filaments to change in direct proportion to this load change. Therefore, regulating the filament voltage before this choke might be somewhat ineffective. I decided to regulate the current of the front end filaments instead. This would insure that, no matter what changes due to temperature occurred in the front end tubes or choke, there would always be more or less proper and stable heater power applied to these filaments. If anything were to change, the regulator would simply adjust the voltage applied to the front end so that a constant amount of current was consumed.

A DC power supply is required to operate this filament regulator. This was accomplished by mounting a couple of terminal strips under the chassis and constructing a simple half wave rectifier/filter circuit. Disconnect the lead to the front end filaments attached to pin 19 of the power transformer and remove the ground from pin 20. Solder a wire from pin 20 to pin 15. This connects the 7.5 volt front end heater winding in series adding with the main 6.3 volt filament supply to the rest of the receiver, which produces 13.8 VAC at pin 19. This provides about 14 VDC under load when rectified and filtered. The regulator needs about this much voltage to provide enough regulation 'headroom' and to operate properly, hence the use of this series transformer connection.

A note on the filter capacitors used in

continued next page

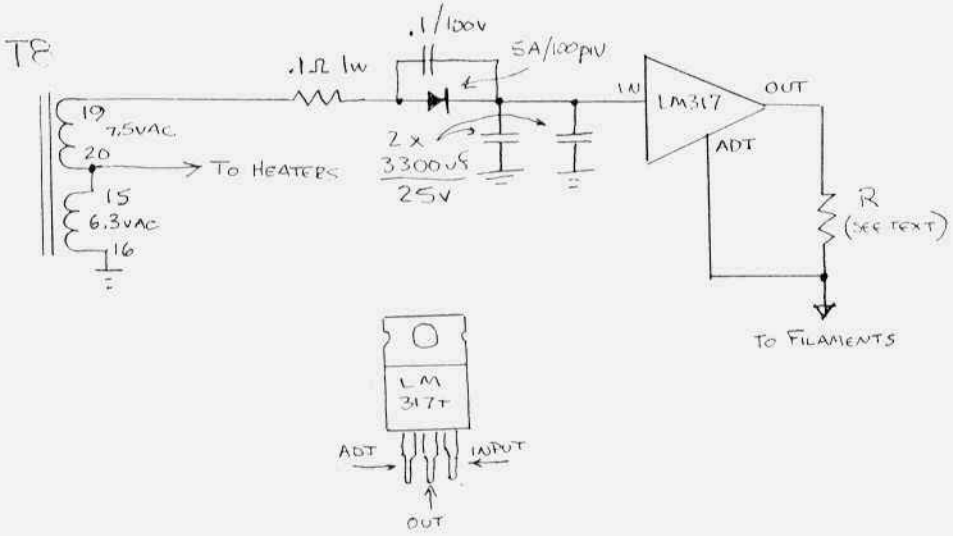
Update That Super-Pro from previous page

this circuit. There is a large ripple current through them, and they get noticeably warm. This is why two capacitors in parallel are used. I recommend that fresh capacitors with low internal resistance be used; a cruddy old capacitor from the junk box might possibly overheat and fail with catastrophic results (as in spraying electro-lyte all over the inside of your receiver).

The regulator used is a LM317T, which is a three terminal device in a TO-220 package. The case must be heat sunk and insulated from ground, so its bolted on the side of the chassis using insulating hardware next to the DC power supply. Nominally a voltage regulator, all one needs to do is add a resistance between the adjustment pin and the output pin. The resistance value is calculated using Ohm's law - if you know the desired current, you merely calculate the resistance value required for a 1.25 volt drop across this resistor. The wattage can then be calculated. What happens is that the LM-317 will change it's ouput voltage to produce 1.25 volts at the adjust pin, so if the current changes, the voltage across R changes and the regulator will respond to this load change until the voltage fed to the reg pin stays at 1.25 volts.

Let's go through the way this works in the SP-600. The four tubes in the front end (two 6BA6s, a 6BE6 and a 6C4) pull a total rated heater current of 1.05 amps at 6.3 volts. As R=E/I, then R=1.25/1.05, or about 1.19 ohms. I used (4) 4.7 ohm 1/2 watt film resistors in parallel which produced 1.175 ohms - pretty close.

All you need do is wire the input to the current regulator to the 14 VDC source, and connect the lead that went to pin 19 to the filament transformer to the output of the regulator. The circuit works extremely well; if you unplug one of the tubes in the front end, you'll see the other three light up much more brightly as the regulator continues to pump 1.05 amps into the remaining tubes. This same means of current regulation can also be used in other receivers or applications, for example, to replace an expensive Amperite regulator.



DC supply/filament regulator for SP-600

The last change I made to improve stability was replacing the stock 5R4/5U4 rectifier tube with a 5AR4. The 5AR4 has about the same specifications, however, it has a much lower internal voltage drop/internal resistance. Therefore, load changes in the receiver have much less effect on the B+ supply. An added bonus is that by being a heater/cathode type of tube, the 5AR4 has about the same warm up time as the rest of the receiver's tubes so B+ doesn't appear before the tubes are warmed up and there's a load on the supply. This keeps the B+ from wildly rising to a peak value during the warm up time as happens with the quickly heating cathode of the 5U4/5R4 type of rectifier. The components in your SP-600 will thank you for sparing them this hi-pot test during every start up cycle.

