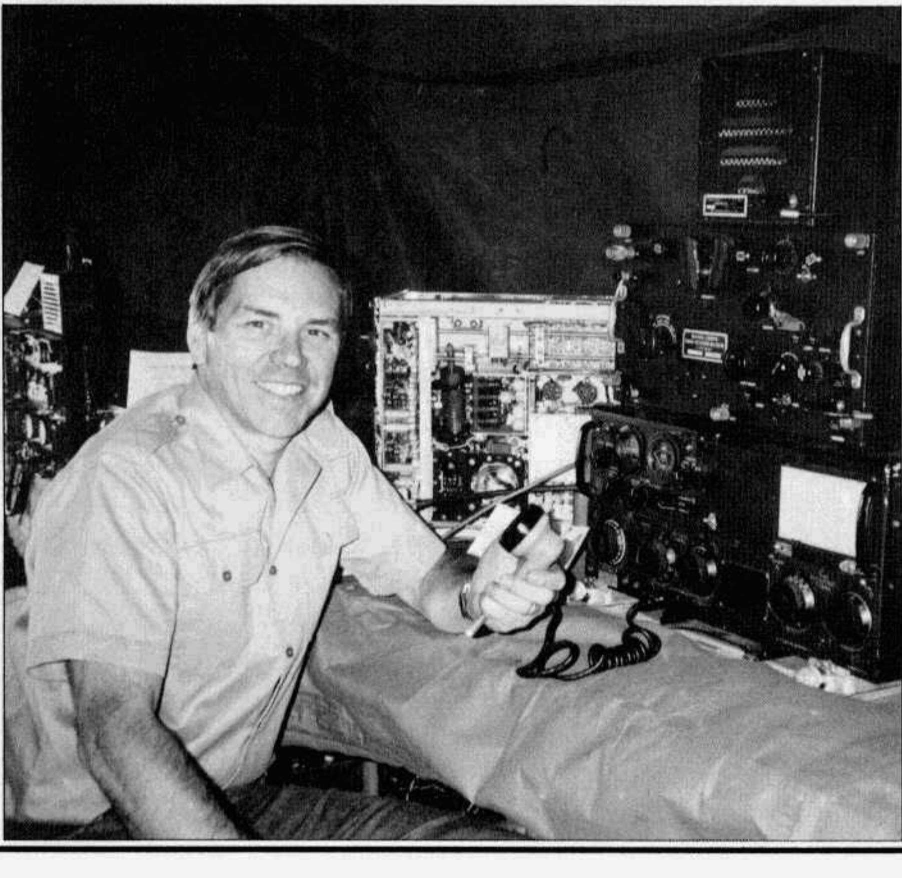
ELECTRIC RADIO

celebrating a bygone era

Number 10 February 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 CW 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

First thing this month I want to note the passing of a good friend, Gordon Bachand, W5ERJ. Gordon died this January in Albuquerque at the age of 69.

Gordon was not well known in ham circles; the last few years he operated only on 75 and 40 meters and ham radio to him was primarily a way to keep in touch with friends.Those friends were mostly men he had worked with at Sandia Labs in Albuquerque (he was a scientist there for many years). He joined these friends afternoons on 40 meters. Bob, N5IOS and myself have been meeting with him on 75 meters for the last few years. There were others who joined us on 75 - most regularly for the past year or so Kevin, KA5STE.

In a recent letter Bob, N5IOS summed up Gordon very eloquently,"Gordon both on the air and off, was a thoroughly decent gentleman. His intelligence and wit allowed him to make any point he wished to make without offending anyone. He never resorted to cheap shots, put downs or rough language. Gordon cared about his friends and we cared about him".

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Reflections Down the Feedline

by Fred Huntley, W6RNC
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It was kind of a setup, and I was the willing victim. In 1962 I went over to San Francisco to visit W6EAR, the maestro of the Wheatstone perforator keyboard and paper tape automatic CW. Soon after we went down to his shack in the basement, next to the laundry room, he started lamenting that his wife didn't like the Techrad T-350XM transmitter - that it was too big, took up a lot of room etc. Then, with pleading eyes, he asked me if I wanted to acquire it.

While we conducted our eyeball QSO, I thought the matter over and then concluded a deal; I bought him a new E.F. Johnson Co. Warrior amplifier and he gave me the Techrad. The Warrior was a small black box with a pair of 811A's rated at 500 watts input.

So, a week later, we loaded the transmitter into the back of my 1951 Willys station wagon and went over the San Francisco Bay bridge to my QTH in Berkeley. The transmitter was set up in the garage - near my radio shack.

Today, 1990, W6EAR's Warrior amplifier is long gone, W6EAR himself is gone, but the Techrad T-350XM is still going strong in Nevada City.

The T-350XM was built in 1944/45 by the Technical Radio Co. of San Francisco, California. It's physical dimensions are: 60" high, 16" wide and 24"deep. Weight is 690 lbs. The power output is rated at 350 watts CW and 250 watts AM phone. Actually, it is capable of 500 watts output on CW and 350 watts output on phone. The frequency range is from 2 to 20 Mcs continuously. The T-350XM consists of a power supply, modulator, rf section with vfo and antenna tuner.

The tube line-up is a 6SJ7 m.o., 6SK7 buffer, 6J5 xtal osc., two 807 buffer/doublers driving parallel 813's in CW or class B modulated by a pair of 805's. The speech amplifier is separate in a receiver-size cabinet.

Equipment of the size and shape of the T-350XM was originally built by RCA for the British Air Force during WW-II. The narrowness came about because 3 or 4 of these transmitters had to sit side by side within a trailer that served as a base station for the British aircraft. The trailers were moved from place to place as airfields were captured during the African campaign. Several hundred of the T-350XM's also were used in the British/American campaigns in the Burma theatre.

The original RCA design was rather primitive in comparison to the later Techrad design. E.R. Johnson Co. also made some of these transmitters, but they were a copy of the RCA design. Techrad built 2,000 T-350XM units during the war. When peace was declared, an additional 300 units were disposed of on the surplus market.

All power supply equipment and transformers are of broadcast quality. Construction through-out the transmitter is truly superb; heavy duty, beautifully designed and of high quality. The final test for each unit was to load to maximum input with all covers on and let it run for 24 hours! Every set met these standards because in desert environments, where the trailer was operated, interior temperatures might exceed 135 degree F.!

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AM POWER ISSUE UPDATE: AMERICAN RADIO RELAY LEAGUE SUPPORTS AM POWER POSITION

by Dale Gagnon, KW1I
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Saturday evening January 20, I received a call from Tom Frenaye, ARRL New England Division Director, who had just returned from the close of the ARRL Board of Directors meeting. Tom called to report the good news. A motion to petition the FCC for retention of present AM power privileges was passed with a vote of 11 to 3, with one abstention. The motion specified that a petition would be filed with the FCC by the ARRL requesting modification of Part 97.313 (b) to include a separate power measurement for AM DSB. The petition will specify a maximum unmodulated carrier output power of 750 watts.

The previous Saturday, I was invited by Tom to attend his Section Manager staff meeting and to present a request for ARRL action on the scheduled power reduction. The presentation was well received. Tom indicated he would make a motion at the ARRL Board of Directors meeting the following week in favor of the AM position. He had already corresponded with other directors on this topic and two of them were ready to second his motion.

This is an ideal example of how the League works to represent amateurs. If AM operators had not written and called their Section Managers and Division Directors the vote might have been far different.

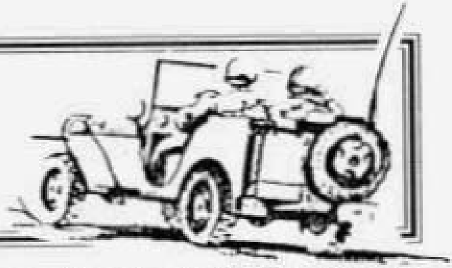
Many of us were very pessimistic about League support. This gives us something to think about and something to be thankful for.

The next action will come from Chris Imlay, the ARRL's counsel in Washington, D.C. I contacted him shortly after the ARRL Board's decision. He was planning to submit a petition to the FCC in several weeks time. I forwarded him my correspondence on the subject for reference. He seems very enthusiastic about his task.

After the ARRL submission to the FCC we must wait for a response. Hopefully, this will be an assigned docket number and a Petition for Rule Making Public Notice. A comment period of 30 days follows this public notice. The AM community must be ready to demonstrate its vitality with a significant number of supporting comments.

Many thanks to the American Radio Relay League and those Division Directors who faithfully represented the sentiments of concerned amateurs in their geographies. Also thanks to each petition signer, letter writer, and phone caller who took this issue to heart. Finally, thanks to AM Press Exchange publisher Don Chester and Electric Radio publisher Barry Wiseman for keeping the AM community informed and positioned on this important subject.

ELECTRIC RADIO IN UNIFORM



by Walt Hutchens, KJ4KV
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The TBY

Recent columns have discussed relatively complex radios. All were 'successful' and some were milestones, establishing new standards for effectiveness. This time we'll go to the other extreme, and study a set which is simpler than many ham homebrew projects and which -- while clever and interesting -- was hardly a pebble on the trail, let alone a milestone.

Overview

The TBY is a seven tube transceiver designed in the late 30's. It is capable of AM and MCW, and covers 28 to 80 Mcs in four bands. By postwar standards it is a primitive set. The transmitter is a modulated oscillator -- a pair of 958A 'acorn' tubes in push-pull giving about 1/2 watt of output. The receiver consists of a 959 detector followed by two stages of audio. So far as I know, this is the first U.S. military radio to be operable from a man's back -- not a small man, however, since the radio (with battery, headphones, antenna, and mic) weighs almost 40 lbs!

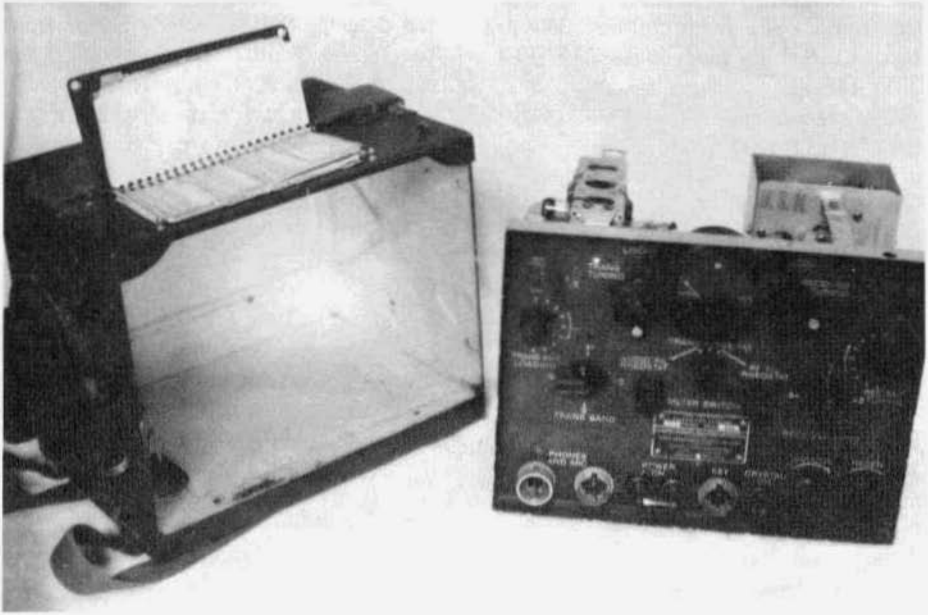
History

The story of the TBY begins in 1936 with a Navy specification for a portable transceiver for use by the Marines and naval shore parties. Westinghouse got a contract to build a demonstration model and 54 sets. The model was built using 'G' glass tubes; when it was tested the next year, the Navy considered it too large. The introduction of 'acorn' tubes (the 954 was announced in 1935), however, offered a solution and four models of a smaller version were delivered to the Naval Research Laboratory in the Spring of 1938. In 1939, the Marine Corps -- now in charge of the procurement -- asked for delivery of the 54 sets, designated 'TBP'. Before delivery further improvements were made (among these, probably, was the adoption of the 958 and 959 1.25 volt filament acorn tubes announced in 1939) and the TBY nomenclature was assigned. In February 1940 the Navy ordered 474 TBY's from Westinghouse. Later orders (615 TBY-1 in January 1941 followed shortly by 2400 TBY-2, and so on) were subcontracted to Colonial Radio.

Many improvements were made in succeeding models. Among these were: a stronger antenna mounting; on/off switching of all sections of the battery rather than just the filaments; an SO-239 connector to allow use of another antenna; and elimination of the dial lamps which were too weak to be much use but allowed water into the set. The series ended with TBY-8, procured about 1944.

The TBY was the portable and shore-based end of the Navy short range radio communication system. Combatant and other large ships had the TBS transmitter and receiver covering 60 to 80 Mcs. The TBS was the standard 'maneuvering' radio throughout the war and for a few years after, until the adoption of UHF (225 to 400 Mcs) for that function. A third equipment, the MBF transceiver (also 60 to 80 Mcs), was procured late in the war for craft too small for the (several hundred pound) TBS installation and for semi-portable applications.

' Ready to go' with the TBY. A clip on the microphone allows attaching it to your pocket.



TBY-6 removed from the case. The black object on the top of the case is the key.

