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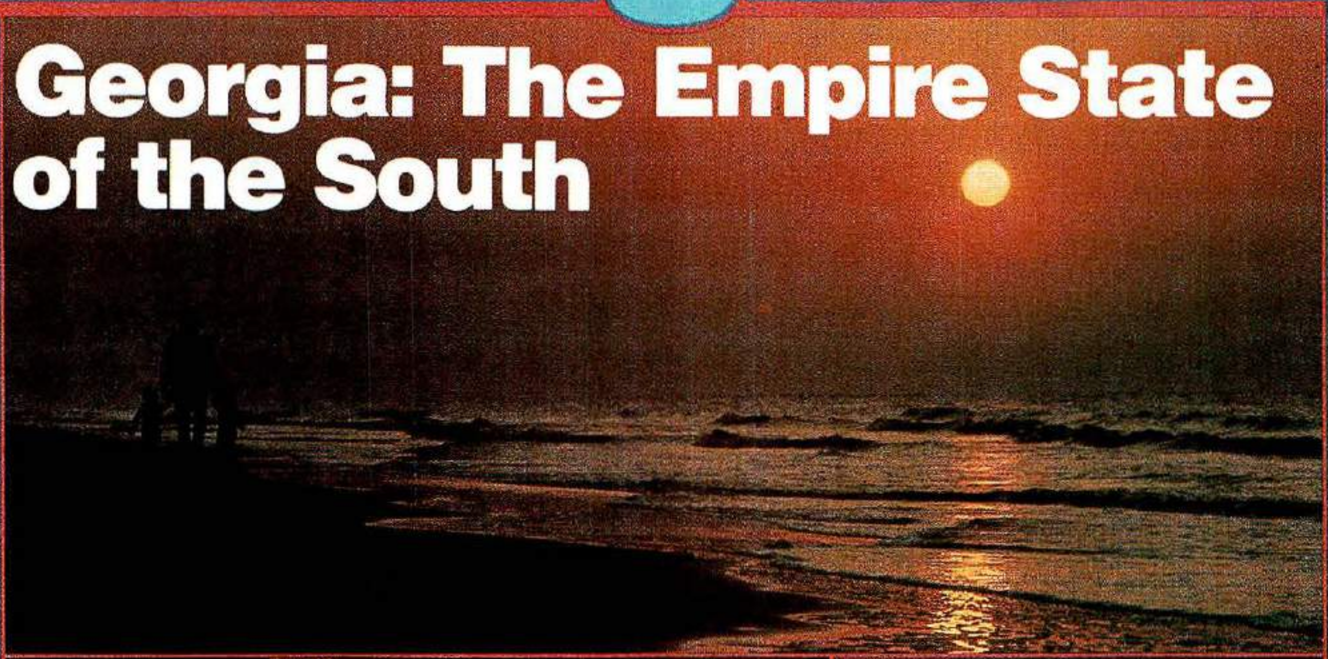

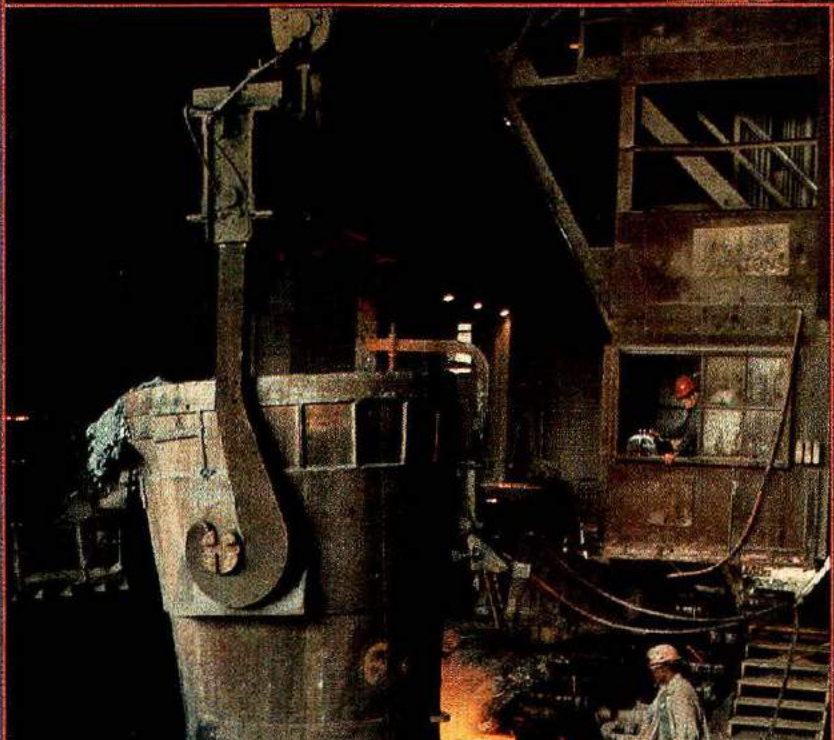

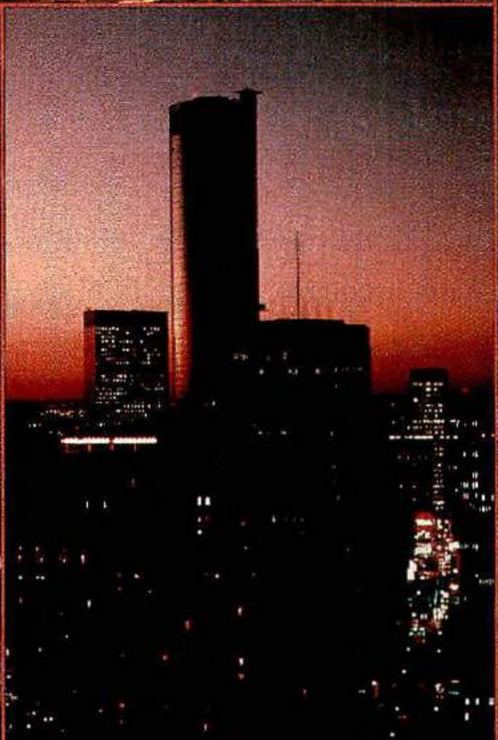

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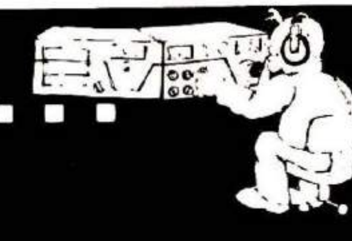

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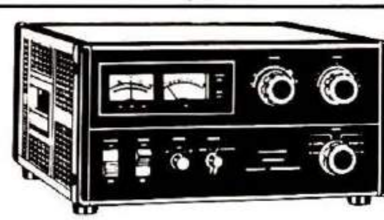

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THIS MONTHS HORIZONS

Beginner's Rig

Yes, you can still find the parts to build a good beginner's transmitter if you know what to look for. Nothing exotic is required in this two-tube rig that'll hit 80 and 40 meters; just ordinary components that you can pick up at suppliers, flea markets, surplus houses, and the like. W8YFB starts you off with some design discussion, so you can see the reason for certain component values, and you'll be able to shop for parts with this information in mind. A complete parts list is included in this first section, so you can have them on hand by the time we present the second installment.