The net results of these changes to the SP-600 were most gratifying. Once the receiver reached thermal equilibrium, (and it takes several hours to heat up the 20 odd pounds of front end casting in the Pro) one can zero beat WWV at 5 or 10 Mhz and the total drift over each hour is on the order of a few parts per million or better. Commonly encountered line voltage changes at my home produced little observable effect on frequency.

Well, we've gone over the changes required to make the SP-600JX stable enough to use with the most demanding modes used in the 1990s, including SSB, CW, RTTY, AMTOR and Packet. Part two of this article will cover the construction of a high performance product detector and a means of achieving a much lower noise figure, better dynamic range and a real sensitivity of better than 1/10 microvolt for SSB and CW operation.

AM Power Update from page 3

their power privileges have no opponent but the FCC. No offsetting advantage accompanies this FCC action. The rest of the amateur radio, the general public and the FCC would not be disadvantaged in any way by reinstating historic power levels for this emission type.

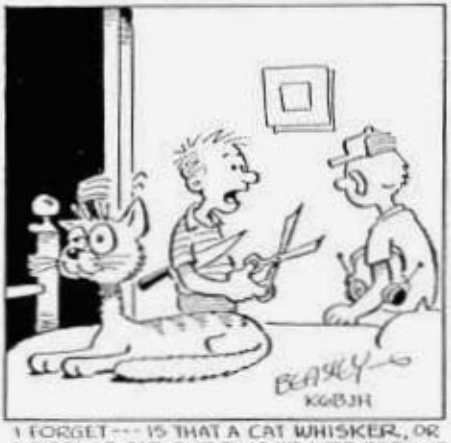
4) The FCC can measure AM power with it's existing field equipment and field personnel without additional training.

5) The FCC in it's public documents on this subject, indicated it would reconsider the planned power reduction if there were enough interest in AM to provide justification. The FCC has ignored the evidence that there is a significant growth in AM useage.

When contacting your representative or Senator you may get better attention if groups of concerned amateurs join in the request rather than each acting individually. Urge your state delegation to contact the FCC and request commissioner review of the petition for reconsideration of RM-7402 and RM-7404.At a minimum the FCC should be urged to create another grandfather period so that they could continue to evaluate AM interest.

Please write or call me if you require any additional information for your letters or presentations.

Editor's Note: For a copy of KW1I's Petition send an SASE to ER.



I FORGET --- IS THAT A CAT WHISKER, OR A PIECE OF CAT GUT THAT WE NEED FOR OUR CRYSTAL SET ?

Reflections from page 2

I thought that must have been the 'ultimate' good deal for me, but in June of this year I outdid it! There was another garage sale ad in the newspaper. I went out early and there at a rural ranch was radio gear of various sorts sitting on the ground in front of an old barn. On the other side of the road was a long line of shoe boxes, side by side, containing various small parts.

It was an estate sale of a silent key, a W6---. The son was disposing of the equipment. The first thing that attracted my attention was a Globe King 500A sitting on the ground. I asked him, "How much for that thing?" He replied,"You can have it. Take anything you want." Then he led me inside the barn, picked up a Collins 75A-1 receiver and handed it to me. So I loaded up the stationwagon again. Included was a Lakeshore sweep tube linear, a TCS receiver and transmitter, a Meissner Signal Shifter Deluxe, a panoramic adaptor plus other items.

This story could go on and on. In January of this year, I placed a want ad in the newspaper and had 8 responses. Out of that, I bought a Hammarlund Comet Pro receiver, an SX-28, 2 TCS receivers and an Apelco marine transmitter. One fellow, who had been a radio/TV serviceman, took me into his metal storage shed and said, "Take the works". So I accepted the Hallicrafters SX-42, a rather corroded '30s BC set, his service test equipment and his large supply of tubes. Two years ago, through an ad I placed, I dug up a Navy SRR-13A shipboard receiver (2-30 Mcs). This fellow's uncle had worked in a shipyard, and this set came out of a decommissioned destroyer.

So -- there's 'gold' out there, if you keep your eyes open and your ears to the ground.

Check out the local ads. Also, let it be known that you like old radios, and they'll come your way. Even ham QSO's sometime produce. A few years ago I contacted K6ZY on CW. We got to talking about equipment and he was lamenting how crowded his garage was with all his radio junk. The end result was that he paid me a visit and brought me a gift of a very nice 1941 Navy aircraft radio receiver and transmitter. Other places that you might find vintage gear are pawn shops, antique stores, junk stores and flea markets. Good luck.

TV-7/U Tube Tester from page 25

switches, but working them for a while cleared the problem. One tube socket had carbon tracked and shorted.

The primary line fuse is a small filament light bulb, which was missing. I substituted a fuse and holder, which fitted into the light bulb hold in the front panel.

The TV-7/U uses two rectifier tubes, an 83 mercury vapor in the bridge circuit and a 5Y3 in the bias and screen grid supply. I would think that solid state replacements would work, but I have not verified that.

With those repairs, I now have a useful and accurate tester much easier to use than the old Weston. The data charts, if you are lucky enough to get them, cover a wide variety of tube types, including many transmitting and industrial tubes. And you are guaranteed against obsolescence, as the charts won't need yearly updates any more.

I would like to thank Arden Allen, KB6NAX, who provided valuable information for the preparation of this article.

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FOR SALE: Radio, test, electronic, surplus equipment; parts; accessories and manuals. Long list - $.50 J. Orgnero, Box 32, Site 7, SS 1, Calgary, AB T2M 4N3 Canada.