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Safety Warning

The TBY has one design feature which you must consider if you plan to own or restore one. On most models, all front panel labels are done with radioactive paint; likewise the lines on the nine pointer knobs and the meter face and pointer. This paint is 'hot' enough that you must take a few precautions. No one should be within a few feet of this radio on a continuous basis. You can work on it, test it, and show it to visitors, but don't store or display it by your favorite chair or under your bed.

Take great care to avoid swallowing or breathing paint particles. Stay away from sets with peeling paint on the panel. If you clean the panel, wear rubber gloves and clean only with cotton swabs and paper towels, using only water; discard used materials and gloves in a sealed bag. They will not be radioactive enough to be detectable from a foot away, but you must not get particles in your mouth, lungs, etc.

Under no circumstances use abrasive on or scrape any of the markings. Keep this radio away from children. We are talking CANCER here, so BE CAREFUL.

TBY Design

The set is a cube, 8" x 10" x 7" inches (H x W x D) with a top which opens on a hinge at the rear like a lunchbox. A whip antenna about nine feet long in ten sections mounts on the left side. The RF circuits are in the top of the box and audio and other components are on the chassis. A five pin plug on the bottom of the set connects to a dry battery or other power supply strapped underneath.

These mechanical details are so similar to the Army's BC-222/322 (of SCR-194/195, an early '30s design) that it is apparent that Westinghouse was looking at that radio, however the electronic design is miles beyond the Army sets.

There are separate bandswitches, tuning dials, and antenna adjustments for the transmitter and receiver. All coils are in open turrets rotated by the bandswitch knobs; they are wound of enameled solid silver wire held together with glued strips of polystyrene. A panel meter calibrated only by a mark at the center is used to load the transmitter and to set the filament voltage on the AF and RF tubes. Connectors for mic and phones and a key are along the lower edge of the panel.

Rated receiver sensitivity is five microvolts. On receive, the detector is coupled to a type 30 triode driving a 1E7 dual pentode with the sections in push-pull. On transmit, the mic feeds the grids of the 1E7 to plate modulate the 958's; the 30 is used as an oscillator when sending MCW. A 5 Mcs crystal oscillator (another type 30) provides markers for calibration of the transmitter and receiver.

While the concept is primitive, the implementation is excellent. A push-pull oscillator is better behaved under modulation than a single ended circuit; a push-pull modulator gives good linearity with less power consumption than a single ended circuit. With an RF stage ahead of the detector there's little radiation from the receiver and the superregeneration is smooth and problem free.

The tuning range of 28 to 80 Mcs is divided into 131 numbered channels, each 400 kcs wide. A spiral bound calibration chart on the top of the set shows dial settings for each channel; dials are calibrated 0 - 12 on a flat dial (first two digits) and 00 - 99 on a drum (second two digits). There are separate charts for receiver and transmitter and the settings for a channel sometimes differ considerably – even to the point of being on different bands!

The calibration chart also gives the number of antenna sections to be used – five to ten, depending on the channel. Calibration charts were individually prepared for each radio.

Getting the TBY to Work

My set came with a fairly complete set of accessories, including the vibrator supply. The price was about $50; prices for TBY's range from $10 to perhaps $75 depending on accessories and condition.

In order to find out more about the set, I put TBY-6, S/N 578, back in operation. I won't relate the details but after several hours of work I tuned the set to 29 Mcs, attached the whip antenna, and -- an AM QSO came blasting out of the phones! Somehow it is always a thrill when this happens....

The receiver bandwidth is about 200 kcs at 29 Mcs; about what you'd expect for two tuned circuits and a superregenerative detector.

On 'transmit' the dummy load says over 1/2 watt on selected frequencies in each band so there's no troubleshooting to be done.

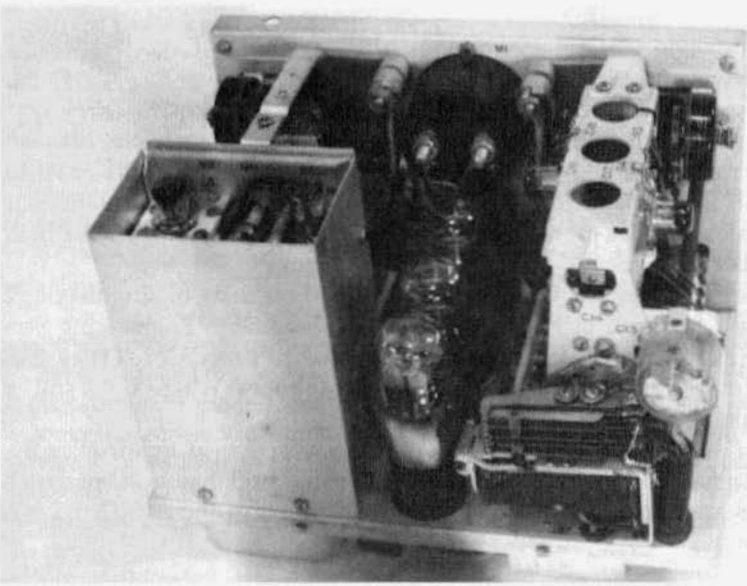
Stability is terrible, as you might expect for an oscillator coupled directly to an antenna.

At 29 Mcs, handling the mic cord changes the frequency by about 10 kcs and touching a control causes a shift of up to 20 kcs. Touching the base of the antenna changes the frequency by 25 kcs, at the center, 200 kcs, and at the tip, even more.

The usual forty minute frequency stability test cycle was attempted but because of the effects listed above I could not get meaningful data. During a one minute transmission the transmitter drifts down about 10 kcs.

Conclusions

This radio is (and was even in 1940) a living dinosaur -- a refined example of what life was like when radio was much younger. But, however strange it seems to us, a communication system based on a transmitter which drifts or jumps 20 kcs could be effective, given 400 kc channel spacing and a receiver bandwidth of 200 kcs -- and provided you have enough megacycles of spectrum to provide the required number of channels.



Rear view of the TBY-6 with the case removed. The superregenerative detector is in the box at the left; the transmitter oscillator is the assembly at the right.

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Part of the design group on the 30L-1. **Left to right; Gene Senti, Fred Johnson and Les Arthur . The fourth person is unidentified.**

A brief biography s of E.W. Pappenfus:

In 1941 he started with Collins Radio as a test engineer. He worked his way up through the ranks and when he left Collins in 1962 he held the title of Head of Development, Department 'B'. This department was involved with amateur equipment , AM broadcast transmitters and SSB HF military equipment both ground and airborne.

Since 1962 he's worked for Granger Associates (President of Engineering), Hoffman Electronics (Head of High Frequency Development, Engineering Section) and lastly as the President of the Vega Division of Cetec Corp.(They pioneered in the development of cordless studio microphones) where he is still a part-time consultant.

At the age of 72 'Pappy' is still very busy; he is active in amateur radio, continues to pursue his hobby of restoring Corvairs, and has a small ranch where he grows grapefruit. He is also long time member of the ARRL and is a fellow of the IEEE.

THE BIRTH OF SSB AT COLLINS

by E.W. (Pappy) Pappenfus, K6EZ
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Single sideband is a communications technique that was developed in the mind of a Bell Labs pioneer in 1915 but it took a long time before it became commercially usable. It was not until 1927 that the telephone company was able to start trans-Atlantic radio telephone service using SSB. This service was expanded in the 1930's to cover most of the civilized world but there was not much other use until after World War II. Central Electronics in Chicago started selling kits to the hams in about 1950 using the phasing method of single sideband generation. This requires accurate control of phase shift in both the r-f and in the audio paths to achieve good sideband suppression. R-f phase shift is not hard to control but a wide band accurate and stable audio phase shifter is more of a problem. In spite of the potential limitations, the Central Electronics equipment introduced many hams to the new world of SSB.

To make SSB practical for wide applications for the radio amateur, several technical advances were necessary:

1) Improved frequency stability

2) Better sideband selection filters

3) Linear amplifiers with low extraneous signals

4) Receiver circuits with low cross-modulation and large dynamic range

The early telephone SSB systems used a pilot carrier in the transmitter and an automatic frequency control in the receiver. This resulted in greater receiver complexity and put an undesired carrier "whistle" on the air. Even though the pilot carrier was reduced it still could result in undesired interference. To avoid the pilot carrier, much better frequency stability was needed in both the transmitter and the receiver.

It was the firm belief, among us in the Collins engineering department that the successful adaptation of SSB to ham use was to make the system as stable and fool proof as AM. This, we felt, meant using the filter method of stripping off the undesired sideband.

If one uses SSB to reduce the band occupancy it does not make sense to build an amplifier that produces unwanted modulation products that splatter over a large part of the band. Low amplifier intermodulation distortion is also a must in linear amplifiers.

On the receiving end, the spectrum-saving advantages of SSB will not be realized if the receiver cannot nestle up to a strong adjacent channel signal without difficulty. Receiver circuits having the capability of handling very strong signals while copying a weak signal were needed. Also the receiver could not produce internal signals due to the frequency generating scheme or by interaction of in band and out of band signals if the full advantage of SSB was to be realized.

How do you get to these new levels of technical achievement?

Art Collins in late 1952 walked into my engineering department at the Collins Radio Third Street Building and pointed at my best engineer and technicians and said, "Next Monday I want these people and supporting test equipment in the Butler Building next to the main plant to start a crash development program for single sideband circuits". I swallowed hard thinking of the commercial and military projects that were affected and said,"Yes Boss". At the time it seemed like a real problem for existing projects but in retrospect, it was a brilliant decision with almost perfect timing.

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SSB at Collins from previous page

The frequency stability problem had been solved by the permeability tuned oscillator developed by Ted Hunter for the early post war amateur and military equipment. This oscillator used temperature compensation and a variable pitch coil with an accurate lead screw driving a powdered iron core for linear tuning with excellent accuracy. In addition, the double conversion scheme with a low frequency variable oscillator and high frequency crystals for each ham band gave nearly the stability of a crystal controlled rig with the tuning ease of a VFO system. Thus the techniques were in hand for sufficient frequency stability to permit tuneable SSB transmitters and receivers without the need for a pilot carrier in the transmitter and automatic frequency control in the receiver. It was natural for the crash SSB development project to use the proven frequency scheme of a low frequency VFO and double frequency conversion with a high frequency crystal oscillator in the prototype equipment that came out of the Butler Building.

Experiments were conducted using automatic frequency control of variable frequency oscillators using frequency counters but the counting circuits available at the time used vacuum tubes, the counters were large and burned up lots of power. This meant that they were not practical for amateur equipment. Now all of the current ham equipment uses voltage controlled oscillators and frequency counting to get stable transmitters and receivers. All of this was anticipated in the work done at Collins in the early 1950's.

The frequency control system developed in the Butler Building was called a Stabilized Master Oscillator or SMO. In this system, a spectrum of, say, one khz, signals were generated and a variable frequency oscillator was locked to this by using automatic frequency control driving a motor control frequency correction circuit. In this way the variable frequency oscillator was made as stable as the frequency standard generating the one khz spectrum. This scheme was used in a number of military applications but, as said before, it did not get into amateur gear.

Very sharp filters were needed to pass 300 Hz in the desired sideband and reject 300 Hz in the undesired sideband. It is nice to get some attenuation of the carrier also to reduce the balance requirements in the balanced modulator of the transmitter. One would like to get, maybe, 20 dB reduction of the carrier and 50 to 60 dB of the unwanted sideband from the filter. Crystal filters were very expensive at the time and were not generally available. Coil and capacitor filters just could not provide the selectivity curve needed except at very low frequency. However Collins had developed the mechanical filters which solved the problem of sideband selection. This solution was used in the first prototype SSB equipment and subsequent designs.

In SSB generation, the signal is produced in a balanced modulator, where the carrier is balanced out. Then the signal is filtered where the desired sideband is selected. The resulting SSB signal is at a very low level and must be amplified to the required output power level. For up to few watts of power it is not difficult to reproduce the signal without distortion products but at 100 to 1000 watts and above, the intermodulation products are a problem. Just as in audio high-fidelity, the presence of distortion products not in the original signal are very annoying. The problem was solved by Warren Bruene in the SSB task force by the same solution used in audio -- inverse feedback. At r-f the problem is much more difficult because the stray circuit inductance and lead lengths enter into the phase shift. It is hard to cover 2 to 30 Mhz without instability but the problem was solved and intermodulation products were held to at least minus 30 dB. As I stated earlier, some of the advantage of the spectrum savings of SSB are lost if the amplifier chain in the transmitter does not keep the distortion products to a low level. Every ham knows of the annoyance of sideband splatter from an adjacent or nearby QSO.

Receivers are, in many ways, harder to design than transmitters. This is because of the large dynamic range of signals handled in the receiver from antenna to detector. From 0.1 microvolt to 1 volt is 126 dB. That is a horrible range of levels to put into one box. At the same time there could be one volt or more interfering signals present on the antenna input terminals. All of these conditions must be handled if a successful receiver is to be designed. Again, if the full spectrum saving advantages of SSB are to be realized, the receiver must be able to select the desired signal in the presence of large undesired signals and not produce spurious signals in the process. Careful attention to stage gains, frequency conversion schemes, automatic gain control and many other factors investigated by the design group led to excellent receivers. The mechanical filter was used to get the receiver selectivity needed and served as an excellent component as it did in the transmitter. The crash project made a breadboard SSB receiver by taking the 75A-2 and adding an outboard Intermediate Frequency amplifier, a product detector and a carrier BFO. This eventually became the 75A-4. Several other circuits were developed at that time. These included Automatic Load Control (ALC) for preventing overdrive in transmitters, and dual time-constant Automatic Gain Control (AGC) for receivers. A good AGC is harder to design for SSB because there is no constant carrier to set the receiver gain but the new circuit design worked very well in SSB receivers. It turned out that the receiver and transmitter both used the same frequency scheme so it was natural to combine transmitter and receiver (a transceiver) where desired.