Lightning Protection

Lightning can melt coax and rotor-control cables, vaporize ground wires, fuse wiring, and generally cause havoc with your equipment. There are some measures that can be taken to decrease the chances of being hit, and many things that will decrease the amount of damage caused if a strike should hit nearby.

Nostalgia

A case of spring-cleaning that brings on some fond memories of rigs and things of the past. It also triggers a replay of an early instance of getting clobbered by the local big-time operator while chasing DX. So our hero lost out in the pile-up — but maybe he got the best of the deal after all. We present a story borrowed from the pages of April, 1972, *ham radio*.

There's A War On

There are many amateurs active today who can remember the FCC order to cease transmitting, and who "loaned" equipment to the Army and Navy in a time of shortage. However, there are a couple of generations of amateurs who have never known the eerie feeling of not being able to hear an amateur signal anywhere — no matter what band you tuned across. Author Orr tells what it was like when the pool of amateur ability and skill was tapped for the big effort immediately after December 7, 1941.

Two-Meter SSB

There's no arguing with the popularity, usefulness, and proliferation of fm and repeaters on the vhf bands. There are other modes in daily use on two-meters, too, and the pioneering DX work was done using them. The equipment is not much different, and the antennas are almost the same as needed for fm work — but the advantages for daily DX opportunities are tremendous. Read what author West has to say about this exciting type of communications that still thrives beyond the squelch tails of the local machines.

Another Approach To Becoming A Ham

If you're a dedicated ham you'll surely want to help others across the great barrier — passing the amateur-license exam. This story illustrates what's happening all over the country. It's a tale of a licensed amateur who cared enough to help another chap who really wanted to become a ham operator but who didn't quite know how to go about it. Let's drop in on WD8KQN and see what happened.

Ham Slang

Newcomers and short-wave listeners are sometimes mystified by what they hear when tuning across the amateur phone bands, and sometimes the CW bands as well. We've had a translation of many CW terms ("How to Speak Ham," January, 1978 *Ham Radio Horizons*), so here is a key to the hidden meanings behind some of the words and phrases.

VHF Antenna Matching

Many antenna experts disagree on just how vital it is to have an antenna and transmission line that are perfectly matched, and their arguments carry right through the spectrum into the vhf and uhf realm. Regardless of how important the match is, it is nice to know that all the parts of your antenna system work well together, and that you can look at some previous readings to see if anything has changed. Are these readings hard to get? Not necessarily — you can make some simple instruments that will do the job and help you learn about vswr and matching at the same time.

The Cover

Here's a rig you can really get into. Although it's billed as a beginner's transmitter, our guess is that plenty of older hands will really enjoy building one and putting it to use on the ham bands. It's a two-tube, 50-watt rig for the 80- and 40-meter bands. Part 1 of the description starts on page 12. Original painting by Tom Broscius, WA2RWA.

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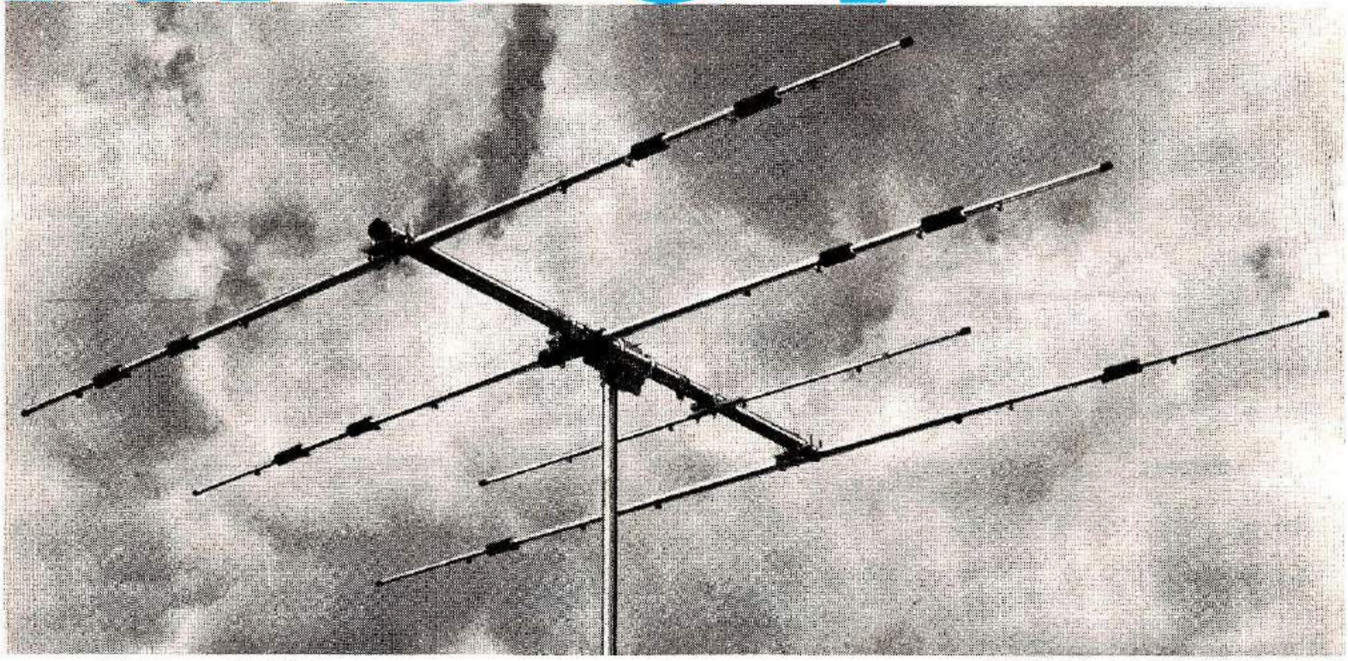