FOR SALE: New Bird elements: 5000H - $50; 25 watt 1.8 - 2.5 Ghz, CU-1678 - $75. Plus shipping. **WANTED:** 4" knobs 0-100 scale 1/4" shaft. Duane Angerhofer, POB 540, Edgemont, SD 57735. (605) 662-7692

FOR SALE: Homebrew 550 watt output AM transmitter, commercial quality construction and wiring, PP 100THs RF and PP 100TH mods., 45"x 22" sq., with Johnson exciter and pair of 100TH spares - $300; WRL Globe Champion 350 xmtr, excellent condition w/manual - $150; spare final tubes for Globe Champion 350, 6083/AX9909, new in box - $50 for pair. Cash only, you pick up. Ronald Reu, WBØLXV, RR 1, Box 334, Winfield, MO 63389. (314) 668-6518

FOR SALE: Tubes, new in box. Please send $1 for list of 300+ tubes. Refundable. Wilson Hauck. BTB. Inc. E.R., 6820 Stout Rd., Memphis, TN 38119

WANTED: Any model of Brown Brothers Machine Company key, paddles or bugs. Jim Zimmerman, KG6VI, 2316 W. Dallin St., Lancaster, CA 93536-5702. (805) 945-6539

FOR SALE: National RBL5 VLF receiver, 1943, never in service, near mint - $150. Pick up only. WANTED: Hallicrafters S38E in perfect condition or close. David Rogers, WA7ZYQ, 238 - 10th St., St. Maries, ID 83861. (208) 245-2070

FOR SALE: ART-13 and BC-348R - $175 OBO; Valiant II w/manual, complete, but dead - best offer. Mike Blazek, 16737 Monitor, Baton Rouge, LA 70817. (504) 753-7194

WANTED: Manual for B&W model 5100B and 515B SSB generator, photo copy ok, will pay copying cost. Larry Flegle, 210 Wylie Lane, Woodstock, GA 30188.

FOR SALE: Bigelow Electronics has been in the electronic mail order business since 1954. Vintage parts and equipment available. Request free "Vintage Flyer". Bigelow Electronics, Box 125, Bluffton, OH 45817.

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FOR SALE: Hammarlund SP-600 JX-17 and Hammarlund SPC-10 SSB converter, military cabinets for both; RME -VHF converter model 126; Hallicrafters SW-500; Hallicrafters S-38E and BC-344D. Joe Overmeyer, 1212 Main St., Evanston, IL 60202. (312) 663-0150 days

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FOR SALE: Manual for TMC: SBE & VOX. **WANTED:** Watkins - Johnson 8617 receiver; any tech. info on Racal 6217A receiver (or similar type); TCS transmitter; HQ-170 manual. Bill Dudan, N2KQA, POB 45, Salem, NY 12865.

WANTED: R4C in excellent cond. with SW xtals, AM filters. Cash or trade for R-1000, SP'R-4 or cash. Levy, 8 Waterloo, Morris Plains, NJ 07950. (201) 285-0233

FOR SALE: Western Electric tubes for sale or trade. Also W.E. caps, xfmrs, inductors and relays. Vogt, 330 S.W. 43rd St., #247, Renton, WA 98055.

WANTED: Museum setting up B-17 and B-29 radio stations,need: ART-13A and BC-348, complete, unmodified; BC-375E top cover; RF terminal strip; shock mount; SCR-211; DM PE-9YB for SCR-522; BC-375E tuning units and cases. Pete Patton, WØEWQ, 7053 Delaney Ave., S. St. Paul, MN 55076. (612) 457-5665

FOR SALE: Choice Navy station! Minty TCM-2 transmitter w/ps, cables and RBB-1, RBC-2 receivers with power supplies and manual - $400 or trade for clean T-368. Pickup only. George Babbits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147

FOR SALE: Eico 950B cap checker with manual - $15; Heath TC-2 tube tester - $15; freq. meter TS-175/U, 85 - 1000 Mhz with power supply and manual - $20; National NC-300, no cabinet - $35. All plus UPS. **WANTED:** Bandspread lock knob for SX-42. Dan Mason, 1325 N. Lima St., Burbank, CA 91505. (818) 848-9474

FOR TRADE: ARRL Handbooks. Have 1932, 56, 58, 63, 73, 75 and 78. Need 1931, 35, 37, 38, 39, 40, 41 and 42. **WANTED:** Gross Radio CB55 transmitter schematic/manual, circa 1937. 1938. Bob Mattson, KC2LK, 10 Janewood, Highland, NY 12528. (914) 691-6247

WANTED: Copy of service manual with schematic for Hammarlund SP-400. Willing to pay reasonable rate for copying. Steve Miller, WA3JJT, 909 Walnut St., Erie, PA 16502. (814) 454-8990

FOR SALE: BC-610E with speech amp. and manuals - $125. Chuck Graves, KØRFQ (417) 869-6884

WANTED: National NHU VHF rcvr and SW-4 for cash or trade. Robt. Enemark, W1EC, Box 1607, Duxbury, MA 02331. (617) 934-5043

FOR SALE: Pickup only at Schenectady, NY, the 1930's transmitter of Union College Radio Station W2UC, modified in the late '40s with 810s in final. 1000 watts AM, complete with exciter, speech amp, modulator and power supplies. In 3 relay racks with 2 KVA variac. As trustee of W2UC I am authorized to offer this for sale. Further info contact me at Box 1607, Duxbury, MA 02331 or (617) 934-5043. Robt. Enemark, W1EC

WANTED: Speakers -NC-101X, SX-100, HQ-129X, RAS5, RME-69, CR88; manuals-NC-101X, SX-100, SP-400X, NC-240D, RME-69, CR-88, FB7; main tuning dial- HQ-120/HQ-129X; clean HC-10 converter. Bill Busetti, 1124 W. 2nd St., Florence, CO 81226. (719) 784-3540

FOR SALE: Collins mech. filter type F-70L- 40, new, never used; Heath HO-10 monitor scope; new 807s (mil spec type). Marty Drift, WB2FOU/5, (817) 497-6023

FOR SALE: Do you need tubes, parts, schematics? Send SASE. Nick Marshal, 2207 Peachland Ave., Sebastopol, CA 95472.