This combined function was embodied in the design of the KWM-1. The conclusion of the Butler Building investigation of SSB was the construction of a few rack mounted SSB stations that included a receiver, an exciter and a 500 watt linear amplifier. These units were loaned to amateurs who worked in Collins Engineering and the group including Art Collins and myself. This caused me to return to ham radio after a long period of non-operation. There were few stations to talk to at the time but the experience, especially in DX contacts was enough to get me enthusiastically back into the active pursuit of amateur radio.

After the crash design program was finished, the technical staff returned to my engineering group for the development of amateur, commercial and military SSB equipment. The first amateur receiver specifically designed for sideband use was the 75A-4. At about the same time, the KWS-1 was designed and produced. These products were followed by the KWM-1 transceiver and the KWM-2. The 30S-1, one KW linear amplifier was added soon thereafter. Art Collins took a great interest in the design of ham equipment at that time. For example, he insisted on the leather grain look on front panels that he found on quality 35 mm cameras. That is how the panels got 'goose bumps'.

General LeMay and General Griswold (commander and vice-commander respectively of the Strategic Air Command) were amateur radio operators who saw the improved communications potential of SSB. They took SAC into SSB very early and installed Collins SSB at SAC bases around the world and in the bomber fleet. This was at the height of the Cold War and it was essential that the command headquarters at Omaha could contact any base or bomber in the air at all times.

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A KILOWATT CLASS RF DECK

by Bill Kleronomos, KDØHG
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For the past several months I've been enjoying the benefits of running the legal power limit on AM with the amplifier described in this article. Having been a ham for 'only' the last 25 years, I was unaware of many of the tricks required in the design of a stable, efficient, grid driven Class C RF deck - I had built many grounded grid SSB linears in the past, so I am no stranger to RF amplifier design, but this project was something else. I decided to write this story mostly for the benefit of other 'short-timers' to the world of 'non-linear' plate modulated amplifiers. If ever there was a project that fits the term 'reinventing the wheel' this was it!

This amplifier was built around a 304-TL low mu triode, but I want to emphasize that there are many suitable choices in tubes: availability is the key factor. There is also no reason why two or three parallelled tubes cannot be used instead of one large one. Suitable alternative tube types to run a KW with include the 833-A, 849, 806, 450-TH; or parallelled 810's, 8000, 100-TH/TL, 805, 250-TH etc. Note that these are all low to medium mu triodes. Some may be hard to find, all are horribly expensive if purchased new from some sources, but many of these types are easily available as broadcast station pulls, or new surplus at reasonable prices from many sources. The newer generation triodes such as the 3-500Z or 3-1000Z might also be usable, but they are designed for grounded grid linear service, and their high mu might make for instability in a grid driven circuit. But, hey, being ingenious hams we can handle it, right? In any case go for 300 to 400 watts as an absolute minimum plate rating.

Note that I haven't mentioned tetrodes at all so far. There is no reason why you can't use a tetrode such as one of the famous Eimac 4-65 through 4-1000 series and benefit from reduced drive requirements, but a plate modulated tetrode amplifier requires somewhat different design features, and I'll cover them in a future ER article. In fact, my RF deck was originally designed around a pair of 4-400s.

Why Class C?

We use class C operation in plate modulated RF amplifiers for two reasons. First, a class C amplifier is generally linear with respect to the plate voltage applied. If you double the plate voltage (at 100% modulation), you double the plate current (see Ohms law for details), and with double the plate voltage and double the plate current, the output (or input) is four times that at no modulation. That's how a 1 KW DC input transmitter of the AM variety has 4 x 1KW, or 4 KW PEP input.

The second reason for class C operation is the excellent efficiency. Coming from a world of linear amplifiers for SSB, I am constantly astounded at the 80+% efficiency this amplifier has as compared to the usual 50 to 60% a linear amplifier exhibits. And, there are tricks to further increase efficiency to beyond 90%. Such tricks involve the use of extreme amounts of bias and drive, but doing so also makes an excellent TVI generator. Let's be happy with 80%, and keep the neighbors happy, too. This RF deck is well shielded, I use a low pass filter, and I only see the slightest herringbone on channel two. This high efficiency also means that a tube impossible to consider for use a KW class SSB linear will work fine in class C operation. The plate dissipation will be much lower.

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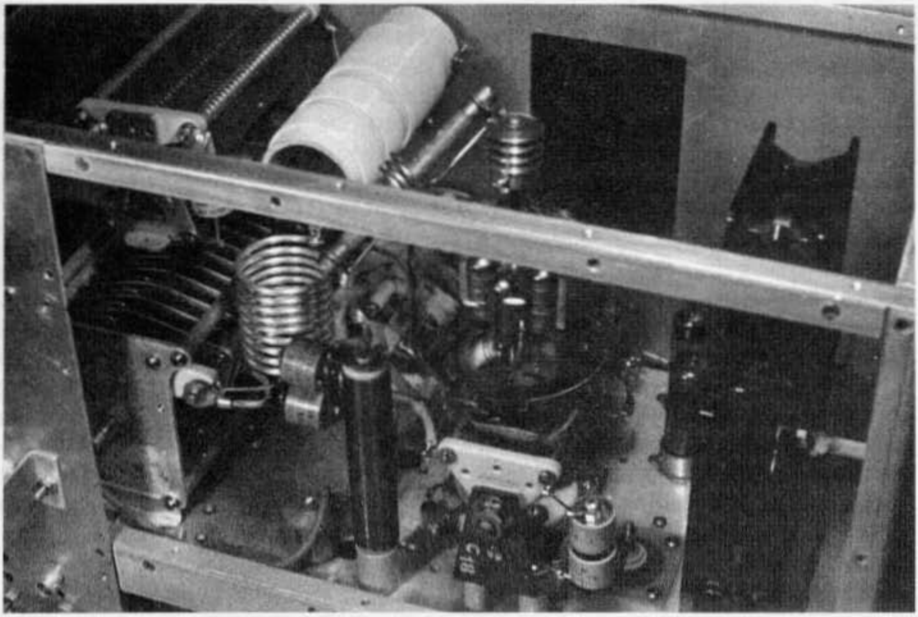
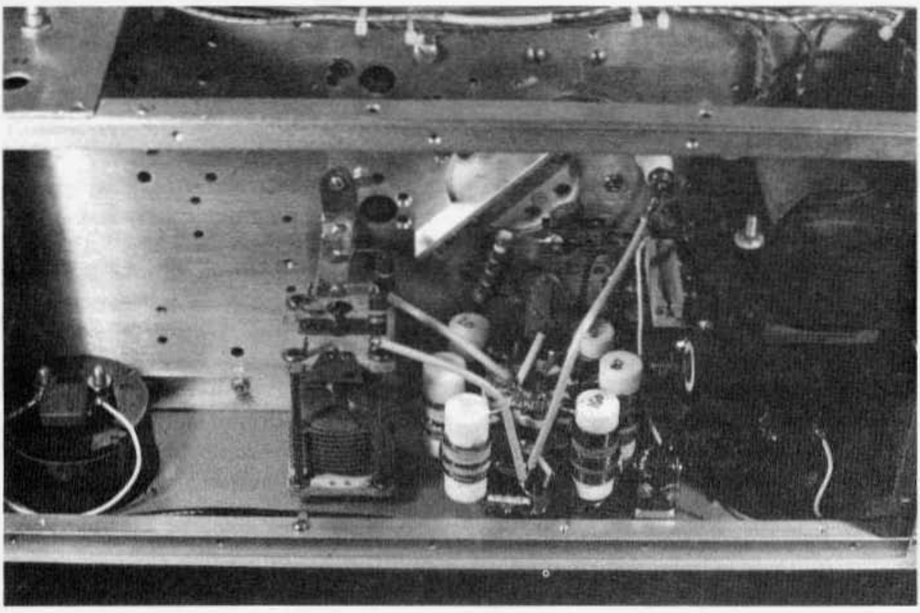


Rear view of the RF deck , muffin fan on right side.



Underside of the RF deck. showing grid coil turret.

RF Deck from page 12

This might be a good time to consider the question - just exactly why is class C operation so darn efficient? The answer is quite easy, and one doesn't need to get into esoterica such as operating angles - just yet.

Let's borrow an analogy from the world of solid state for an explanation of how a class C amplifier works. A vacuum tube can be viewed as nothing more than a switch. When the grid is biased positive, it is switched on; current flows from plate to cathode, and when the grid is biased sufficiently negative, the tube is switched off; no current flows from plate to cathode. Now, remember that a class C amplifier is always biased off with lots of grid bias, and it is always driven hard, with lots of drive.

OK - what's the tube dissipating when it's biased off? Nothing. Say, with 2,000 plate volts, and the plate current is zero, using P=IxE, P=Øx2000, or Ø watts. What's the tube dissipating when it's driven hard to an 'on' state with full current flow from plate to cathode? Again, very little. There is little resistance to current flow in the tube.

Let's look at it another way. If the tube is operated in a mode as a switch, then it operates in the same manner as a wall switch that operates a light bulb. Whether this wall switch is on or off, it dissipates no power. (If it does, you're in trouble...)

This is why a class C amplifier is so darn efficient. The tube is biased way beyond cut-off - it's off. When it's driven hard with an RF sine wave, the positive peaks of the sine wave drive the tube into an almost instantaneous hard 'on' state for part of the RF cycle. For the rest of the RF cycle the tube is biased off. The tube, being either on or off during the RF cycle dissipates little heat. Note the 'on' time is only a fraction of the 360 degree RF cycle. That's what "angle of operation" means.

By comparison, in a linear amplifier, the tube is always biased on - a little - idle current flows in class A, AB or B. The tube does not operate as a switch, as in the above case. Instead, it operates as a big variable resistor so that the plate current is an accurate reproduction of the grid drive. Resistors get hot when you put them across a 2,000 volt plate supply! You don't ever want a tube in a linear to be saturated on - doing so causes flat-topping and splatter. The tube in a linear is constantly operating in an area neither fully on or off, and as a result, dissipates lots of heat.

Let's get back to our class C amplifier. If the tube is either 'on' or 'off', what would you expect the output waveform to look like? Yes, it will resemble a narrow square wave. You digital guys out there know a square wave is loaded with odd order harmonics of the fundamental. That's why class C amplifiers can be horrible TVI generators. This is where some judgement comes in. The harder you drive a class C amplifier, the harder you turn it 'on', and the more efficient it becomes. This, however, causes the output wave form to get more ' square', with increased harmonic output. A real good way to keep the harmonics down in a class C amplifier is to use a higher Q plate tank than you would with a linear. The higher Q provides a better ' flywheel' effect to smooth out the output RF waveform at the antenna jack and keep you from operating on 3885 Khz times 3, or 5, or 7, or 9....get the picture? Keep the Q around 15 or even 20 and use low loss tank circuit components.

As far as the tube operating conditions go, such as plate voltage, bias, and drive, follow the recommendations for class C phone operation as listed in the tube data sheets or handbook. It's hard to go wrong doing this. Also note - class C phone generally requires more grid drive than class C CW. There is a reason for this.

Remember that at the crest of the modulation cycle, assuming 100% (plate) modulation, the plate voltage is doubled, doubling the plate current and thereby quadrupling the power output of your amplifier. Well, this is only true IF there is adequate grid drive. The tube requires good drive at the crest of the modulation cycle - insufficient drive will cause the inability to achieve 100% modulation, no matter how much modulator power you have.

A clever way to make sure that you have enough grid drive at the modulation crest, if you have a marginal situation, is to put some plate modulation on the driver also, so that it's output peaks in the proper phase when the final needs it. I am modulating my Johnson Ranger I RF exciter some 30% or so by means of a small external modulation transformer. But get the phase right if you do this by reversing the connection to the transformer primary or secondary as required by watching the rig's output on a scope. The wrong phase will make your modulation look really awful on a scope.

Building the RF Deck - The Nuts and Bolts of It

The amplifier I'll be describing is a conventional, grid driven, grounded cathode affair. Grid neutralization is used. The chassis I built my amplifier from was originally part of an RF deck from a VHF paging transmitter that was tossed off the roof of a ten story building because the janitor got tired of it being in his way..... Of all the remaining pieces, the RF deck chassis was the only salvageable thing left. The entire RF deck is compact in size for it's power capability measuring just 14" H x 19" W x 9" D. While the spec sheets on the 304-TL state that the tube is cooled strictly by convection and radiation, I have added two muffin fans to blow air across the tube and it's socket. Don, K4KYV, has advised me that running the 304 without forced air cooling will lead to premature failure of the filament structure and it's seals. In any case, a muffin fan is cheap insurance for those expensive tubes that run with bright orange anodes. Into a dummy load, I am able to obtain over 1 KW of carrier output at 2300 plate volts without exceeding the tube's dissipation ratings. Efficiency has been measured at something over 80% with the use of a Bird wattmeter.

The amplifier has been designed to operate on 160 through 20 meters, and appears to be unconditionally stable and free of oscillations. A switch has been included in the grid bias circuit to allow a bias change for linear operation when SSB is used.