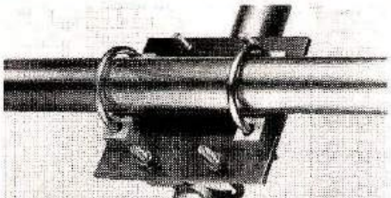

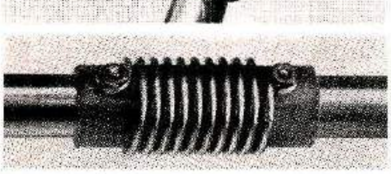

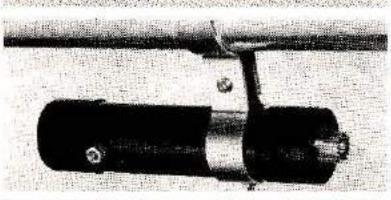

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CONTENTS

THE VIEW FROM HERE

In recent months there has been rising concern about the possible harmful effects to living tissue due to heating by radio-frequency energy at 10 MHz and above. The weekly CBS TV news magazine, *60 Minutes*, devoted a segment to this topic several months ago, numerous "rf radiation" stories have been published in newspapers and magazines, and now there is a best-selling book on the subject: *The Zapping of America*, by Paul Brodeur. Although much of Brodeur's book is devoted to what he calls the "deadly risk of microwave radiation" and its "cover-up" by the government, he apparently doesn't know the difference between high-power radar or TV transmitters and high-frequency amateur and CB equipment. He would have you believe that little or no research has been done on the dangers of electromagnetic radiation; if your friends and neighbors believe him, you may find your radio activities squelched by local citizens who are afraid of being "zapped" by your amateur transmitting equipment.

Contrary to what Brodeur says, microwave engineers have been aware of rf radiation hazards for 30 years or more, and the scientific community has spent thousands of man hours investigating its effects and establishing safety standards. It is known, for example, that the internal body organs are susceptible to damage from heating caused by high-power radio energy in the range from 150 to 1200 MHz, and that the eye is especially prone to damage from radiation above 1000 MHz. More importantly, it is known that power levels which cause damage are much higher than those found in the average ham shack. Kilowatt transmitters on the amateur uhf bands (432 MHz and above) are potentially hazardous, but if they are completely shielded they are not dangerous to your health. On the lower frequencies there is practically no danger, even if you're running 2000 watts PEP.

Based on present knowledge, which is extensive, various government agencies have established rf radiation safety standards with recommended exposure limits referred to as Radiation Protection Guide Numbers (RPGN). The accepted RPGN value is 10 milliwatts per square centimeter of body area, the standard set by the Occupational Safety and Health Administration (OSHA). Although there are some scientists who disagree with this standard, most authorities agree that rf power levels one-half the OSHA standard (5 mW/cm^2) do not have any noticeable effect on the human body.

At this point you're probably asking yourself, "What does this mean, and how do I relate it to my own amateur transmitter?" Since your transmitter is presumably shielded, and you use shielded coaxial transmission line, the only possible danger is the radiation from your antenna. Assuming 1000 watts into the antenna, what is the minimum safe distance? This depends on the directivity of your antenna and how much power is radiated in a given direction; for a half-wavelength dipole it equates to a distance of about 15 feet. If you're running less than 1000 watts, of course, the distance is much less (about 5 feet at 250 watts input). Since most amateur dipoles are installed at least 25 feet above ground, they are obviously no threat.

What about multi-element Yagi beams and stacked arrays? Since most of the power is concentrated in front of the beam, there is practically no danger above or below the antenna; and with 1000 watts input, the beam must have at least 13 dB gain before the power density reaches 5 mW/cm^2 in the center of the forward lobe 50 feet in front of the antenna. Few amateur antennas have this much gain, and those that do are used on uhf where it's difficult (if not impossible) to pump 1000 watts into an antenna and stay within the legal amateur power limit. On the high-frequency bands there is no danger beyond about 15 feet, even if you're running a kilowatt and a 4-element beam. If your beam is on a tower, more than 20 feet from the nearest living area, there is absolutely no hazard. Keep these facts in mind if you start getting grief from your neighbors.

Jim Fisk, W1HR
editor-in-chief

More details? Ad Check page 94.

FOCUS & COMMENT

Things are beginning to get interesting on the propagation scene — a condition brought about by the increased sunspot activity. There are several noticeable side effects from this activity, too. Effects that are somewhat predictable, but are, at the same time, amusing and surprising. For instance, how about the guy who received his brand new Novice license in the mail, and went dashing off to his hamshack for an evening's operating — only to find the 80 and 40 meter bands practically dead! Imagine the perplexity of checking the antenna, feedline, power output, and still you cannot raise anyone. I well remember the bewilderment in his voice the next morning when he asked, "Can you give me any idea what might be wrong with my rig?"

Fortunately, I had been keeping somewhat current on what was happening on the Solar surface, and was able to reassure him that things would improve in a couple of days — then I went home that evening and worked two new states on 144 MHz, using the aurora-enhanced propagation that the solar flare produced.

All of which points out that what the sun does can be bad for one type of operating, but beneficial for another. To get the most out of the hobby, you should be prepared to move around, to take advantage of changing conditions.

This is one of the strongest recommendations I can think of for going for your Technician-class license as soon as you can absorb enough theory. You'll still have all the Novice privileges, so nothing is lost there — and you'll gain vhf privileges, where there is a style of operation that just never gets to the low bands.

Going back to the aurora propagation as an example — you gain some thrilling insight to the interplay between solar particles and the Earth's magnetic field as you follow the shifting reflections in the northern sky. Occasionally, the signals are loudest from a point several degrees away from true north. At one time I could improve signal strength an S-unit or two by pointing my beam at 330 instead of 360. As the sun progresses to the west (or, the earth rotates more eastward, to be correct), the pattern shifts and changes. At times the ionization becomes too diffuse to reflect a coherent signal, but then returns to a more dense state which lets the signals start booming in again.

There are many areas where the curious or the experimenter can apply himself on vhf, especially when old Sol is making life difficult for the high-frequency crowd. How high in frequency can the auroral effects be noticed? Does tilting the antenna make a difference? Can auroral QSOs be made at sunrise, just as they can at sunset? Is there a tie-in between increased (or decreased) solar activity and the incidence of sporadic-E vhf propagation?

I know of no ongoing program to collect and evaluate all this information, but, in the course of investigating the possibilities of vhf propagation, it is inevitable that records will be set, and noted in various publications. Trends will be visible, and, what with all the parallel interest in home computers, you can be sure that someone will start searching for answers. But first they need the data.

It's not hard to become part of the experiment, really. When things just don't seem right on the lower bands, fire up the converter or receiver on 6 or 2 meters and see what is happening. It wouldn't hurt to listen a couple of times a day to WWV for their propagation and solar-activity bulletins either — listen on 5, 10, or 15 MHz at 18 minutes after the hour.

The experts are somewhat divided in their opinions about the level of solar activity for the next two or three years. Some say it will be the highest ever, others say it will be a disappointing low-activity period, and others say we will not know until it is over just how good or bad it was.