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WANTED: ARC-65 and ARN-7 equipment, accessories, etc. Mark Meltzer, 335 Prentiss St., San Francisco, CA 94110-6140. (415) 826-3889 home or (415) 826-8994 ext. 3019 work

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FOR TRADE: My mint Thunderbolt amplifier for your mint 75A-4. Must have SN greater than 3500 and AM filter. Will consider trade for collector quality SX-115. Pick up only. Ron Skipper, AA8AD, 18801 Middleton Rd., N. Benton, OH 44449. (216) 584-2198

FOR SALE: Letine 6 meter transmitter model 242 - $22; new Shure magnetic communication microphone, 404B - $12; as new Daven power output meter, OP-961 - $40. Ward Becht, 625 Tufts Ave., Burbank, CA 91504. (818) 842-3444

WANTED: Collins KW-1. Joel Thurtell, 382 N. Harvey St., Plymouth, MI 48170. (313) 453-8303

FOR SALE or Trade: For Western Electric tubes: Blaupundt Bauj. 1943, WR1NR. 82598; National AN/WRR-2. Vogt, 330 S.W. 43rd St., #247, Renton, WA 98055. (206) 251-5420 ext. 247

FOR SALE: Collins S-Line: 75S-3B rcvr w/ cw filter, 32S-3 xmtr, 516F-2 ps and 312B-4 console. Very good condition. Package - $675. Charlie Vaughn, KD4AJ, 1968 Huntington Hall Court, Atlanta, GA 30338. (404) 396-0276

FOR SALE: National HRO, early model pre-WW-II, rack mount, 2.5 v tubes, 4 coils, HB power supply - $200. Vance Lockenour, W9CNL, RR #15, Box 932, Bedford, IN 47421. (812) 275-4836

FOR SALE: Collect keys? You'll enjoy W1IMQ's illustrated references. "Introduction to key collecting", 64 pages - $9.95, "Vibroplex Collectors Guide", 87 pages - $14.95. Add $2 s/h to total. See your dealer or order direct from: Artifax Books, Box 88-E, Maynard, MA 01754.

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FOR SALE: Books on the history and technology of computers. For catalog send $.50 (stamps) and ask for catalog C1. Rainy Day Books, POB 775, Fitzwilliam, NH 03447.

WANTED: Hallicrafters SX-115 and SX-73; National NC-300; speaker for National NC-303. Will pick up receivers within 300 miles or in Texas or will pay UPS. Bill Smitherman, KD4AF, Rt #4, Box 79, East Bend, NC 27018.

WANTED: Manual and/or schematic for RME DB23-A pre-selector. Bill Skidmore, VE3AUI, RR#1, The Anchorage, Hyde Park, Ont. NØM 1ZØ Canada. (519) 471-8280

FOR SALE: Johnson 275 W Matchbox w/ swr; KW Matchbox w/swr; Collins 75A-4; 32V-3. Inquire about price and availability. Gene, KA6NNR, Box 58003, Philadelphia, PA 19102. (215) 665-6182

FOR SALE: Hallicrafters SX-100 - $95; Johnson Invader - $150; Hallicrafters SX-28 w/speaker - $195; copy of SX-73 manual - $20. Steve Harmon, N9HGF, 4340 N. Congress, Evansville, IN 47711. (812) 474-0842

WANTED: Johnson 213 tube socket; Collins F-455J-60 filter and old Gates or RCA broadcast equipment catalogs. Evan Haydon, NØCMR, 4308 N. 15th St., Lincoln, NE 68521. (402) 435-4083

WANTED: Complete SW-3, SW-5 or Pilot Wasp; Johnson Navigator, Adventurer; Speed-X bug; Ranger meter; WRL 755 vfo and manual. Brian Roberts, 3068 Evergreen, Pittsburgh, PA 15237. (412) 931-4646

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FOR SALE: TCS receiver, converted AC - $20; 1948 ARRL Handbook - $8; 1948/49 Callbook - $8; Archer 6 position coax switch - $3; Magnavox 1-D-1915 speakers - $20 / pair; Alliance M-U100 rotor and control - $10; Elements of Radio, Marcur, 1943 - $5; homemade RTTY demodulator - $10; Heath GW-10 CB converted to 10 meters - $10. Shipping extra. George Babits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147

WANTED: Round or square meter for the Millen 90800 exciter in good condition. **FREE:** Give away used tubes: (12) 2E24; (15) 2E26; (1) 3E29; (3) 814; (8) 837 and (5) 1625. You pay UPS. James T. Schliestett, W4IMQ, POB 93, Cedartown, GA 30125. (404) 748-5968

WANTED: Hallicrafters S/SX-23 info: anyone using a Racal RA 71 receiver? (not RA 17). Wayne, NØTE, Rt 1, Box 114, Burlington, KS 66839. (316) 364-5353

FOR SALE: Heath Apache - $50; Central 600-L - $300 (both need help); BC-453 - $25; Collins 516E-1 - $75; old homebrew amplifier, pair of 813s w/ps - $100; Drake 2-B - $100. Joel Thurtrell, 382 N. Harvey, Plymouth, MI 48170. (313) 453-8303

WANTED: Johnson Viking 500 or Globe King 500. J.M. Roseman, W9UD, 2716 West 3rd St., Coal Valley, IL 61240.