There is nothing radical or unusual about the construction itself. Let's go over the design of this unit.

Input and Bias Circuit

I ended up spending far more time than expected in the design of a compact bandswitching grid coil and turret assembly. After melting some prototype coils wound on polystyrene tubing, I obtained some 3/4" diameter teflon rod from a plastics supply house and wound the coils on that. These coils do get hot, and besides the teflon forms, insulation between the coil and input link winding was 3M glass cloth tape. The coils need to have a high L and C ratio for best operation, I found. If you have the room, I recommend the use of larger air wound grid coils.

As previously mentioned, the bias circuit is designed for dual mode operation, class B or class C.

The bias supply voltage is set to about -200 volts, which is the proper value for class B operation of the 304-TL. This holds the plate current under no drive conditions to about 50 mA in both classes of operation. In class C operation, additional operating bias is provided by a 2 K resistor switched into the grid circuit.

The grid bias regulator is rather unique. I was faced with the problem of keeping the fixed bias voltage stable, even with more than 50 mA of grid

continued next page

RF Deck from previous page
current flowing into it from the tube. VR tubes were considered, but the amount of grid current used was far more than they could sink to ground, and the voltage isn't adjustable, anyway. The bias regulator circuit I ended up using is an adaptation of a circuit found in pre-war editions of the Editor's and Engineers Radio Handbook. A triode connected 6BQ5 power pentode is used as a shunt regulator. Almost any tube with a plate current and dissipation rating adequate for the job can be used. To calculate the tube size you need, multiply the bias voltage used by the PA tube's grid current. In this case, 200 V. times .05 A, or 10 watts plate dissipation is required. Suitable tube types to consider besides the 6BQ5 are the common audio output tubes such as triode connected 6AQ5, 6V6, 6K6, etc. Of course, a larger triode could be used such as a 2A3, 6N7 (with sections parallelled), or 6A3. This regulator works extremely well, holding the bias voltage it's set to within 20 volts from 0 to 100 mA of grid current.

In any event, regardless of if you plan to use your RF deck as a linear or not, set the fixed bias voltage to about the cut-off value for the tube(s) you use, and obtain the proper operating bias with the addition of the appropriate resistance in the grid circuit. Use Ohm's law to calculate the proper value. The way to do it is: R (grid resistor) = the required grid bias for class C phone operation - your fixed bias voltage; this divided by the grid current from the tube's specifications. Example: in this amplifier the fixed bias is -200, the desired operating bias is -300, and the grid current with the proper drive is approximately 50 mA. So we get R = 300 minus 200 divided by .50, or 100 divided by .05, or 100 divided by .05, or 2 K. Power dissapated is given by P = I2R, or 5 watts.

Neutralizing Circuit

Neutralizing is accomplished by feeding some of the RF present in the final plate circuit to the bottom end of the grid coils. This is referred to as grid neutralization, and is the only kind usable on a multi-band final with a single ended pi network output. For several esoteric reasons, grid neutralization is not perfect from band to band. Neutralization adjustment procedures are given in any older ARRL Handbook, and I won't repeat them here. I marked the proper settings, of the neutralizing capacitor on each band, then set the capacitor at the nominal, or 'average' setting found. This worked out fine; as I mentioned, the amplifier shows no signs of instability under any condition on any band. To build additional stability in, I added R1 and R2, which provide some resistive loading and further stabalization of the grid circuit, but they are optional. Due to the high RF voltages on the grid circuit, make sure R1 and R2 are TWO watt carbon resistors in series. A single resistor will not withstand the high voltage, it will eventually fail. (Take my word for it!)

Take note of where the neutralizing capacitor is connected in the plate circuit - it's on the cold (for DC) side of the DC blocking capacitor. Most designs I've seen connect this capacitor directly to the tube's plate, and there is no reason to do this as it puts high voltage DC on the capacitor, thereby increasing the required plate spacing. Connecting the capacitor to the 'cold' side of the plate blocking capacitor makes more sense, and makes it easier to find a suitable neutralizing capacitor, an item that's not often found in everyone's junk box anymore. Plate spacing of this unit should be at least the same as that of the final tuning capacitor.

To aid in achieving a stable circuit, parasitic suppressors Z1 and Z2 have been included. Without them the amplifier had a nasty oscillation in the 40 Mhz region. Don't leave them out. Z2 is made from a large 'Globar' resistor, which is another item not commonly available.

An acceptable substitute would be a 10 watt Corning Glass non-inductive resistor, or four parallelled 2 watt 200 ohm carbon resistors. If the resistors tend to overheat in operation, reduce the parallelled inductance. If oscillations occur, increase the amount of inductance. This test should be done on the highest frequency the amplifier is designed for (20 meters).

Final Tank Circuit

On paper, at least, the plate circuit resembles a conventional Pi-Network, but it includes fewer of the king-sized components commonly used in an amplifier of this power level, thus contributing to the small overall size. The two key components are the compact tank coil, and the three deck PA bandswitch, which allows the switching in of fixed padder capacitors for tuning and loading. This allows the use of physically smaller plate tuning and loading variable capacitors.

The tank coil is highly compact, measuring just over 5" long by 1 3/4" diameter, a size often associated with transmitters in the 100 watt class. It's compact size is due to extremely low loss material used in it's construction. The wire used is #16 silver plated copper, teflon insulated, and the coil form is made from a length of fiberglass pipe. Oboy, you say, where can I get this material? The wire is available from a couple of advertisers in ham magazine classified sections. The fiberglass pipe used was cut out of the housing of a Phelps - Dodge Stationmaster VHF antenna which was burned out from a lightning strike and retired. Almost any commercial two-way radio shop will have a few such antennas lying around to be had for the asking. Fiberglass pipe is also available from plumbing supply firms, although it comes in 20' lengths. Other low loss coil forms can be considered, such as those made from ceramic or mycalex. Other low loss coil forms can be considered, such as those made from ceramic or mycalex. Although this inductor doesn't get very warm in operation, don't use any thermoplastic or a lossy bakelite. Also, avoid the use of magnetic hardware in the form. I found a plated steel screw getting almost smoking hot in a prototype inductor. Also, don't use regular wire!

The bandswitch needs to be able to withstand big RF voltages. The switch I used was made by Radio Switch Corp. and is rated at 12 KV flashover. It is approximately a $60 item if purchased new from RadioKit, but I obtained one at a hamfest for $1. This is one item best found by cultivating friends with well stocked junk boxes! There have been some scrapped military units appearing from time to time with such a switch in them - knowing the military, they are probably from 50 watt transmitters....

As with any project like this, component substitutions can be made depending on what components can be begged or stolen by the builder. There is, for example, no reason why the B & W kilowatt sized pi-network inductor can't be used if you have one and size isn't a problem. Vacuum variable capacitors would be a nice touch, if you have them.

I have been extremely satisfied with the performance of my transmitter. Used with the modulator shown in ER#3, this transmitter has performed without a hitch, providing many hours of reliable service. It is a great feeling to be able to light up a full KW and know that nothing is being stressed out, including the operator.

The complete parts list and figures 1 (the schematic) and figure 2 (the plate tank coil) are on the following two pages.

Parts List - KDØHG RF Deck

C1 - C3 470 pf mica compression trimmer (Radio Shack)
C4 1500 pf mica
C5 - C6 120 pf 1000 volt mica
C7 dual section 100 pf variable, 1500 volt spacing
C8 - C9 500 pf 7.5 KV Centralab ceramic (RadioKit)
C10 15 pf 10 KV neutralizing variable (from BC-610 or homemade)
C11 150 pf 7.5 KV air variable
C12 (160 meter loading padder) 1500 pf 2 KV "FIL" mica
C13 (80 meter loading padder) 500 pf 2 KV "FIL" mica
C14 (40 meter loading padder) 200 pf 2 KV "FIL" mica
C15 600 pf 1500 volt air variable
C16 - C17 10 uf 500 volt electrolytic
C18 100 pf 5 KV Centralab transmitting ceramic (Fair Radio or RadioKit)
C19 200 pf 15 KV Centralab transmitting ceramic (RadioKit)
C20 500 pf 20 KV TV doorknob type ceramic
C21 .001 uf 6 KV ceramic feedthrough
All .001 and .01 shown are 1 KV or better mica or ceramic types

R1 - R2 100 K 2 watt carbon composition
R3 7500 ohm 10 watt wirewound
R4 100 K 5 watt wirewound
R5 10 K 1/2 watt
R6 22 K 1/2 watt
R7 2 to 5 K 20 watt wirewound

L1 (20 meter link) 2 turns #18 enamel wound over center of L8
L2 (40 meter link) 3 " L7
L3 (80 meter link) 5 " L6
L4 (160 meter link) 6 " L5
L5 (160 meter grid coil) 1 1/8" long winding of #28 enamel closewound on 3/4" teflon rod
L6 (80 meter grid coil) 1 1/8" long winding of #26 enamel closewound on 3/4" teflon rod
L7 (40 meter grid coil) 1 1/8" long winding of #22 enamel closewound on 3/4" teflon rod
L8 (20 meter grid coil) 7/8" long winding of #22 enamel, 19 turns spacewound
L9 National R-175 RF choke (other usable types from RadioKit)
L10 (20 meter plate coil) 9 turns 1/8" dia. copper tubing, 1 1/2"dia., 2 1/4"long
L11 (40 - 160 plate coil), see figure 2
L12 - L13 2.5 MH 100 MA RF choke
L14 15 Henry 50 mA choke

S1 3 pole 4 position ceramic rotary switch
S2 3 pole 6 position ceramic rotary switch, Radio Switch Corp., model 85 (12 KV flashover)
S3 SPST toggle switch

Z1 (grid parasitic suppressor) 2 turns #22 wound over length of a 50 ohm 1 watt carbon resistor
Z2 (plate parasitic suppressor) 3 turns #14, 3/4" dia., 1/2" long over 50 ohm 10 watt "Globar" non-inductive resistor

T1 500 VCT 50 mA, 6.3 volt 1 amp
T2 to suit tube used

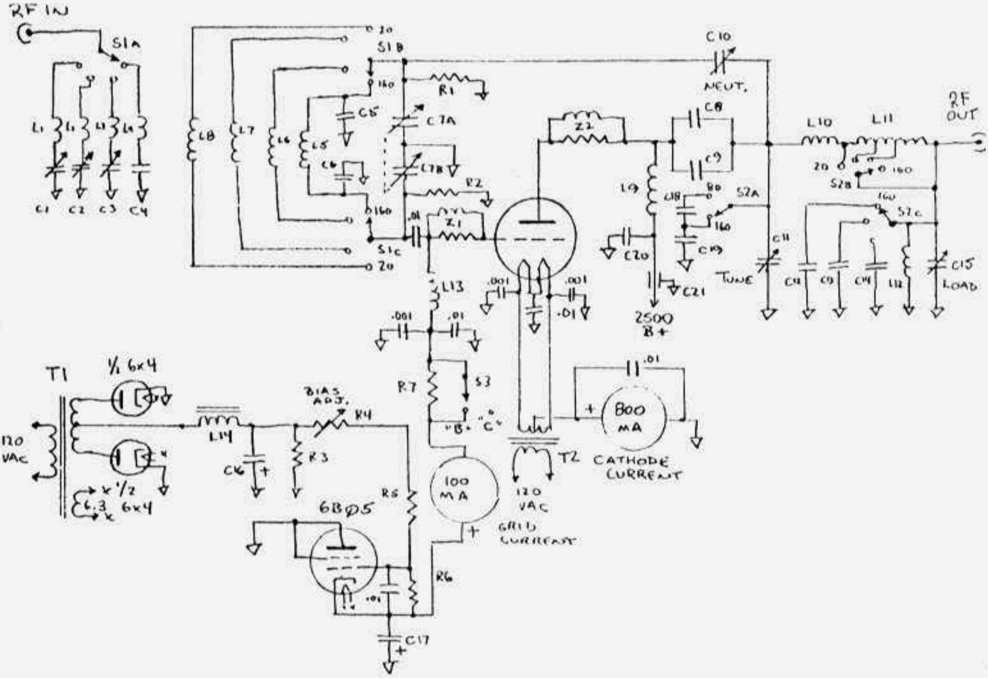


Figure 1

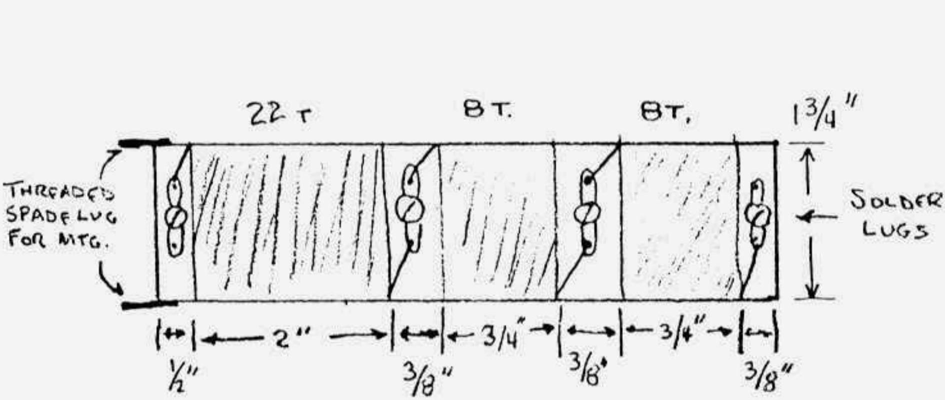


Figure 2 Plate Tank Coil

A MODULATION MONITOR FOR YOUR AM TRANSMITTER

by Bob Dennison, W2HBE
82 Virginia Ave.
Westmont, NJ 08108

For maximum effectiveness of an AM phone transmitter, it is desirable to keep the average modulation as high as possible without exceeding 100% modulation on negative peaks. Negative modulation in excess of 100% (so called overmodulation) is prohibited by law since itresuits in excessive bandwidth which causes 'splatter' on adjacent channels. It also produces audio distortion and may even damage the modulation transformer. Thus a modulation monitor is an essential accessory for every AM transmitter.