I intend to make the maximum use of amateur radio to help form my own opinion — and there's plenty of room for you to join me in this "solar session" that happens once every 11 years. Now, go get that Technician ticket. See you on vhf.

Thomas McMullen, W1SL
Managing Editor

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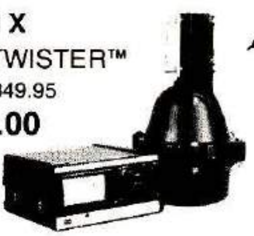

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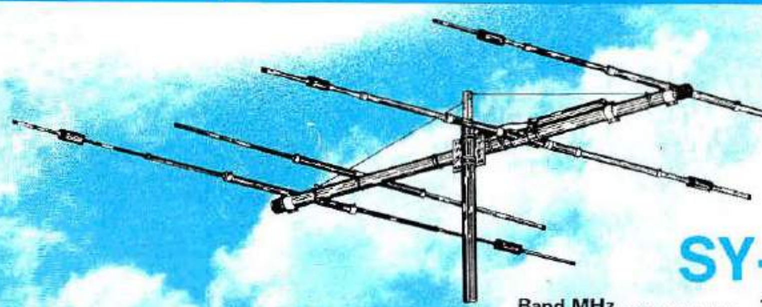

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Mast Diameter	2" O.D.
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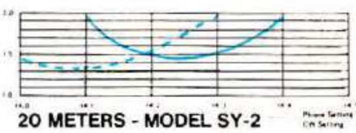
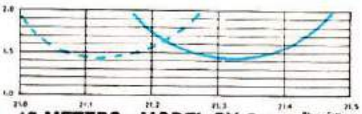


20 METERS - MODEL SY-2



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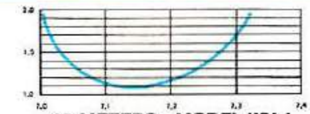

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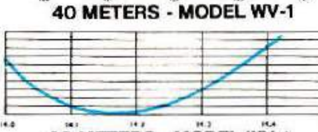
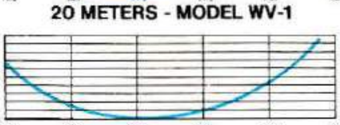
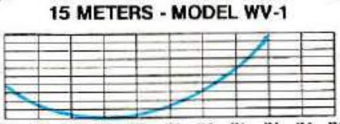


20 METERS - MODEL WV-1



15 METERS - MODEL WV-1



10 METERS - MODEL WV-1

WV-1 WILSON VERTICAL TRAP ANTENNA

No bandswitching necessary with this vertical. An excellent low cost DX antenna with an electrical quarter wavelength on each band and low angle radiation. Advanced design provides low SWR and exceptionally flat response across full width of each band. Featured is the Wilson large diameter High-Q traps which will maintain resonant points with varying temperatures and humidity. Easily assembled, the WV-1 is supplied with base mount bracket to attach to vent pipe or to mast driven in the ground. The new WV-1 Antenna is priced at $65.00 . . . and ships via UPS!

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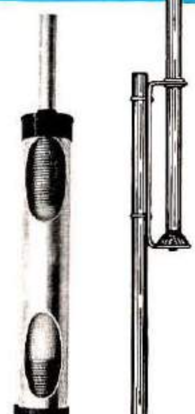

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NEWSLINE

EX-NOVICES WHOSE LICENSES expired less than a year ago will be eligible to apply for reinstatement just like any other Amateur licensees under the FCC's recent rules change making Novice licenses good for five years and renewable. This means any former Novice whose license expired after May 15, 1977, can submit a Form 610 after May 15, 1978, but within one year of his original expiration date, when the new provisions become effective, and regain his license for a full five years — without retaking an examination.

Present Novice License holders must realize the new five-year Novice license terms are not retroactive — their licenses still expire in two years on the expiration date they bear, and must be renewed with Form 610 — available from Ham Radio Horizons for a self-addressed, stamped envelope.

NEW 10, 18, AND 25 MHz AMATEUR bands were all proposed in the FCC's WARC 79 eighth Notice of Inquiry released early in May. On the negative side, the Commission proposed shifting 50 kHz from the top end of 80 and the bottom of 60 kHz of 160 to the broadcast service, but did also propose that all the HF Amateur bands (except for part of 160) be exclusively Amateur throughout the rest of the world. Specific FCC proposals for the Amateur Service:

160 Meters:	1800-1860 kHz, Region 3 only (shared); 1860-1900 exclusive Amateur worldwide; 1900-2000 shared
80 Meters:	3500-3950 kHz (loss of 50 kHz)
40 Meters:	6950-7250 kHz (shifted down 50 kHz)
30 Meters:	10.1-10.2 MHz (new)
20 Meters:	14.0-14.35 MHz (unchanged)
17 Meters:	18.068-18.168 MHz (new)
15 Meters:	20.95-21.45 MHz (50 kHz added at low end)
13 Meters:	25.11-25.21 MHz (new, moved from 25.76 proposed in the fifth NOI at the request of Radio Astronomy)
10 Meters:	28.0-29.7 MHz (unchanged)

Arguments By Amateurs were responsible for the new 10 and 18 MHz proposals, the Commission noting that they were "so strongly requested and justified in the Service Working Group report while reducing the overall impact on the fixed services..."

FCC IS ENFORCING its marketing ban on linears. At least one large dealer has been shut down and a considerable stock of illegal amplifiers seized, and a number of less flagrant violators are receiving strongly worded "cease and desist" letters.

SERIOUS QUESTIONS ABOUT AUTOPATCHES and the apparent increase of business-type communications on the Amateur bands are raised in an April FCC release, which likened "telephone interconnection at Amateur stations" with "the situation in the Personal and Business Radio Services." Though there were some text problems with the release as issued — the Personal Radio Division has requested that it be corrected and re-released — it strongly points up growing Commission concern with this area of Amateur Radio.

HARD-TO-UNDERSTAND QUESTIONS or answers on any of the FCC's amateur radio license examinations should be brought to the attention of Bob Kite, Federal Communications Commission, Personal Radio Division, Room 5114, 2025 M Street, NW, Washington, DC 20554. Naturally, he will need to know specifically which questions, answers, or wordings you think need to be rewritten.

GENERAL-CLASS LICENSEES will be permitted use of 50.0-50.1 MHz in a rules change announced by the FCC. The change brings General 6-meter privileges in line with those of Technicians, who were granted the low end of six in the second Report and Order on Docket 2028 adopted March 22. Effective date was May 15.