FOR SALE: R460/UR National receiver - $200; Viking Valiant - $175. **WANTED:** IC 2F Varitronics or equiv. Cliff Fleury, AI7Y, 64174 Tumalo Rim Dr., Bend, OR 97701. (503) 382-9162

WANTED: Heathkit HR-10B rcvr; SB 620 Scanalyzer. John Rozanski, WB1CUP, 26088 Kay Ave., #305, Hayward, CA 94545. (415) 785-7240

WANTED: Manual and schematic for RME-69. John Anderson, KA7QKB, 572 S. Deer Trail, Maricopa, AZ 85239.

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Bumper sticker - $1 each with a #10 SASE. We service American made amateur radio products circa 1940's, 50's and 60's. Manuals and/or schematics available for most rigs and radio sets back to mid 1920's. Call or write for a quote on your service or tech data requirements. **Classic Radio,** PO Box 3486 Eureka, CA 95502. 24 hour phone (707) 444-3911. K6VHP

FOR SALE: Collins 30K-2, SN #20; Collins 32V-2; Collins 75A-4 with 3.1 filter; F455J .05 filter - $55. **WANTED:** Valiant II or Globe 350A and NC-303 rcvr. Steve, KE4MN, 4070 W. Hwy 4, Century, FL 32535. (904) 327-4179

WANTED: 6 Kc and 500 cycle mech. filters for Collins 75A-4 rcvr. Dennis Cody/ Marla Banuelos, 1386 St. Louis Ave., Apt. #C, Long Beach, CA 90804. (no phone)

FOR SALE: Test equipment: Eico M-324 Signal Generator; Sencore CG-135 color generator; Eico M-145 signal tracer; Ballantine 310A VTVM; Superior TV-11 tube checker; Sylvania 104 electronic switch - $10 each. HP-410BR VTVM; Simpson 480 Genescope - $20 each. 17 Sams Photofacts; 1950's TV; Tek 53/53 plugin; Tek "D" plugin; RCA M-158 5" scope - $15 each. Pocket VOM - $3; TV Cyclopedia, Coyne, 1951 - $5; Navy LP-5 signal generator w/ ps - $30, HP-608D - $35. Shipping extra. George Babits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147

WANTED: Collins KWM-2 -2A; 75S3B; 32S3 and 516F-2 in need of repair and/or refurbishing. Duane Vasold, K8CCE, 5768 N. River, Freeland, MI 48623. (517) 695-5140

FOR SALE: Transmitting/receiving tubes, new and used. Exa: OD3, 3B28, 4X150, 4X500, 4-65A, 4-125A, 6A3, 12A6, 45, 807, 809, 810, 811A, 812, 815, 829, 832, 836, 872, 1619, 1625, 5894, 6130, 6146, 9003 plus others. LSASE for list. I also collect old and unique tubes of any type. Maybe you have something to trade? John H. Walker Jr., 16112 W. 125th St., Olathe, KS 66062. (913) 782-6455

FOR SALE: 75A-4 AM filter as finder's fee for vintage xmtrs. SASE for details. Parker, W1YG, 87 Cove Rd., Lyme, CT 06371.

WANTED: Johnson SSB adapter; Ranger mobile assembly instructions; RE-2/ARC-5 antenna relay; MT-65; MT-64; MT-71; MT-70; J-17 (all ARC-5, not 274N). Henry Engstrom, POB 5846, Santa Rosa, CA 95402. (707) 579-2070

FOR SALE: Collins - 32V-3, KWM-2 +516F2; Meissner - 150B (300 watt AM rig); Hammarlund - HQ-140X, HQ-145A, HQ-150, HQ-105TR; Heath - DX-35, DX-40, DX-100, VF-1, QF-1, 301/401 combo, SB-300, SB-401, HA-14+HP-14, HW-30; Challenger, Adventurer, Ranger, 250 W Matchbox, Johnson Viking +VFO 122, 6N2 +VFO; Hallicrafters - HT-32, HT-37, HT-41, SX-115, SX-140; Globe - 680A Scout, 90 Chief, 90A Chief+VFO 755, #62 Hibander, Antenna Matcher AT-4; National - 1-10A; NC-183D + spkr; NC-300; NC-303. Drake: 1A; 2B/2BQ; Clegg Intercepter; Gonset: G-28, G-66B; Ameco TX-62+VFO G21; Knight -T-50, T-60; RCA AR-88D; Scott SCR-F. Please write for price, condition etc. Parker, W1YG, 87 Cove Rd., Lyme, CT 06371.