An elementary modulation monitor is shown in Figure 1. The tuned circuit is coupled to the transmitter's final tank by a link. The modulated carrier is demodulated by diode D1. The coupiing or tuning is adjusted to produce half-scale deflection of M1, which should remain consiant during modulation. A change in reading of M1 during modulation is called 'carrier shift' and indicates distortion of the modulation envelope. The detected audio is passed through transformer T1 to be rectified and applied to M2 which is calibrated in percent modulation.

This simple monitor has serious shortcomings due to the characteristics of the meter at M2. Meters are made with various degrees of damping-low, medium and high. If low damping is used, the meter pointer attempts to follow the rapidly changing modulation envelope. The resulting wild gyrations of the pointer produce fatigue in the operator who has to observe it any length of time. If a meter with more damping is used, it will not deflect sufficiently when very narrow audio peaks occur. Similarly, the inertia of the movement keeps it from fully responding to impulses of short duration. Thus the transmitter may be badly overmodulated even though the meter indicates a safe level.

One solution to this problem is to employ a fast attack - slow decay detector similar to those used in modern AGC circuits. The audio rectifier (V1-B in Figure 2) has short time constant (less than 10ms) when charging C4. Thus C4 charges quickly to nearly the peak of the audio modulation and holds this charge long enough for the meter to deflect to the proper reading. Condenser C4 discharges into a very high resistance (44 megohms) so the meter return is greatly slowed down thus preventing the undesired rapid pointer fluctuations. The time constants chosen here work with a Radio Shack 0-1 mA meter and will probably be suitable for most general purpose meters.

The voltage across C4 is applied to a simple vacuum-tube voltmeter using a single 6C4 tube. Resistor R12 is adjusted until the current in M2 is zero when the carrier is unmodulated. Since V2 operates on the curved portion of its Eg-Ip characteristic, the meter scale is not linear. Table 1 can be used to make a percent modulation scale for M2.

Commercial modulation monitors employ a switch to simultaneously reverse the connections to the RF diode, V1-A, and the carrier meter, M1. This allows the modulation monitor to read either the positive or negative peaks of the modulation envelope. This monitor reads the negative peaks for reasons explained later.

CONSTRUCTION HINTS: The experienced builder will have no difficulty in deciding how to package the modulation monitor and incorporate it into his AM transmitter. On the other hand, there are many fellows who began their operations with commercial sideband gear and then discoverd the joy of real ham radio - AM operation with their own homemade equipment! Thus a few suggestions on construction, layout and parts procurement may be helpful.

The modulation monitor could be built on an aluminum chassis with a panel of aluminum or masonite to support the meters and controls. Mine was built on an aluminum panel which also supports the dial and tuned circuit of the VFO of my 160 meter AM rig - see Figure 3. The ZERO and CALIB pots do not have knobs, instead the shafts are hacksawed off to a length of 1/4 inch and slotted to a depth of 1/8 inch.

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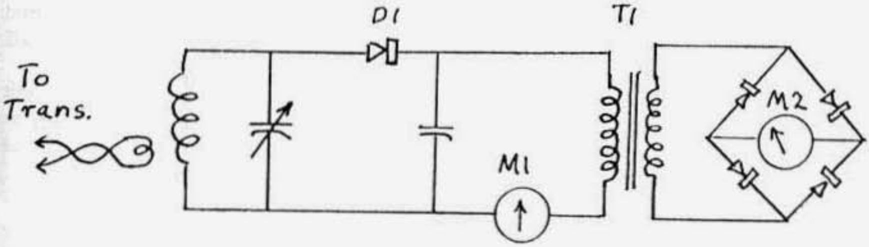


Fig. 1. Simple modulation monitor.

Table 1. Data for converting scale of M2 in Fig. 2 from mA to % MOD.

M2 mA	% MOD.
0	0
.03	10
.08	20
.14	30
.23	40
.30	50
.40	60
.49	70
.54	80
.64	90
.72	100

.72 to 100 color red

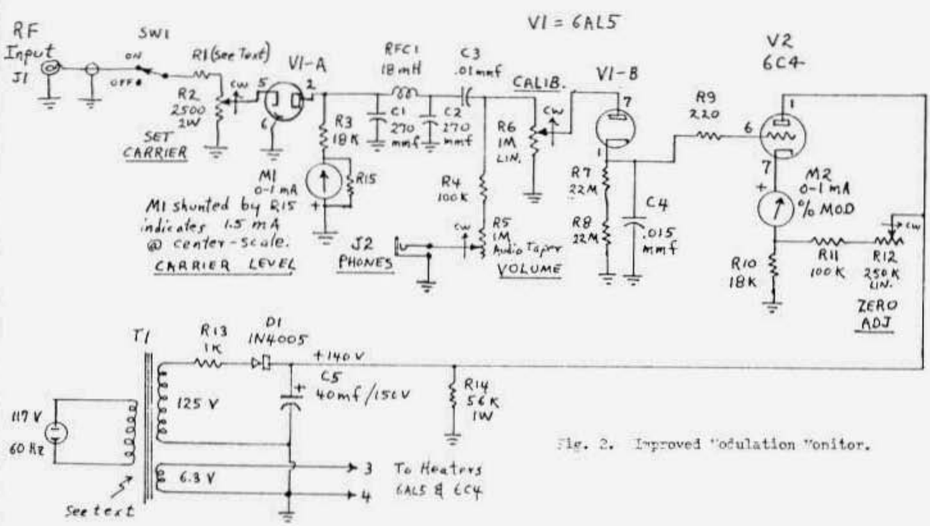


Fig. 2. Improved Modulation Monitor.

The carrier level meter was found at a flea market and requires about 200 UA for full scale deflection. It needed a shunt of 75 ohms to convert it to 3mA full scale. The rear view of the monitor is shown in Figure 4. The 7-pin tube sockets are mounted on L-shaped aluminum brackets, the feet of which are slotted to fit under potentiometers R12 and R2, which hold them tightly to the panel. Small parts are supported by tie points (Radio Shack 274-688). These can be modified as required by clipping off lugs not needed. The RF input jack, J1, can be a phone jack in a low power rig or an SO-239 coax socket if high power is involved. If it is mounted more than a few inches from switch SW-1, use coax to connect them.

The power transformer, T1, is a Stancor PS-8415. A new one may be hard to find so take one out of an old, discarded Heath RF Signal Generator. These can often be picked up real cheap at a hamfest or flea market. When soldering diode D1, protect it from the heat of the soldering iron by using needle-nose pliers as a heat-sink. When the pliers grip the lead, where it enters the body of the diode, they conduct damaging heat away from the silicon element. Be sure to install the diode with the correct polarity - the end marked with a band is the cathode.

The cylindrical shield at the center of the 7-pin tube socket for V1 is grounded but the shield at V2 is used as a convenient tie point for R7, R9 and the wire that runs to Pin 1 of V1.

SET-UP AND CALIBRATION: Couple the monitor's RF input to the output of the transmitter in an appropriate manner depending on the design of the transmitter and its power level and choose a suitable value for R1 so that when R2 is at approximately 70% full on, M1 reads center-scale. The unmodulated carrier voltage at pin 2 or V1-A will be about 60 volts peak-to-peak. With my 35 watt transmitter, R1 is not required.

Connect an audio oscillator to the input of the speech amplifier and set it to 400 Hz. Using an oscilloscope, preferably connected to display a trapezoidal pattern, adjust the modulation level to 100% or the maximum undistorted level attainable. Make sure M1 is still at center-scale and then adjust the CALIB pot R6 so that M2 reads the proper level of modulation.

A headphone jack is provided to permit checking audio quality and hum. Switch S1 is provided to turn off the RF input when the transmitter is being retuned.

EXTENDED POSITIVE PEAK MODULATION: The waveforms of certain male voices are non-symmetrical about the AC axis. It is possible to take advantage of this by polarizing your modulation voltage such that the larger audio alternations cause upward or positive modulation. Thus when the negative excursions reach 100% modulation (carrier level reduced to zero), the positive excursions will exceed twice carrier level and yet produce no splatter or distortion. In my transmitter, I use a DPDT switch to reverse the polarity of the audio signal at the grids of the push-pull modulator tubes. I use a scope to observe the waveform of the modulation voltage applied to the plate of the final. CAUTION: In a high-power transmitter this voltage must be reduced to a safe level by a suitable voltage divider.

While talking into the microphone, observe the waveform of your voice and choose the polarity with the greater voltage swings extending above the axis. The RADIO HANDBOOK (1) recommends voicing the prolonged sound '----errrr' for this test.

Earlier in this article, it was stated that the RF diode polarity was chosen so that the negative modulation peaks are measured. These must be limited to 100%. Thus when the meter reads 100%, we may actually be modulating over 100% on positive peaks and this is permissible.

1. Radio Handbook, 7th Ed., Oct. 1940,p. 187, Editors &Engineers, Santa Barbara, CA.

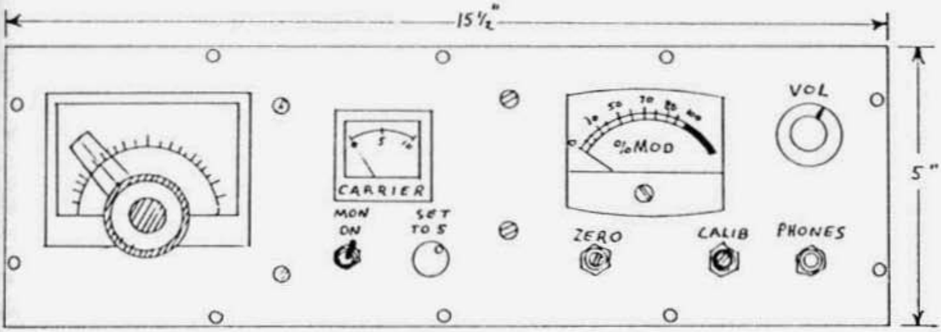
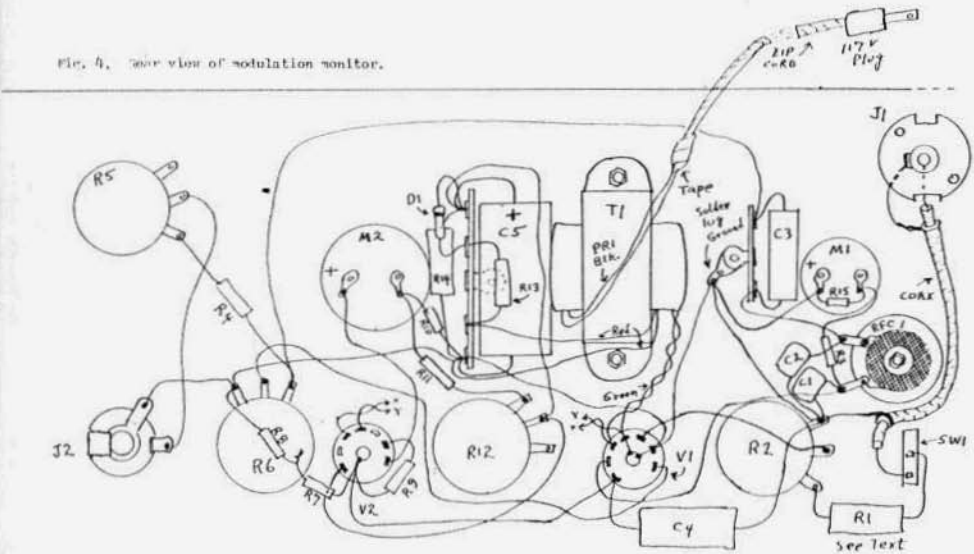
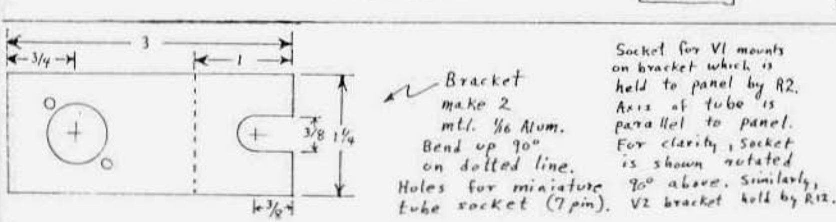


Fig. 3. Front view of possible implementation of modulation monitor.

Fig. 4. Rear view of modulation monitor.





VINTAGE MILITARY ENTHUSIASTS DISPLAY RADIO GEAR AT GIANT AIRSHOW

by Dale Gagnon, KW1I, 9 Dean Ave., Bow, NH 03304

Mark-KB1KJ, Mike-WB2UID, Al-WA1VHD, Charlie-KA1GON, Philip-KA1RZF and Dale-KW1I sponsored a military radio exhibit on the airfield at the Warbirds Military Airshow in Manchester, New Hampshire, on October 9 - 10, 1989. The show drew 20,000 people per day to see two B17's, two B24's, P51's, a B26, a PBY, a P40, a TBM and dozens of other classic aircraft and military paraphernalia.