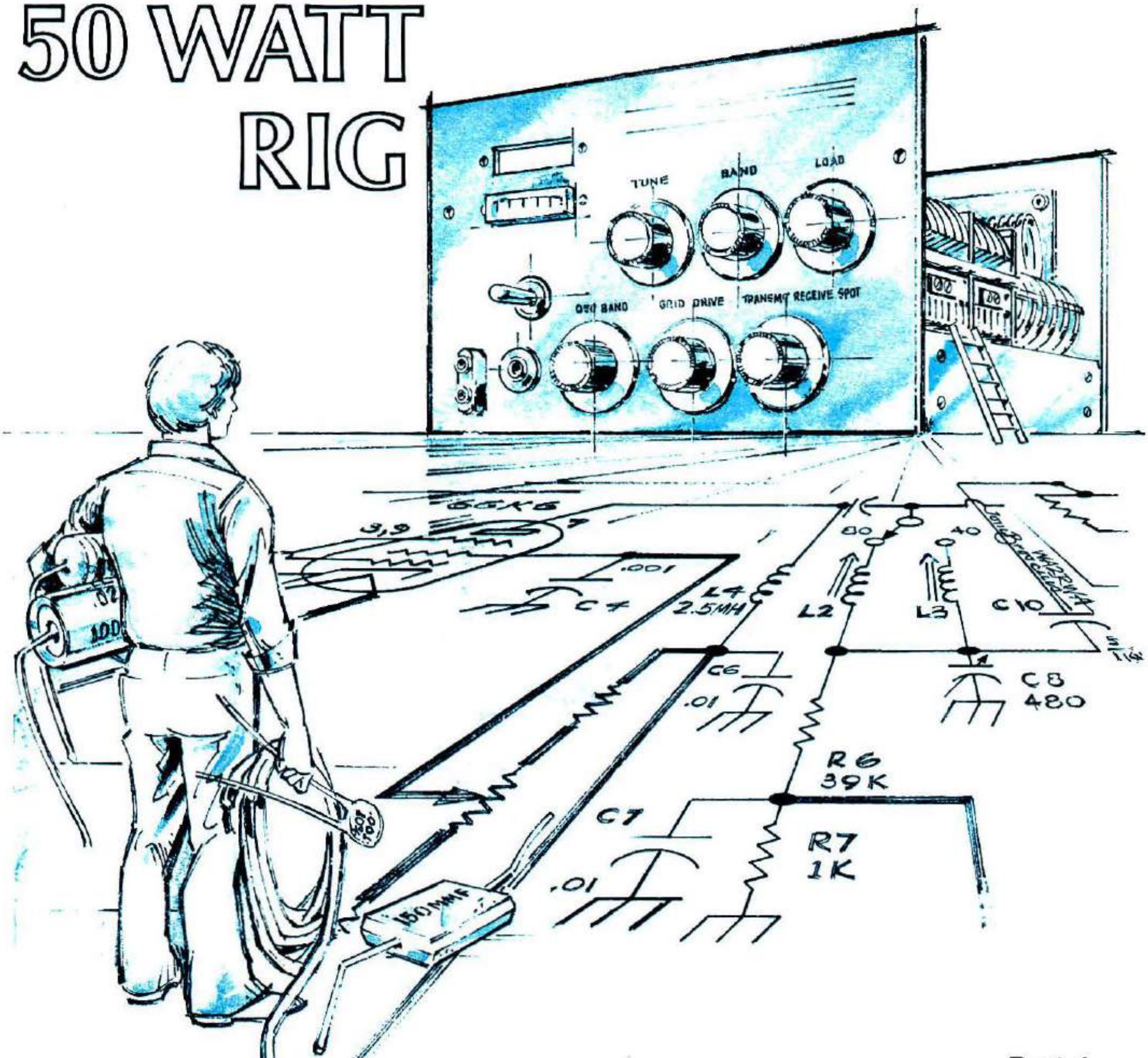
OSCAR 8'S ORBITAL DATA is now so refined that its change in period due to gravitational drag has been determined. The formula is $103.231836-1.117\times10^{-6}N$ where N is the orbit number, with the shift in longitude $25.80870162-2.325\times10^{-7}N^{o}$ per orbit. This calculates out to be a decrease in period of about 60 microseconds per orbit, or about 0.0001 minute per week, at which rate OSCAR 8 should fall back into the atmosphere in about 2300 years!

THE RUSSIAN "RS" AMATEUR satellites are now reported due to be launched before the end of this year and are to be inserted into "high altitude" orbits.

AN ENFORCEMENT GROUP to track down those who steal, purchase, or operate stolen radio equipment has been formed with headquarters on both sides of the Canadian/U.S. border. The name of the organization is Single Sideband International, and their stated aim is to ask law enforcement agencies to inquire about proof of ownership of a radio in any car stopped for traffic violations. A "Hot Sheet" will be regularly updated and circulated to all such agencies, including insurance companies.

For Additional Information about the group, write to Single Sideband International, PO Box 2478, Sarnia, Ontario N7T 7T1.

A BEGINNER'S 50 WATT RIG



Part 1

BY BILL WILDENHEIN, W8YFB

The transmitter presented here was designed to be a low-cost way for a beginner to become familiar with transmitter construction, trouble shooting, and intelligent parts-substitution. To be more universally attractive, it was designed to use parts from scrap radios and TV sets. In case you are unable to find all of the needed items, a list of suppliers of the critical items is included. Other objectives were: the rig must be stable, efficient, free from key clicks, harmonics, and TVI. It must include full station control with a single switch, have a keying monitor, be adaptable for VFO operation at a later date, and must have good keying characteristics.

This first article will explain some of the simple "ball-park" methods with which you can select parts for the transmitter. If you take the time to become familiar with each step, you are well on the way to being able to actually design your own equipment. If you are afraid that a homebrew rig is an invitation to TVI, let me say that I have taken the necessary precautions to be sure of a "clean" rig.

Fig. 1 is a schematic diagram of the transmitter. Note that it is divided into sections: transmitter, keying, keying monitor, metering, station-control switching, and TVI filtering. I will discuss each section separately so it will be easier to understand. **Fig. 2** is the power supply. Power supply components are quite expensive, so start looking now for scrap TV sets. Try to get several so you can select the one with the highest voltage power transformer.

Tubes

Most designs start by selection of the power amplifier tube, and a knowledge of the plate voltage under load. Let's assume our power supply is capable of providing 375 volts when loaded to about 180 milliamperes. What tube will work at this plate voltage? Any of the TV horizontal-output tubes will! A good choice would be a 6CD6, 6DQ6, 6GJ5, 6GV5, 6GW6, 6JB6, 6JM6, or 6JN6. All are very similar except for socket type and pin connections.