FOR SALE: Pick up in Santa Rosa, CA. Westinghouse MW-2 3KW output AM rig. Less than 3 hours on filament meter - $750; Johnson Thunderbolt - $400; Johnson Viking Invader 2000 - $400. Jack Osborne, K6LVD, 5636 Del Monte Ct., Santa Rosa, CA 95405. (707) 539-3949

FOR SALE: Invader 2000, real good condition - best offer. Jay Bromley, KA5DGH, (501) 648-9138 (leave message)

CLASSIFIEDS

WANTED: SX-122; mic element for Collins SM2/3; Ranger meter switch; speakers for NC-300, HQ-170, SB-300, SX-117 and 2B; also want 2BQ, calibrator and Gonset G-28. Bill, KE7KK, 6712 Lake Dr., Grand Forks, ND 58201. (701) 772-6531

FOR SALE: Collins KWS-1 (2) - $750 each; 75A-4 (2) - $350 each; 312A1 speaker - $125; 312A2 speaker - $250; National NCX-5 - $150; National HPS, w/ps and coils - $125; Harvey Wells T-90 - $75; NC-173 - $75; NC-2-40 CS - $150; NC-400 - $300. Jack Osborne, K6LVD, 5636 Del Monte Ct., Santa Rosa, CA 95405. (707) 539-3949

FOR SALE: Good used 813s - $15; 811As - $10; 866As - $5; 6L6s (metal) - $3; 810s - $20. SASE for list. Gary Cain, 1775 Grand, #302, St. Paul, MN 55105.

WANTED: GO-9 or TBW surplus transmitters and a "Junker" BC-375-E. Ted Bracco, Quincy College, 1800 College Ave., Quincy, IL 62301. (217) 228-5213

WANTED: Viking Ranger I; model 122 vfo; information on Viking I TVI suppression kit; info on PA oscillation suppression for Pacemaker. John Brewer, WB5OAU, 7605 Roberts NE, Albuquerque, NM 87109.

FOR SALE: B&W 5100 transmitter, some rust spots on face panel otherwise good - $95 pick up only; Hallicrafters SX-101A Mark 3, condition good but not mint - $85; RME VHF 152A converter - $35. Henry Engstrom, POB 5846, Santa Rosa, CA 95402. (707) 579-2070

WANTED: Late model R4C with AM filters and SW xtals. Trade 51J4 or cash. Levy, 8 Waterloo Dr., Morris Plains, NJ 07950. (201) 285-0233

WANTED: Very old or unusual Hallicrafters equipment, entire 1934 "11" and "Z" line of Silver Marshal, parts, memorabilia and manuals. Chuck Dachis, "The Hallicrafter Collector", WD5EOG, 4500 Russell Drive, Austin, TX 78745.

CLASSIFIEDS

WANTED: ARN-1 schematic/book, altitude limit switch, antennas or other accessories. Brown, 4141 West L-2, Lancaster, CA 93536.

FOR SALE: Tubes: miniature and octal, most $1, transmitting, antique. Over 3000 in stock. Nearly 500 different types. $1 plus large SASE brings list. George Babits, WA7HDL, Rt 1, Box 178-A6, Salmon, ID 83467. (208) 756-4147

FOR SALE: Hallicrafters HT-32, SX-101, SX-101A and SX-42 with speaker - $100 each; Hallicrafters SX-117 and HX44 - $275 for pair; Collins 75S3 - $225. All units good working, offers considered. RME VHF 152A, untested - $45; unused B&W FL10/1500 low pass filter - $30. Tubes, mostly NIB: 6146A - $6; 813 - $18; 807 - $4; 2E26 - $4; 27 - $3.90; 30 - $4.30. **WANTED:** Still need Collins 3251 or 3253 for parts. G. Stevens, WØATA, Box 704, Longmont, CO 80502-0704. (303) 776-9036

Electric Radio - the first year - all twelve issues delivered First Class in a padded envelope - $25. Individual copies $2.50 delivered. #1,#2 #5 and #11 are reproductions.

WANTED: Coils, power supplies, speakers, manuals and accessories for National HROs (early black wrinkle models). Also, want early HRO receivers. Absolutely top dollar paid. Jim Allen, 1653 Newcastle Drive, Los Altos, CA 94024. (415) 968-0640

FOR SALE: Miscellaneous odds and ends, antique radios and parts. LSASE for list. Hidyne Research, POB 3342, Williamsport, PA 17701. (717) 326-2148

WANTED: RCA AVT-15 transmitter; AVA-120 trailing wire antenna reel and related hardware; SCR-319 items. Ken Gillis, 27217 Garden Way, Franklin, MI 48025. (313) 390-6873 days.

FOR SALE: Repair and restoration on all vintage equipment; 35 years experience. Barney Wooters,W5KSO, 8303 E. Mansfield Ave., Denver, CO 80237. (303) 770-5314

ER Parts Unit Directory

At this point the directory has 135 units in it and it's growing daily. If you need a part for a vintage restoration send $1 and an SASE for the list. If you have a parts unit consider putting it on the list. Your dead unit can help bring others to life.

CLASSIFIEDS

FOR SALE: DY-17A/ART-13A NOSB - $45; BC-306A or B, good - $45, fair - $35; connectors for most military radios before 1955; TM's and TM repros; TM 11-487 repro - $35; tubes, all FOB Houston, LSASE and 2 stamps for list (s). **WANTED:** BC-344/BC-314; SCR-506 parts; MP-37, MP-47, MP-48, MP-50 antenna mounts; dynamotors DM-41, DM-43, DY-31/ARC-2, DY-96/VRC, DY-142/VRC and other dynamotors; cables, chests and other parts for SCR-499 (BC-610-E, etc.); VRC-29, GRC-46 units. Misc parts especially hard to find. If you have something that you can't identify, call or write. Robert Downs, WA5CAB, 2027 Mapleton, Houston, TX 77043. (713) 467-5614

WANTED: CQ Surplus Radio Conversion Handbook; CQ Surplus Schematic Handbook; CQ Anthology Volume I and Volume II; Index to Surplus by Roy Pafenberg, W4WKM, published by 73 Magazine. Alan Mark, POB 372, Pembroke, MA 02359.