Housed in a 16'x30' military tent and powered by a PE75 generator, the radio display included a working ART13/BC348 and R392/T195 stations. A 30' Navy whip antenna was used to make contacts on 40 and 80 meters. An ARC2A was powered up and displayed on it's side so that it's moving mechanical assemblies were in view when the channel selector was actuated. A PRC47 backpack radio, BC348, BC375 and command set pair were also displayed.

Between 500 and 1000 people walked through the tent during the show. Many ex-military radio operators had moments of nostalgia standing in front of the equipment. Over a hundred Amateur Radio brochures provided by the ARRL were picked up.

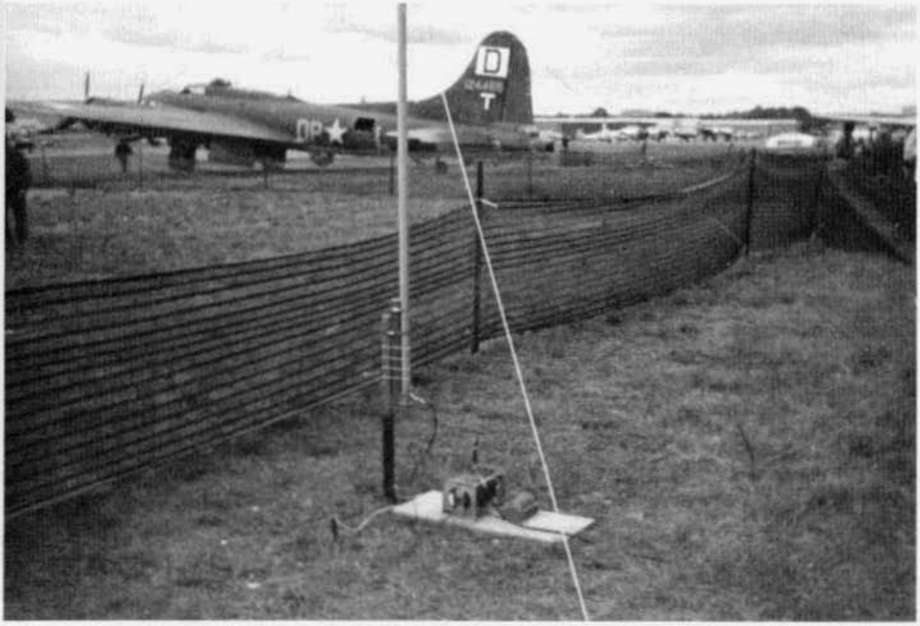
Airshow organizers were enthusiastic about the radio display proposal. Part of this was due to our promise to demo radios that were used on the B17 and B24 bombers.

All radio equipment displayed was identified by name, frequency range, power, mission and production dates and figures, if available.

The tent was ideally located next to the B17. In fact, when they were warming up, the tent lines had to be held to keep the tent from going over in the prop wash.

It was an exciting time for WW-II radio buffs and we're planning to participate again in September, 1990.

Dale, KW1I and son Philip, KA1RZF at one of the displays inside the tent.



Vertical antenna with B17 in background.

Entrance to the display tent with military aircraft in background.

The TBY's design is, in many ways, an appealing one. Simple methods are used whenever possible, for example, calibrating the transmitter and receiver is done by setting the drum dials to the right reading after tuning in a crystal checkpoint. Tuning slugs and trimmer capacitors have been 'designed out' -- saving perhaps a couple of dozen parts. Everything which might reasonably require service in the field -- tubes, crystal, calibration settings -- is under the hinged lid which is held with a couple of catches like those on a lunch box. Further disassembly (if required) is simple. There's one spare of each type of tube inside the set. The fact that there were so few problems getting the radio to work (after fifty years!) is a tribute both to the quality of the parts and the simplicity of the design.

Some attention was given to the problems of a field radio. The mic and phones are a single assembly with all connections vulcanized and a single (sturdy) connector. Late models have tight fitting bigger washers under the knobs to shield the control bushings from splashing water. The key and MCW 'send' switch assembly is enclosed in a tight fitting rubber cover. The antenna on later models can be angled to the rear to ease operation on a man's back and is made of corrosion resistant stainless steel.

Unfortunately, these are the features needed for the set to work well under the conditions faced by Marines operating in peacetime in the continental U.S. In the conditions of the Pacific campaign in which it was used -- mountainous terrain, dense jungle, frequent heavy rain with near continuous 100% humidity and high temperatures -- it did poorly.

I was fortunate to be able to talk to a TBY user when preparing this column. Steve Kiraly, WA2O, used the TBY while in training as a Marine radioman; after training, his CW proficiency brought afloat assignments with the Navy, where good CW operators were in critically short supply. His first amphibious landing was the assault on Pelelieu (15 September,1944) -- one of the grimmer such operations of the war. By that time, the TBY was gone from operational units, replaced by an assortment of other radios which could be supplied quickly. For control of Marine gun batteries, (90 mm and 105 mm howitzers) the Army's excellent SCR-300 (the radio itself is the BC-1000) was part of a system of low-VHF FM radios which were rapidly replacing all HF equipment for short range communication. In the Marines, however, the '300 stood alone: neither the Marines nor the Navy had any other set which could talk to it.

For longer range (than the SCR-300) and to talk to the Navy, the Marine Corps dusted off the TBX -- an HF set of early 30's vintage. This radio could be carried and operated by a few men, with power supplied by a hand crank generator if necessary; its four watts of AM output was barely adequate and it is complex, quirky, and hard to use -- but it could reach the ships, which the TBY could not. Later, the TCS -- a well designed Navy HF set with over 10 watts AM power, intended for PT boats, tugs and the like -- was mounted on jeeps and used for applications not requiring true portability.

What was wrong with the TBY? Based on his experiences with it, Steve reports that, "It didn't work! The signal would go about six feet through the wet leaves, and after three days it grew green fur (fungus) all over the wiring". Another user told me that the low power and VHF frequency range of the TBY made it useless in the deep valleys found on many of the Pacific islands.

From the tests on my set, the short range in heavy foliage is probably not due just to absorption; the transmitter frequency shift, if the antenna was within a couple of feet of "wet leaves", would be great enough to take the signal outside the receiver's bandwidth! At the receiving end, the severe detuning caused by proximity effects would reduce sensitivity by 10 db or more.

The TBY really isn't tough enough for assault use, either. It will, for example, be ruined if immersed while wading the last few yards from your LCM to the beach. Likewise for an accidental tap on the meter face from your M1 carbine.

Human factors are poor. There are far too many adjustments for a radio which might have to be operated when one's concentration is less than perfect. The controls are small and would be hard to operate with cold stiffened hands or gloves on. Moving quickly while waving a nine foot steel antenna isn't easy, even in open country; all later field radios (that I can think of) offer a short antenna, at least as an option.

In spite of generally good electronic design, the TBY has to be rated a failure as a field radio. Because the problems are in the basic design, there was no practical fix-up and although ten thousand or so sets were made I don't know of any combat use after about 1943.

The TBY is, however, a truly interesting failure because its deficiencies are all in one area -- its designers did not understand the conditions under which it was to be used, so they did a good job building the wrong radio. The set was tested by the Navy, the Marine Corps, and the U.S. Army Signal Corps labs at Fort Monmouth before it was procured, so it wasn't only the Westinghouse engineers who did not know what the coming war would be like.

It is at best difficult for an equipment designer to project himself into the shoes of the user -- to sit in a warm, well lighted room, stir his coffee, and appreciate and plan for the effects of cold, darkness, mud, rain, impossible terrain, dense jungle, numbing fatigue, and continual fear. It is hard to criticize the TBY's engineers for not having done better than the three military services at anticipating the conditions of the Pacific campaign.

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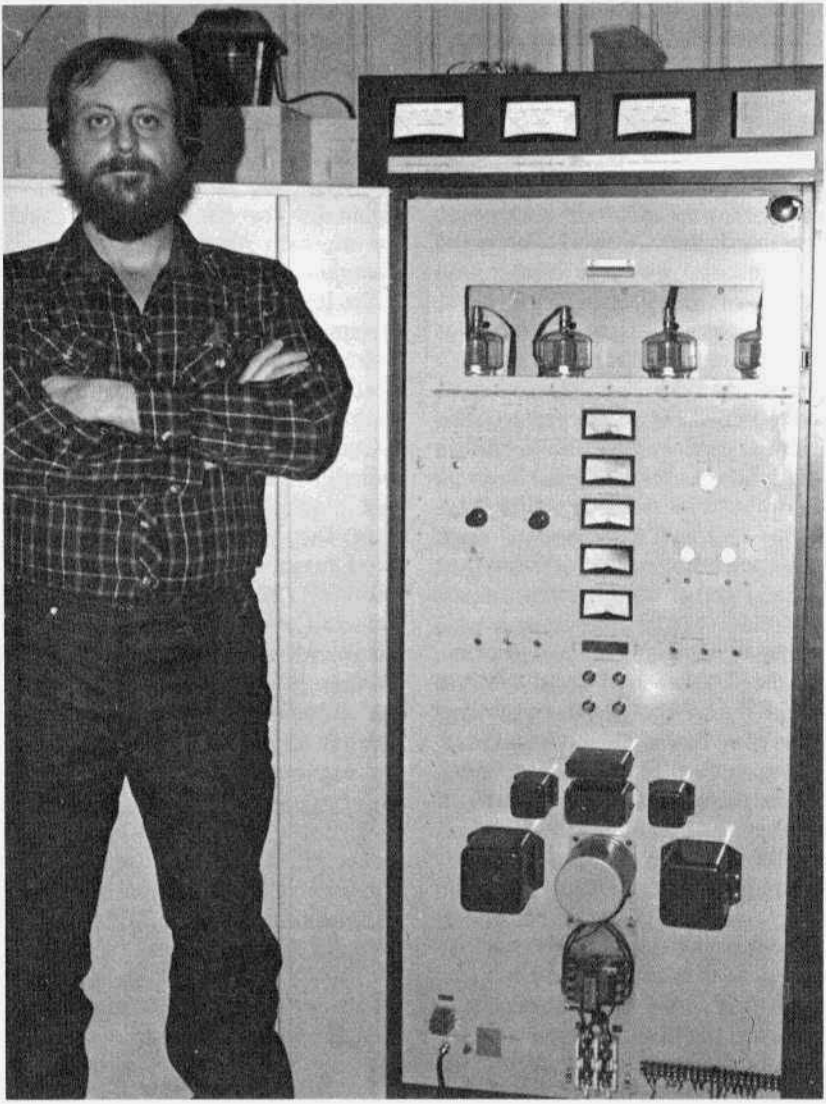
What the TBY teaches us about the design of small field radios is clear enough: such radios must be able to operate with the antenna actually in foliage; they must be rugged and water - and fungusproof; they must be simple; and, a 1/2 watt isn't enough power for use in the jungle. Some of these lessons really were 'learned'; others were forgotten, to be discovered again years later. After the war... but we are getting ahead of our story. 'To be continued', in a future column!

C'MON IN--- WE WERE JUST DISCUSSING THE RELATIVE MERITS OF THE OLD RIBBON MICROPHONE VERSUS THE ELECTRET MIKE !



Gary Kabrick, WA7WOQ, Amado, AZ with his recently restored Bauer transmitter.

The 'ex-broadcast'transmitter consisists of a pair of 4-400's modulated by a pair of 4-400's. Gary can be found on 160 most evenings. He has a 'big signal'with beautiful audio.

This photo represents the 'Radio Treasures' discovered and purchased in 1987 by left to right: Hugh - WB5YLQ, Mike - K5FZ, Lee - WØVT, and Darrell - WA5VGO.

Other gear purchased that year, but not brought in for the photograph, included two SX-42s and one each of the following; SX-24,SX-11, SX-28A, 75A-2,32V-2 and a wooden AM-SW set.

Hugh, Mike, Lee and Darrell are all collectors, restorers, and active operators. Mike says that since 1987 he has found the vintage gear harder to find and that the prices have gone up considerably.