The oscillator tube can be a 6AG7, 6CL6, 6GK6, 6HB6, 12BY7, 7189, or the pentode section of a 6EB8. Again, you will have to consult a tube manual to determine the type of socket and the correct pin connections.*

Most tube manuals will not give you all the specifications for operation of these tubes in rf service, but enough information is given so that you can correctly use them. For example, the *RCA Tube Manual* lists the following for a 6DQ6:

Maximum plate voltage	770 V
Maximum plate dissipation	16 W
Maximum screen (G2) voltage	220 V
Maximum screen dissipation	3.6 W
Average cathode current	175 mA

Now you can determine the values of parts and operating conditions in a series of easy steps.

1) Find possible power input: For all of the sweep tubes, assume that you can run about 85 per cent of the listed average cathode current. So, 175 mA x 0.85 = 148.75 mA; call it 150 mA. Power input equals plate volts x plate amperes, or, 375 V x 0.15 A = 56.25 watts.

2) Find correct load impedance: This step is important for two reasons: In order to get maximum output, you must have the correct load for the plate circuit, and an incorrect plate load can lead to increased harmonic radiation and TVI (television interference).

$$Impedance = \frac{Plate\ volts}{2 \times Plate\ amperes} = \frac{375\ V}{2 \times 0.15\ amperes} = \frac{375}{0.3} = 1250\ ohms$$

3) Find values for the output network (C13, C14, L7, L8): Refer to **Fig. 3** and find 1250 ohms on the left side of the graph. Follow a line straight to the right until you reach the 3.5-MHz line (the lowest frequency this transmitter will use). Now, follow a line straight down to the bottom of the graph to find a value of 370 pF. A two-gang broadcast-set capacitor will be the cheapest solution here. If you can find several types, use the one having the greatest plate-spacing for C13. The value you

*The RCA Receiving Tube Manual is available from Ham Radio's Communications Bookstore, Greenville, New Hampshire 03048; order RA-30, $2.95 plus 35 cents postage and handling.

It's a two-tube, crystal-controlled, CW transmitter that will hit 80 and 40 meters. W8YFB does more than tell you where to put the nuts and bolts — he describes the reasons behind his selection of vital components so you'll understand how a transmitter is designed. If you can't find the exact parts called for, don't worry; you'll be able to pick an acceptable substitute by carefully following the theory presented.

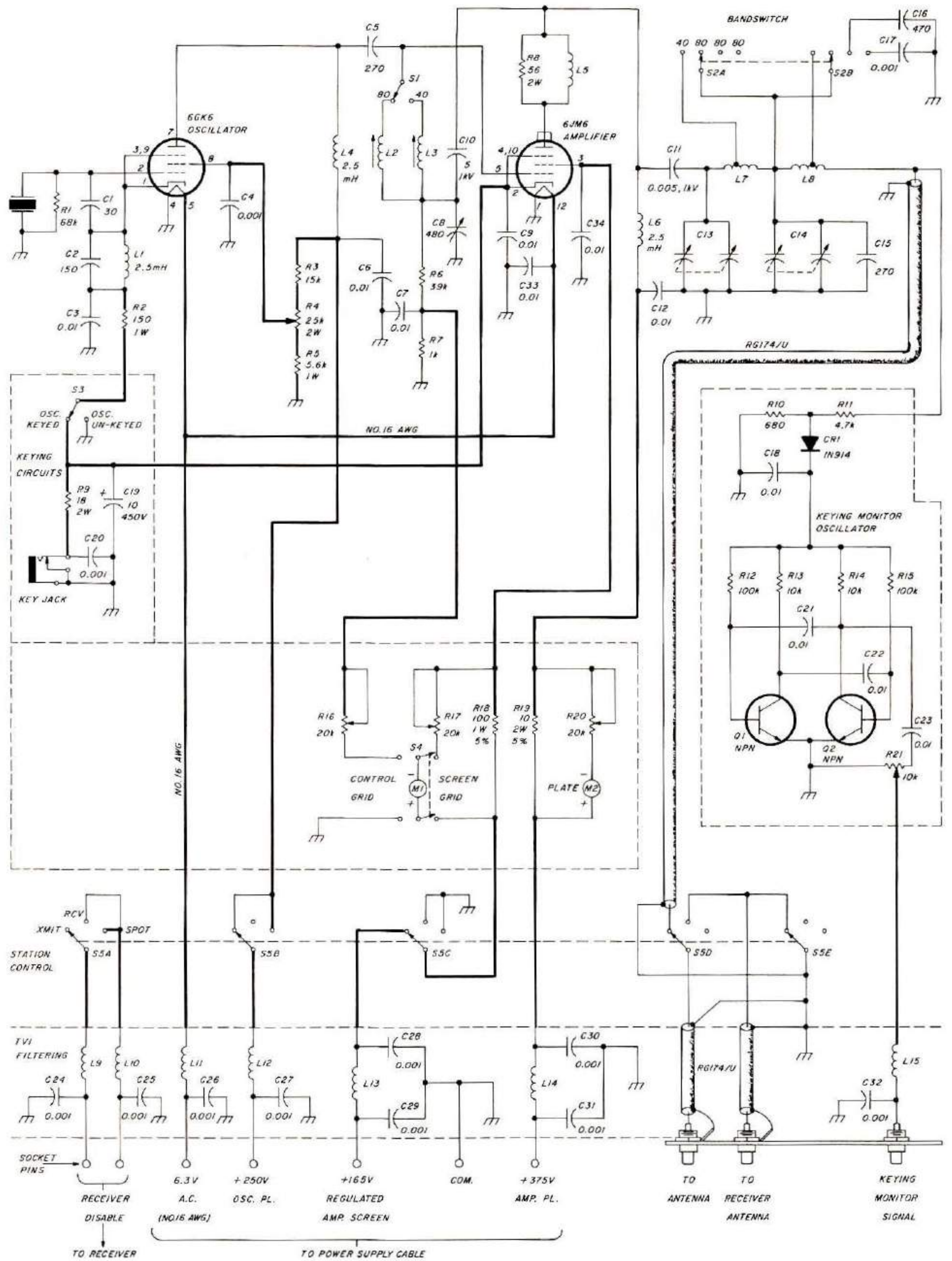


Fig. 1. The schematic diagram of the beginner's fifty-watt transmitter. The lines that are shown heavy are not critical, and can be bundled together for convenience and routed around the chassis in a neat manner. All other connections should be kept short and isolated from other wires as much as possible. A parts-placement drawing will be given in the second part of this article.

Table 1. Inductance values for B&W no. 3049 coil stock.