FOR SALE: Zenith Universal 5-tube, portable radio, yellow-orange colored cabinet, works, front lid and knobs (2) missing. Parts radio? - $30 plus shipping. Stanley Stenerson, 11464 Palm St., NW, Coon Rapids, MN 55433. (612) 755-4485

FOR SALE or TRADE: Collins 75A-3 rcvr w/6 Kc and 3 Kc filters, excellent cond., w/manual - $200; Dentron 2500B linear, 2 KW PEP - BO; Dentron antenna tuner/monitor, 2 KW PO - BO; Tubes: 805, 813, VT4C (211) - $15 each; 866A - $5; tube sockets for all above tubes; 60 yrs of QST -BO, PU only. All items plus shipping. Russ Hunt, W9HZD, 201 Sharon Dr., Barrington, IL 60010. (708) 381-6237

WANTED: A good copy of NC-303 schemati; S-meter for NC-300 or NC-303; S-meter for Communicator III; manual for Tek type 543 scope and 1A1 and L plug-ins. These are urgently needed. Please take the time to look. Thanks. Clyde Sakir, N7IOK, 4243 East First St., Tucson, AZ 85711. (602) 323-1120

FOR SALE: Have parted out a Hammarlund SP-600 and a Collins 32V series. Anyone need parts? **WANTED:** In excellent operating condition, National NC101X with 'S' meter and RME DB20 preselector. Roland Matson, K1OKO, RFD#1, Box 2943, Kennebunk, ME 04043. (207) 985-3751

WANTED: Military sets: R-61/ARQ-5 rcvr, BC-966 IFF, ATB xmtr, ID 59/APA-11 and IP-148/APA-11A indicators. Leroy Sparks, W6SYC, 924 W. McFadden Ave., Santa Ana, CA 92707. (714) 540-8123

WANTED: I now have a Hallicrafters HT-40 xmtr. Does anyone have the matching SX-140 receiver for sale? Charles J. Graham, K6KDZ, 20335 Casa Loma Rd., Grass Valley, CA 95945. (916) 273-6847

WANTED: Manual for Johnson Courier and Olson RA-48 comm. rcvr; Electronics Illustrated, June 1961, Sept. 1962, Nov. 1972; Radio Electronics Jan.'55, Jan. '56. Al Bernard, NI4Q, POB 690098, Orlando, FL 32819. (407) 351-5536

WANTED: Audio driver xfmr Stancor A-3802 or Thordarson 22S78 or SNC 6P726, also NC-303, must be in good condition. Merle Crowley, W1GZS, POB 51, W. Kennebunk, ME 04094. (207) 985-3086

WANTED: Cash reward! For clean unmodified Heath DX-35 or HX-11. I need a junker Johnson Navigator too. Marcus Frisch, WA9IXP, Box 28803, Greenfield, WI 53220-0803. (414) 545-5237

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

Please remember to count the words in your ad. If you are over 25 words please send 15 cents for each addictional word.

CLASSIFIEDS

WANTED: Buy and sell all types of electron tubes. Harold Bramstedt, C&N Electronics, 6104 Egg Lake Road, Hugo, MN 55038. (800) 421-9397, (612) 429-9397

FOR SALE: Newly published instruction books, authorized by Rockwell International, are now available for the Rockwell/Collins S-Line. These instruction books are brand new and have been printed from the latest editions - complete in every detail, including the front and rear color covers. A money-back guarantee of the purchase price ensures your complete satisfaction. Instruction books for the following models are currently available. KWM-2/2A ($35); 75S-3B/C ($30); 32S-3A ($30); 75S-3/3A ($25); 32S-3 ($25); 312B-4/5 ($20); 516F-2 ($15). For U.S. orders, include 7% of the purchase price for shipping and handling. (Canada and Mexico add 12%; all other international countries add 25%) Ohio residents add 6% sales tax. VISTA Technology Incorporated, 3041 Rising Springs, Bellbrook, OH 45305. (513) 426-6700

WANTED: Collins 51SI general coverage receiver, parts or complete, any shape. George Cato, K4RYH, 915 Hunter Hill Dr., Roswell, GA 30075. (404) 993-5403

WANTED: Brown case "Oceanic" type radios. Also want SR-500 and Electro-Voice 419 mike stand, mike or both. Edward Deptula, KA3OTT, POB 751, Havertown, PA 19083.

WANTED: Transistor radios from the '50s and early '60s. Cash or trade. James Weil, 15915 Armada Ctr. Rd., Romeo, MI 48065. (313) 784-9860

FOR SALE: Thordarson multi-match modulation xfmr, type 21M64, 300 watts - $30. Tom Berry, K9ZVE, 1617 W. Highland, Chicago, IL 60660. (312) 262-5360

WANTED: Cabinet for Collins 30L-1 linear amplifier. Stewart Meyer, W2GHK, 2417 Newton St., Vienna, VA 22181. (703) 281-3806 or FAX (703) 281-3868

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FOR SALE: Antique radios, parts, tubes, books, 150 panel meters, knobs, amateur, test equipment, transmitter crystals, etc. 13 lists. SASE + $2 cash (no checks). Richard & Rose's Radio Mart, POB 691443, Tulsa, OK 74169.