RESTORATION / REPAIR TIPS

Winding Your Own Transformers The Easy Way

If you need a custom power (filament,etc) transformer at the 35 watt level, the Radio Shack #276-1515 (also 1511 and 1512) transformer at about $9 is outstanding raw material. It disassembles rather easily with a small hammer and an old pocket knife, revealing a nylon bobin on which the primary and secondary are wound side by side with a divider between them. Remove turns from the secondary to get the voltage you want or remove the whole thing and wind on whatever you need. The #1515 is wound at 5.5 turns per volt; the others are probably close to the same. The #1512 is rated at 50 watts so it may have a somewhat heavier primary winding. KJ4KV

Reshaping BNC Male Connectors

When a BNC female connector gets slightly 'bent out of shape' it can be reformed rather easily -- and you may already have the perfect tool. The Sears Roebuck (Craftsman) #41977 3/16" nut driver is the right outside diameter and the center hold is large enough to fit over the center pin of the connector. Just force the socket into the connector; a few knocks from a block of wood on the wrench handle will overcome any reluctance. If the open end of the connector is stretched, it can be straightened with a small hammer while the socket is inside. KJ4KV

Storing Parts

Zip lock storage bags - which come in a variety of sizes - are excellent for storing parts; particularly those odd shaped and larger parts like variable caps, transformers, pots, etc. WB2FOU/5

Organizing Tube Inventories

All of us acquire tubes without boxes; from hamfests, old chassis etc. Everytime we go through these tubes we rub off some lettering and possibly damage the tubes themselves. Antique Electronic Supply - see their ad on the back page - sells boxes. They're plain white with dividers that cushion the tube. They come in four sizes and are reasonably priced. N6CSW/Ø

Self-Adhering Labels

Everyone will agree that 'keeping organized' is very important when restoring or repairing or modifying equipment. Nothing can 'burn up' more time than looking for a screw or a washer or trying to figure out where a wire goes that we've disconnected from a circuit. The self-adhering labels that I use on the magazine - large ones for the mailing labels and smaller ones to hold the magazine closed - are really handy on the work bench. They're very cheap and available at any office supply store. I use the small ones to label wires,resistor and capacitor leads etc. - I just close them around the wire. When I dismount something like a transformer I place the nuts,bolts and washers on a large label, sticky side up. That way they're all together when it comes time to re-mount the transformer to the chassis. If it's going to be a while before I put everything back together - maybe I'm waiting for parts - I'll take another label and place it over nuts and bolts etc. and indicate what's between the two labels. I also use the labels on transformers,chokes,variable caps etc. that I've measured. N6CSW/Ø

Got a good tip? Please send it in and share it with us.

SSB At Collins from page 11

A few years after the introduction of SSB and the shipment of equipment for the new mode of modulation, Collins Radio had $50 million in SSB backlog. These were the days when a million dollars was a 'big number'.

These were exciting days at Collins. All of us in the Collins engineering department were excited and proud of our design achievements. A sad episode after the development was the KWM-5000. This was to be the ultimate SSB transceiver, with two VFO's, a built-in directional wattmeter and many other goodies. Art decided that there were more important engineering worlds to conquer so the project was abandoned, much to the disappointment of the ham design department.

A lot was done in a short time but one of the most exciting projects was the development of the 30L-1 linear amplifier. Gene Senti was one of the design engineers in the ham engineering department. He had breadboarded an amplifier at his home that he thought was innovative. When I saw it, I agreed. We put together a design group of hard working electrical and mechanical engineers and supporting personnel such as draftsmen and technicians with the goal of building a prototype of the 30L-1 in less than a week. We started design on Wednesday morning and worked until about midnight every night on Wednesday, Thursday and Friday. By Saturday night at about eight, the finished model was put on the air at my ham station. The unit performed flawlessly and we made several contacts. This was a total amplifier complete with etched-silk-screened panel, painted case, printed circuit cards, dial and the works. The model phase set a new record for fast design, however, it took several months to write all of the test specs and do the part's list and the final drawings. The engineering model looked just like the models that were shipped about six months later.

Since the project happened to be staged in a room that was painted a light green, it was called the Green Room project. This designation for crash projects persists until today at Collins Rockwell. It is one tradition that many latter day engineers would rather not have started because it is hard on family life.

The Butler Building task force was a strange way to start a major set of programs. However, it was instructive and provided a great education for a dedicated group of engineers who later carried Collins Radio into many design projects. These projects resulted in a host of SSB equipments for amateur, commercial and military applications.

I want to offer my thanks to Bob Miedke (WØRSL) and Warren Bruene (W5OLY) who helped me refresh my memory about the good old days at Collins Radio.

Editor's Comments from page 32

His antenna was 4 halfwaves in phase about 80 ft. high. He received reports from all over the world on 75. Actually he lived in Twinsburg,Ohio; Hudson was his mailing address. Harry specialized in monologues and I remember him keeping the mic for a half hour many times! His wife Winnie, in the photo, usually would keep Harry company in the radio room with her knitting and sewing."

I am absolutely delighted that the ARRL is supporting us - the AM operators - in the matter of the proposed power limitation. I think now we have a good chance of prevailing in this issue. I think we might all contact our directors and pass along our thanks.

On to number 11....

Reflections from page 2

Clayton "Bud" Banes, W6WB and George Weiss were co-owners of Technical Radio Co. W6WB did most of the mechanical design on the transmitter and when a prime supplier, for all fixed and variable capacitors used in the oscillator and rf sections, failed to produce early in the game, W6WB designed all these capacitors from scratch and the capacitors themselves were built from the ground up at Techrad's own plant. Incidentally, the capacitors in the T-350XM are comparable in quality to National Co. or E.F. Johnson Co. products.

As far as is known, there are five other T-350XM transmitters in existence. Techrad chief engineer W6WB is still on the air with one. "Ozona Bob", W5PYT and W6FMY have them also. A few years ago, AA4RM and a friend bought two of these transmitters at surplus from Lockheed Aircraft in Georgia.

All the transformers in the T-350XM were made by Thermidor Electrical Mfg. Co. of Los Angeles. Unfortunately, there was some kind of defect in the high voltage plate transformer. Although the best materials and construction were used, some of the transformers shorted primary to secondary; maybe it was enemy sabotage. Who knows?

After several years of use at W6RNC, my 100 lb plate transformer succumbed. It was replaced by a professional quality Electro-Engineering Co. plate transformer having separated coil windings, only 50 lbs. weight, but greater overload capacity than the original unit. Otherwise, my transmitter is in original condition.

I also have a good supply of spare parts, just in case. If you want to hear a transmitter with 25 watt resistors for meter shunts, you can listen in Wednesday nights at 9 PM to the SPAM schedule on 3870.

Editor's Comments from page 1

The memorial service was well attended with many of his friends coming considerable distances to pay their last respects. Jim, N5COD came over from Casa Grande, Arizona and Father Lamar Speier (K4HQR..."High Quality Radio") came down from Fort Collins, Colorado to perform the service.

The service began with,"We brought nothing into this world and it is certain we can carry nothing out" and ended about twelve minutes later with,"The Lord lift up his countenance upon you, and give you peace, both now and evermore. Amen". Lamar spoke the Elizabethan phrases with great dignity in the tone of a Shakespearian actor. The service was from the 1928 Book of Common Prayer, Episcopal Church. These were the same words used for Shakespeare, Churchill, FDR and other notables. I think they were appropriate for Gordon as well.

Driving home that evening I thought about Gordon and his life. For one thing he had a wonderful wife - Jo - who has always been a part of our friendship with Gordon, he had three outstanding - well educated - children, and a whole bunch of good looking grandchildren. And he had friends that really cared about him. What more is there? Gordon did very well.

We'll miss Gordon but while he was here he was appreciated.

Last month's cover drew a couple of interesting responses. The first one was from Al Gross, W8PAL. He called to say that he had known Harry Steffan, W8RHZ from before 'the War' on 80 and 160 meters. He told me that he called Mrs. Steffan and learned that Harry had passed away and that she is still doing well at 92. Joe Santomas, W2FXM sent a card: " Harry passed away about 5 years ago. He was a fixture on 75 meters. His rig was a KW with 250TH's, also the Temco 750 next to him in the photo.

continued on page 31

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DEADLINE FOR THE MARCH ISSUE: MARCH 5

WANTED: Johnson 122 vfo. Pat, WB9GKZ, 2511 Memorial Dr., Green Bay, WI 54303.

FOR SALE: Pristine condition Heathkit HW-22A, 40 meter transceiver with HP-23 AC supply, HP-13 DC supply, microphone and manuals - $195. Don Bishop, NØEA, Box 4075, Overland Park, KS 66204.

FOR SALE: Hammarlund: SP400X rack model, less power supply - $65; HQ-170 - $250; HQ-180 - $250; HQ-105TR- $150. Lafayette: HE-45 with HE-61 vfo - $75; HE-50A with HE-62 vfo - $75. Parker, W1YG, 87 Cove Rd., Lyme, CT 06371.

FOR SALE: New 6146 and 1P28 tubes - cheap. **WANTED:** Pilot and German radios. Bill Moore, 1005 Fieldstone Ct., Huntsville, AL 35803. (205) 880-1207

FOR SALE: 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

FOR SALE: Collins KW-1, Serial #26, excellent condition with original manual and warranty card - $3500.00. Pick up only. K4OTM, RFD #7, Box 123, Greenville, TN 37743.

WANTED: Factory wired Viking Navigator; E.F. Johnson bug; 160, 80, 40 meter crystals; LF coils for HRO-5; Hammarlund Super Pro 110/210; Hallicrafters HT-7. Brian Roberts, 3068 Evergreen, Pittsburgh, PA 15237.

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

WANTED: 40 TVH and 80 JCL plug-in coils. James T. Schliestett, POB 93, Cedartown, GA 30125. (404) 748-5968

WANTED: CW bandwidth filter for 75A-4. Jim Hanlon, W8KGI, POB 581, Sandia Park, NM 87047.

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J. Earl Scaramella
P.O. Box 1
Woonsocket, RI 02895-0001

FOR SALE: SX-101A and HT-32B as a pair - $375. **WANTED:** BFO assembly T6, Hammarlund part no. 31106-G-4 for SP-600J. Steve Harmon, N9HGF, (812) 474-0842.

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

WANTED: General Radio Company instruments in wooden cases. Especially want laboratory type equipment. Also need GR Experimenter magazines, manuals and catalogs. Frank R. White, KBØTG, POB 2012, Olathe, KS 66061.

WANTED: Tube era audio gear, audio transformers, W.E. gear and parts. Joe Roberts, N4WQC, Box 19302, Alexandria, VA 22320. (703) 683-2955

WANTED: Collins SC-101 station control, any condition, also any literature on this unit. J. Orgnero, Box 32, Site 7, SS 1, Calgary, AB, T2M 4N3, Canada.

FOR SALE: January 1990 catalog of Radio/Wireless and Broadcasting books now available. Send SASE to Rainy Day Books, POB 775, Fitzwilliam, NH 03447. (603) 585-3448

FOR SALE: HQ-215 receiver in very good condition - $195; Hammarlund HQ-110 receiver - $90. **WANTED:** Collins S-Line, must be in VG to MINT condition. Charlie, KD4AJ, (404) 396-0276.

WANTED: Millen 90800 transmitter with coils. Bandspread coils for 160 and 40 meters for the SW-3. Herb Spivey, NF5Y, POB 27, Baldwyn, MS 38824.

FOR SALE: UTC transformers, brand new in factory cartons, 100 different types: transmitting, filament, chokes and modulation transformers. Also audio interstage and outputs etc. Commercial, military and amateur grades. Send #10 SASE for catalog and inventory to: Len Crispino, POB 702, Hudson Falls, NY 12839. (518) 638-8199

WANTED: Instruction booklet or xerox copy for RCA WT-110A automatic electron tube tester; also need plastic cards. State cost. E. Barbacow, 330 Ceylon Rd., Carmichaels, PA 15320.

FOR SALE: Good military junque and parts, including command sets. Lge SASE for list. Walt Hutchens, KJ4KV, 3123 N. Military Rd., Arlington, VA 22207.

WANTED: Military radios 30's - 60's. Particularly need DM-43 dynamotor, ATB, MAR, MAY, RAX, PRC-7 radio sets. Walt Hutchens, KJ4KV, (703) 524-9794.

FOR SALE: Vibroplex Collectors Guide. W1IMQ's new illustrated reference includes history of every key, identification guide, complete patents, and more. 87 pages, softbound. Only $14.95 plus $2.00 S&H. (foreign, $5.00 S&H), Mass. res. add 75 cents tax. Artifax Books, Box 88-E, Maynard, MA 01754.

FOR SALE: Schematics: radio, ham, Canadian, test equipment, surplus, electronics, organs - $3.50 plus postage. SASE for manual quotes. Alton H. Bowman, Rd 2, (Chapin Vlg.) Canandaigua, NY 14424.

FOR SALE: Vintage gear; parts, new and used. Guaranteed service and repair for all vintage equipment. 35 years experience, FCC licence. Harold Guretzky, K6DPZ, 95-15 108th St., Richmond Hill, NY 11419. (718) 847-3090

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HAMFEST NOTICE: at the Human Resources Center in Conneaut, Ohio, March 11. Set-up at 7:00, doors open at 9:00AM. Contact Bob Schultz, W8ERQ for more information.

FOR SALE: Gibson Girl Kites, M-357A, with two balloon inflation tubes and case, used - $30, kite only - $25; RC-292 Antenna Sets for extending operating range of FM radio sets. Cover 20 to 70 Mhz by preadjusted vertical and ground plane elements elevated to 30 ft. by 12 AB-35 mast sections. Portable set includes elements, ropes, stakes, 68 ft. of RG-213, roll bag, instructions, etc., 55 lbs, used - $95 plus shipping. Tartan Electronics, Inc., Box 36841, Tucson, AZ 85740. (602) 577-1022

FOR SALE: Hallicrafters SX-71, with R-46 speaker, cosmetically ok, no manual - $50 plus shipping; Hallicrafters S-4, good condition, no manual - best offer by mail only. Bill Kleronomos, KDØHG, Box 1456, Lyons, CO 80540. (303) 823-6438

FOR SALE: Hammarlund receivers: HQ-180C - $175; HQ-110C - $110; HQ-160 - $110. All excellent with manuals. Plus shipping. Burt Ostby, 2424 F-30, Mikado, MI 48745. (517) 736-8020 after 6:00 PM EST

WANTED: National 183D receiver owners manual/schematic. Photocopy ok.Bernie Doermann, WA6HDY, 452 Oxford Dr., Arcadia, CA 91007. (818) 445-2891

FOR SALE: Hallicrafters Sky Buddy, 2 extra holes in front panel, untested - $30 plus UPS; Gonset Comm. IV - $25 plus UPS; Hallicrafters SX-42, untested - $100, pick up only. Krantz, 100 Osage Ave., Somerdale, NJ 08083.