Turns	Inductance, μH	Turns	Inductance, μH
40	14.0	24	7.75
39	13.6	23	7.35
38	13.2	22	7.0
37	12.8	21	6.6
36	12.4	20	6.2
35	12.0	19	5.8
34	11.6	18	5.4
33	11.2	17	5.1
32	10.8	16	4.7
31	10.4	15	4.35
30	10.0	14	3.7
29	9.6	13	3.4
28	9.2	12	3.15
27	8.8	11	2.85
26	8.45	10	2.55
25	8.1		

found from the graph is the *minimum* allowable value.

To find L7, refer to **Fig. 4.** Find 1250 ohms on the left edge of the graph, go right to the 3.5-MHz line, then down to find an inductance value of 9 microhenries. Note: the 40-meter values for C13 and L7 will be half the values found for 80 meters. One good way to find the correct dimensions for L7 is to use an ARRL Type-A Lightning Calculator.* This is a well-made cardboard slide rule with directions printed on it. If you want to use commercial coil stock, pick a size from **Table 1**. Notice that 9 microhenries falls between 27 and 28 turns. This value represents the *maximum* size you may use, so you could safely select 26 or 27 turns.

At this point I should mention that we will not use a Pi-network output circuit. A Pi-network gives a second-harmonic reduction of about 35 dB, whereas a Pi-L circuit will provide about 50 dB suppression of the second harmonic, merely by adding one piece of coil stock. That is a worthwhile improvement!

Fig. 5 shows how a "Pi" and an "L" network are combined. The Pi is designed to step the 1250-Ohm tube load-impedance down to an intermediate value (350 Ohms, in this case). The L section then steps this 350-Ohm impedance down to 50 Ohms to match the transmission line to the antenna. Notice that each network has a capacitor marked C14, and these are in parallel in the completed circuit.

To avoid some confusion here, let me explain something about the network design I am using. The value of C14A is first found as a part of the *Pi* network as it looks back toward the tube. Then, C14B value is found as part of the *L* network as it looks toward the 50-Ohm transmission-line impedance. The two values are not the same, because the complex impedances at the other end of the networks are not the same. However, once the individual values are found, they can be combined into one value because the networks are connected together.

The value of C14A can be found by using the graph in **Fig. 6.** Find the tube plate impedance on the left side, the same as you did when solving for C13. Follow this 1250-Ohm line across to the 3.5-MHz diagonal, then down to the values at the bottom. The figure given there is approximately 680 pF.

To find the value of C14B, go to **Fig. 7.** This graph is used a little differently: Locate 3.5 MHz on the bottom of the graph. Go straight up to the line marked "Capacitor," then straight *left* to the edge of the graph where you will find 320

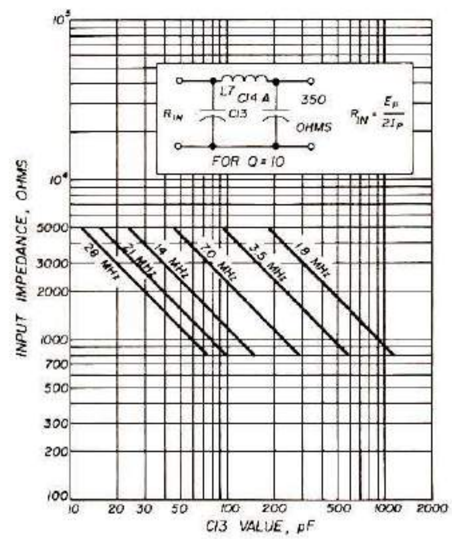


Fig. 3. The value of the input capacitor for the plate-matching pi-network can be found from this graph.

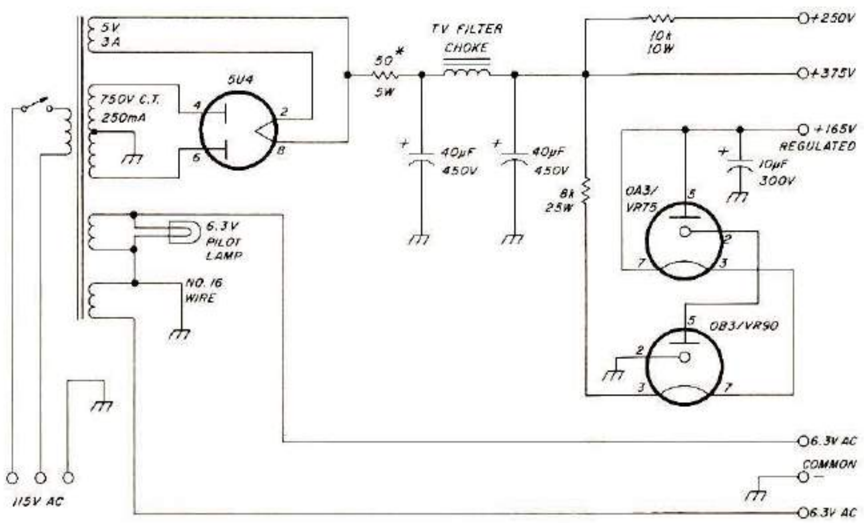


Fig. 2. This power supply will run the transmitter, and the components need not cost much if you can find some scrap TV sets to cannibalize. The 50-ohm, 5-watt resistor* between the 5U4 tube and the filter choke is needed *only* if the first filter capacitor is larger than 40 μF. Some TV transformers have the extra 6.3-V winding which can be used to power later accessories for the transmitter. If the transformer you find doesn't have this winding, you can still use the supply for the transmitter alone.

*Available from Ham Radio's Communications Bookstore; order AR-LCF, $3.00 plus 35 cents postage and handling.

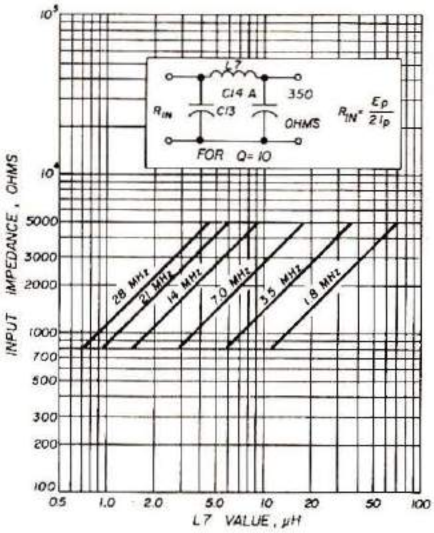


Fig. 4. This graph will help to find the inductance value of L7 in the pi-network section.

pF. Now add 320 and 680 to obtain 1000 pF.