WANTED: WW-II military electronics; test equipment, radios, radar, odd-ball items, counter measures, APS-13; also manuals, books, articles pertaining to same. William Van Lennop, POB 211, Pepperill, MA 01463. (508) 433-6031

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

ELECTRON TUBES: All types - microwave, transmitting, receiving, obsolete, military--Large inventory. **Daily Electronics Corp.**, POB 5029, Compton, CA 90224. (213) 774-1255; (800) 346-6667

CLASSIFIEDS

FOR SALE: Used technical books: radio, electronics, math, military, magazines, etc. $1 for large list. Stamps OK. Softwave Communications, Dept. ER, 1515 Sashabaw, Ortonville, MI 48462.

WANTED: Collins KW-1, 30K, 32V-3, 75A-3, 270G speaker for 75A-4, KWM-2, late W/E for my collection. Will pick up or pay shipping. Joe Rose, WA2PJP, 60 Sunset Ave., Selden, L.I., NY 11784. (516) 736-0261

WANTED: SCR-399A;HO-17 shelter;BC-610E; BC-312; BC-939; BC-614; JB-70A;tuning units; coils; chests; reels; whips; cables etc. Bill Harris, W7KXB, 852 W. Jerome Cir., Mesa, AZ, 85210. (602) 838-0215

WANTED: Type 6000 electron tube for T-368 transmitter. Bill Mills, KC5PF, 1740 Tonys Court, Amissville, VA 22002. Office: (703) 818-3955 Home: (703) 937) 4090

FOR SALE: Monitor oscilloscope, Millen model 90932. Cute little desktop unit, 2" screen, band selector 4-50 Mcs, mint cond.- $50 incl. shipping; various monoband AM limiters pulled from broadcast service, get louder sound from your hi-fi xmtr, very clean, low-distortion processing. WA3VJB, Box 73, W. Friendship, MD 21794-0073.

WANTED: National HRO-60T accessories: HRO-60TS speaker; SOJ-3 Select-O-Ject; Coils,AB & AC; Collins 75A-4 accessories: 270G-3 speaker; mechanical filters, 455 J-08 & 455 J-60. I will pay top $ for any or all of the above. Frank DeCoito, WB6YSP, Star Rt. #2, Box 242, La Honda, CA 94020. (415) 948-2045

FOR SALE: 75A-2 - $150; Drake TR6 - $290. WANTED: SX-88 - $250 paid, dead or alive. Mike Palmer, K5FZ, 16707 Creeksouth, Houston, TX 77068. (713) 444-7737

WANTED: Collins 51S1, 62S1, 51J4, KWM-1, KWM-2A, S-Line, 312B3, 312B4, 312B5, 75A-1, 75A-4 with filters, 270-G speaker, 30L-1, 30S-1 round only. Larry, NE8V, 9307 Worley Mill, Hillsboro, OH 45133. (513) 981-2462

WANTED: Modulation xfmr, RCA HAS 5500 ohm on pri & sec., sec .198 A, 1.14 KVA or UTC CVM-5. Call after 6 p.m. Bruce, W9OTM, (708) 474-8910

WANTED: Instruction manual for Hallicrafters SX-43. Need the alignment pages, particularly the RF-osc-mixer locations for each band. Will appreciate loan of a copy and will return next day. Seymour Krevsky, W2JBI, 69 Judith Rd., Little Silver, NJ 07739. (201) 741-4918

FOR SALE: RAK-7 - $60 pu only; Gonset Communicator IV , 6 &2 - $80 for pair. WANTED: Navy RAX CG-46115 rcvr; manual for ATD xmtr. Steve Davis, KD2NX, 2372 84th St., Brooklyn, NY 11215. (718) 265-2390

FOR SALE: Johnson Desk KW - $1200 or best reasonable offer; SX-115 with R47 spkr - $250; 51J/388 rcvr - $275. All very clean, working, w/manuals. Bill Jenkins, WA5MWJ, Rt 2, Box 429K, Fort Smith, AR 72916. (501) 646-3859

FOR SALE: B&W BTEL 10-80 grid coil - $20; 3C24 tube - $12; 4-65A and socket - $45; Daven attenuator,variable - $15; 100 Kc crystal with oven - $20; 2.5 volt, 14A, xfmr - $20. Jos. Battyany, W6CAS, 1501 Sherwood Ave., Sacramento, CA 95822. (916) 731-8261

FOR SALE: BC-610H with BC-614 speech amp. , BC-939 tuner,manual, scope and Johnson 122 vfo. Larry Wright, N9HRQ, 131 Hilltop Dr., Lake In The Woods, IL 60102. (708) 658-7328

WANTED: Where are those hams and experimenters who like to scratch build their own radio and electronic gear? We've just salvaged 16 Lamda power supplies and have '50s toggle switches, fuseholders, pilot lights, wirewound resistors, paper filter capacitors and other parts. Send us your needs, with SASE, for quote. James Fred, Cutler, IN 46920.

A directory of vintage parts unit rigs available to subscribers for $1 and a LSASE. Presently there are 135 units in the directory and it's growing daily. The list of units is by manufacturer in alphabetical order followed by the owners address and telephone number. If you have a parts unit please let us put it on the list.

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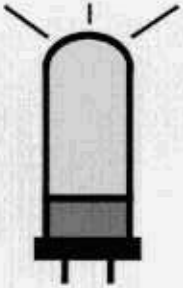

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