WANTED: For Collins 75A-3: cw filter, NBFM adaptor, xtal calibrator; speaker for 75A series. Did they make a 6 kc filter? Vin Tese, WA2UXO, 90 Gold St., #13-B, New York City, NY 10038. (212) 285-2971

WANTED: Drake 1-A, 2-B, 2-C, 2-NT, R-4A, T-4X, TR-3, TR-4, and a Johnson Adventurer. **FOR SALE:** Drake MN2000, Drake MN2700, and Collins 30L1, all in mint condition. Drake TR-4CW, in excellent condition. Steve, WB4IJN, (803) 873-7847.

WANTED: German, Japanese, Italian, WW-II radio equipment or parts, any informational paper, any condition. My special interest is studying, collecting, and restoring to operation the less common equipment of that era. Also interested in USN and Coast Guard mobile or aircraft radio, portable or small CW transceivers. Military manuals. Boat radio manuals, old or recent. **FOR SALE:** 3 new 211, RA-133, ACPS for BC-221?, BX-8 and output tester for BC-191, ARR-15. Thank You! Hugh Miller, KA7LXY, 6400 Maltby Rd., Woodinville, WA 98072-8375. (206) 487-3047 weekends.

FOR SALE: Collins manuals, mint condition, latest edition (not copies) of KWM-2A transceiver (9th edition, 15 Jan 78) - $40; 516F-2 power supply (15 Jul 74) - $15; and 312B-4/5 VFO speaker wattmeter (7th edition, 15 Mar 78) - $15. Complete set of three manuals - $60. All item postpaid. Bill Mills, KC5PF, 1740 Tonys Court, Amissville, VA 22002. Office: (703) 818-3955, Home: (703) 937-4090

WANTED: Drake R-4C w/sw xtals; HQ-215; HQ-180AX; SP-600JX, NC-400. Levy, 8 Waterloo Dr., Morris Plains, NJ 07950. (201) 285-0233

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FOR SALE: Antique radios, parts, tubes, books, vibrators, knobs, amateur, testers, transmitter crystals, etc. Eleven lists. LSASE plus $2 cash (no checks). Richard & Rose's Radio Mart, POB 691443, Tulsa, OK 74169.

FOR SALE: BC-375/191 tuning units - $50; military resistance bridge - $35; original, complete RCA image orthicon studio camera chain, B&W from TV's golden age; WW-II design radar indicator TPS-1 - $125. I buy and sell. SASE for list. Old audio and video formats to new. Allen H. Weiner, 14 Prospect Drive, Yonkers, NY, 10705. (914) 423-6638

WANTED: Collins 75A-1 receiver in good working condition and good appearance with manual. Don Landes, WX4C, Rt. 6, Box 177, Harrisonburg, VA 22801. (703) 434-5710

FOR SALE: RCA VOM model WV98A, no probes - $25 ppd; Measurements grid dip model 59 megacyle meter without coils - $25 ppd; Rollar Smith model "COM", very old - $25 ppd; Geo. Stevens coil winder, model 39 - $50. plus shipping. WANTED: Usable 203A tube. James Fred, R1, Cutler, IN 46920.

FOR SALE: Receiving tubes, power tubes, crt's older models plus late numbers UL and CSE recognized. Donna O'Connor, 824 Main St., Belleville, NJ 07109. (201) 751-2591

WANTED: 750TL tubes. Bill Diggins, WA8LXJ, 2699 Shamrock Rd., Morrow, OH 45152. (513) 899-2876

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FOR SALE: James Millen S.R. Bridge, type 90671, with operating instructions - $17 plus $3 UPS. Need 4 pin ribbed coil forms. Wes, W5DPM, 1950 Chevelle Dr., Baton Rouge, LA 70806.

WANTED: 6 meter AM transceivers from 50's and 60's. Please send description and price. Howard Sine, WB4WXE, 3207 Orion Cir., Rome, NY 13440.

FOR SALE: Collins 75A-4 receiver with 3 mech. filters, mint condition - $450; Drake RR3 commercial gen. coverage receiver, mint condition - $850; Johnson Invader 2000, mint condition, $700; Johnson Pacemaker - $150; Johnson Desk pedestal - $1400; Johnson KW Matchbox with directional coupler - $175. **WANTED:** Top cover for R-388/51J receiver; front panel for RCA AR-88 receiver; NRD 525 receiver; Johnson 500 transmitter. Howard, W3HM, Rt 3, Box 712, Harpers Ferry, WV 25425. (202) 647-2428 days, (304) 876-6483 nights

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WANTED: Which old tube receiver had the simplest crystal filter to align? Am having trouble aligning those 6-position selectivity circuits. W.J. Johnson, Jr., KA3LRE, 1142 Hillsdale Ave., Pittsburgh, PA 15216. (412) 531-9652

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

FOR SALE: Rockwell/Collins authorized reprints of S-Line manuals available for the following models: KWM-2/2A - $35; 75S-3B/C, 32S-3A - $30; 75S-3, 32S-3 - $25; 312B-4/5 - $20; 516F-2 - $15. For U.S. orders, include 7% of total purchase for shipping and handling (Canada and Mexico 12%). Ohio residents add 6% sales tax. Vista Technology Incorporated, 3041 Rising Springs, Bellbrook, OH 45305.

WANTED: RCA model 816K. Chuck Dachis, 4500 Russell Dr., Austin TX 78745.

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P.O. Box 97, Crescent City, CA 95531

FOR SALE: QST's 1928 to 1936 - $3 to $4 plus postage. No list, send wants with SASE. Krantz, 100 Osage Ave., Somerdale, NJ 08083

WANTED: Old National and Hammarlund receivers and accessories. Cash or trade for above my old SW, BC or telegraph sets. Robert B. Enemark, W1EC, Box 1607, Duxbury, MA 02331. (617) 934-5043

FOR SALE: Tubes: 810 - $15 ea. (4); 812 - $7 ea. (4); 809 - $6 ea. (4); 829 - $6 ea. (4); 832 - $4 ea. (4); 815 - $5 ea. (4); PL-177 - $15 ea. (8). Shipping extra. W3NCX, 1005 Wyoming, Allentown, PA 18103. (215) 435-3276

WANTED: Pre-1942 transmitter. Any condition or parts considered. Examples: Gross, Stancor, Collins, Thordarson etc. Also want SX-88. Bob Mattson, KC2LK, 10 Janewood, Highland, NY 12528. (914) 691-6247

WANTED: 152TL and TH tubes; also HK/PL/LG 254 type tubes, post WW-II manufacture preferred. Wendel Baker, K2LZF, 1388 Ridge Rd., Lansing, NY 14882.

FOR SALE: Receiver R100/URR military entertainment radio, 3 bands, AC/DC/Bat., fine condition - $45 plus UPS; Jones Micromatch and Johnson Directional Coupler - $20 plus UPS. Fred Huntley, W6RNC, POB 478, Nevada City, CA 95959.

CLASSIFIEDS

FOR SALE: "Hollow State" ham gear. Stancor ST-202A - $100; Sonar SRT-120, 80-10, 100 watt AM - $150; Hammarlund HQ-105TR, general coverage plus 10,11 meter AM, rare - $150; HT-18, less cabinet - $50; HT-32B, near mint, 150 W SSB/CW/AM - $225; WRL Galaxy 300 with power supply - $100; WRL AT4 Globe Matcher Sr. - $90; Johnson Thunderbolt, 4-400 KW - $475; Lafayette HE-45 6 mtr AM xcvr with matching HE-61 vfo - $75; nice matched pair of Heath HW-30 2 meter AM xcvrs with p/s, mikes and antennas - $70; Elmac AF-67 - $75; HQ-180 - $225; HQ-170 - $160; HQ-150 - $100; GPR-90 receiver - $175. Parker, W1YG, 87 Cove Rd., Lyme, CT 06371. (203) 434-7783

FOR SALE: TM repros for Command Sets, ART-13, BC-348, TM 11-487, other TM 11's to 08's, AN 08's. Replacement pages and some originals available. LSASE for list. Robert Downs, WA5CAB, 2027 Mapleton, Houston, TX 77043. (713) 467-5614

FOR SALE: Transmitting/Receiving tubes, new and used, mostly old surplus. Exa: OC3, 3B28, 4D32, 4-125A, 808, 809, 810, 811, 813, 815, 816, 829, 832, 836, 860, 1625, 5894, 6130, 6146, 6336, 9003 plus others. SASE 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: Ham radio parts: everything for linear amplifiers; power supplies; audio and RF circuits; big tubes like 4-1000, 4PR-1000 and 450TH with sockets and filament transformers. Francis Yonker, 7 Old Farms Road, Saddle River, NJ 07458

FOR SALE: National HRO Jr./RAS (?) receiver with "G" coil, as is - $50; photocopy of National SW-3 receiver manual with additional 16 pages of tech data, includes coil winding data - $7.50. Ward Becht, W6IRK, 625 Tufts Ave., Burbank, CA 91504. (818) 842-3444

WANTED: SX-42, SX-43, R-42, R-43, SX-88, for my "H" room; need two (2) SP-44, mint condition desirable but less than mint may be acceptable. S.R. Luxemburg, (504) 272-2563, FAX (504) 272-4913

FOR SALE: Two rack enclosures racks for 19" panel chassis - $40 each, plus shipping; 115 volt, 15 and 20 amp variacs - $50 each; pair of Hygain 40 and 80 meter KW aluminum enclosed traps - $40 pr.; WW-II frequency meters with built in ps - $50 each; 813, 805 - $20; 803 - $20; 814 - $10; 3B28 - $5; VR regulators, all types - $2; Ceco reflectometer SWR - $30. Levy, W5QJT, 7600 Blanco Rd., San Antonio, TX 78216. (512) 341-9549

FOR SALE: Radio Amateur Handbooks: 1944 - 1949 - $15, 1954 - 1957- $12; Radio Handbooks hardcover 1942 - 1946 - $15. All plus $2 shipping. Postpaid photocopies: RCA ARC-111 - $10; Radiola superhet - $10; Harknes Counterflex - $15; W.E. Vacuum Tubes Data, 56 pages, 101D to 284A - $18; test equipment schematics - radios and scopes - $2 each. Send with SASE. **WANTED:** wirerecorders, PYE radios and small wood table radios. Peter Dieguez, 36-48 - 34th St., L.I.C. NY 11106

WANTED: The 3035/455 kc IF xfmr (T1 in the diagram) for a HQ-170. Hammarlund part number K26402-1. Also 6 kc mech. filter for 75A-4. Bob, K7NWB, (602) 833-7786.

FOR SALE: T-368/URT 400 W+, 1.5 - 20 Mhz, AM/CW/FSK transmitter, with manuals, good condition, 115 VAC. See Electric Radio Sept. 1989, page 10 - $425. Ken, (205) 745-3761.

WANTED: Delco 5300; RS-6; BC-611 and manuals for 310B, SBE-2 and PRC-108. Gary Cain, 1775 Grand #302, St. Paul, MN 55105

Back issues of Electric Radio are available for $2.50 each, delivered 1st class.

CLASSIFIEDS

FOR SALE: Control box C-58/APT-1, checked and OK- $10 ppd; L &N light Beam Galvanometer, cat. no. 2021D, walnut box - $25 ppd; HP model 400D AC VTVM - $30 ppd; Knight AM-FM tuner, tube type, model KF65 - $25 ppd; Hallicrafters S-47, power transformer may be bad, pb caps are missing, no cabinet - $55 ppd. James Fred, R1, Cutler, IN 46920.

WANTED: Knight T-50; Globe UM-1 modulator; meter for Heath AT-1. Still looking for early National receivers; NC-44/5, 80/1, 100/1, etc. Steve Sauer, WA9ASZ, 1274 Londonerry Ln., Greenwood, IN 46142. (317) 882-4598 eves. after 8:00 EST

WANTED: Federal parts, radios and restoration info; loose coupler; VT-2's (good). Send SASE for my old QST and book list. Glen Fritz, N4WDX, 1516 1st Place, Vero Beach, FL 32962.

FOR SALE: WATTMETERS, URM-120, 2 to 1000 Mhz, RF 10 to 1000 W, using three plug in couplers (like Sierra 164). Used, removed from service with TS-1285 meter, couplers, metal case and book, 20 lbs - $140 plus shipping. Tartan Electronics, POB 36841, Tucson, AZ 85740. (602) 577-1022

FOR SALE: Hallicrafters manuals, copies - $4.50 postpaid. Some Hammarlund, Gonset, Johnson. Miller Radio, POB 6604, Erie PA 16512

WANTED: Hallicrafters owners manuals for models T-54, 505, 506, 7" TV's. Originals only. Fred Emerson, 627 Illinois Ave., Elgin, IL 60120. (708) 741-6728

WANTED: Collins parts: complete units, junkers, interconnect cables, speakers for A and S series, anything. Bob, W1CNY, Box 834, Simsbury, CT 06070.

FOR SALE: Drake 1A, with manual, very clean - $219 plus shipping; Heath GR-91, with manual - $39. Al Bernard, NI4Q, POB 690098, Orlando, FL 32869-0098. (407) 351-5536

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