Back in **Fig. 1** you can see a two-gang capacitor with a fixed capacitor (C15) in parallel. This was done because my variable capacitor had sections of 365 and 170 pF. You can usually "guesstimate" the minimum capacitance of such a broadcast capacitor as 30 pF per section. The minimum then is 60 pF, and the maximum is 535 pF. This is too small, so I added 270 pF (C15) in parallel. Now the range becomes 330 to 805 pF. This capacitor is your LOADING control, so it must have some range either side of the desired value to accommodate antennas that are not precisely matched. Also, the total capacitance range has to be small enough to cover 40 meters. Again, the 40-meter value will be half of the 80-meter value. With the choice of capacitor values I have given above the 500 pF 40-meter range allows adequate variation on either side.

Also in **Fig. 1**, notice that the bandswitch (S2) has two sections. S2B, to the right, has two functions: on the first switch position it shorts out a section of L8 to permit 40-meter operation. On the next position, the short is removed to put all the coil in the circuit. On both of these switch positions, C14 and C15 provide the range of 330 to 805 pF. On the next 80-meter position, the entire section of L8 is left in the circuit, but the switch adds C16 in parallel with C14 and C15. C16 is a 470 pF capacitor, which brings the total range to 800 to 1275 pF. I could have used 390 pF just as well, but the 470 happened to be in the junkbox.

On the fourth position of S2B, a different capacitor is added to C14 and C15. In my case it was 1000 pF, to give a range of 1330 to 1805 pF. It would have been better to use 820 pF instead of 1000, but the gap in the capacitance range (1275, maximum on position three, and 1330, minimum, on position four) is not serious. It means that if the antenna load fell in that particular area, your plate current might be 5 mA too high or too low as compared to an ideal match. That small difference out of 140 mA of plate current isn't going to be a problem. If you have to purchase this variable capacitor, it would be just as well to buy a three-gang, 365 pF per section, and have a basic range of 90 to 1095 pF. Then you could eliminate the fourth position and just add a 1000 pF capacitor in the third position to give a total range of 1090 to 2095 for the last 80-meter step.

To find a value for L8, refer to **Fig. 7**. Start at the bottom at 3.5 MHz and go straight up to

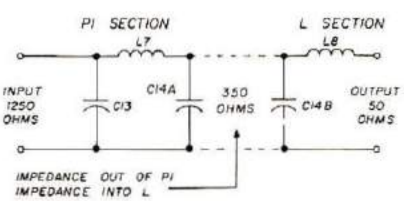


Fig. 5. A pi-network and an L-network are combined for better harmonic rejection. In calculating the value for the center capacitor, C14, it is treated as independent parts of each network, then the value is combined for a total capacitance that satisfies the needs of the entire network.

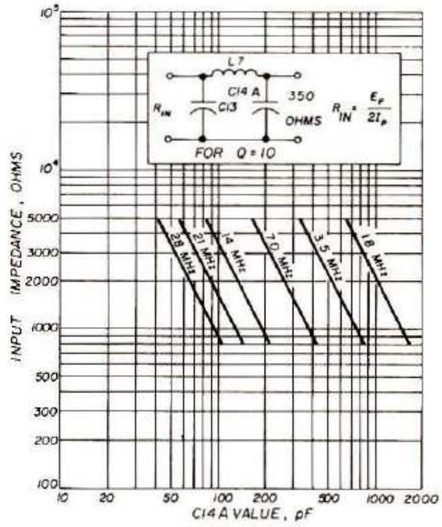


Fig. 6. This graph will give you the approximate value for C14A.

the "Inductance" line, then *right* to the edge of the graph to find 5.6 microhenries (or half of that value for 40 meters). **Table 2** will help you to select an exact value for 80 meters using standard coil stock. Notice that the nearest value to 2.8 microhenries is 11 turns. The connecting leads will add enough to make it very nearly correct.

Efficiency

The foregoing steps are important because they determine the harmonic-suppression capabilities of the rig, as well as its output efficiency. If you must make any change, the safe direction is to increase the value of C13 and C14 slightly, and reduce the inductance of L7 slightly. The rig built for this article was designed for 150 mA plate current. Actually, maximum output occurs at 140 mA, and at that point it has about 55.5 watts input, with 38.5 watts output on 80 meters. Efficiency is 67.5 per cent. If I run the tube at 155 mA input, efficiency drops to about 50 per cent, power output drops about 10 watts, and I am now pushing the amplifier tube very hard. Instead of 17 watts of "lost" power, I now have 26 watts lost in heat (plate dissipation). The tube is rated

Table 2. Inductance values for B&W no. 3015 coil stock.

Turns	Inductance, μH	Turns	Inductance, μH
48	17	27	8.7
47	16.6	26	8.3
46	16.15	25	7.95
45	15.7	24	7.6
44	15.3	23	7.2
43	14.9	22	6.8
42	14.45	21	6.4
41	14.0	20	6.0
40	13.6	19	5.6
39	13.2	18	5.25
38	12.8	17	4.9
37	12.5	16	4.5
36	12.1	15	4.1
35	11.8	14	3.72
34	11.45	13	3.38
33	11.1	12	3.02
32	10.7	11	2.7
31	10.3	10	2.35
30	9.9	9	2.02
29	9.5	8	1.69
28	9.1		

for 17.5 watts maximum plate dissipation, but in CW service, the tube will easily take that abuse. On the other hand, reducing the input to 125 mA plate current does not hurt the efficiency too much, and actually improves harmonic suppression. In my case, the severe drop in efficiency at higher plate currents is due to the low plate voltage. In any case, if you must vary the plate current, make the change to a lower-than-design value for safety, particularly if your power-supply voltage is low.

Coupling capacitors

Capacitors C5 and C11 are called coupling capacitors. They couple the tubes to their respective loads. In the case of C11, we don't want the plate voltage to appear on the antenna lead, so C11 also serves to prevent dc from passing. Similarly, if the oscillator plate voltage were to be put on the amplifier control grid, the amplifier tube would be destroyed in a few seconds. Obviously, both capacitors must have a high voltage-rating. C11 must withstand the dc plate voltage plus the peak rf voltage. For safety, use a 1000-V capacitor. C5 can be of 600 to 1000 V rating. If the capacitors are pulled out of an old TV set, be sure to check for shorts, with an ohmmeter on its highest range. A "leaky" capacitor should also be avoided (one that shows less than infinity on the high-ohms scale). Both capacitors can be inexpensive disk ceramics.

Bypass capacitors

Several capacitors, called *bypass* capacitors, are used in the transmitter. Examples are C3, C4, C6, and C12. **Fig. 8** shows the path of rf and dc currents in the amplifier plate circuit. The dc flows from the negative end of the power supply to the cathode, then to the plate, then through L6 back to the positive side of the power supply. If the rf energy had to take the same path, the transmitter would work very poorly, if at all. The power supply leads would act as an antenna and radiate heavily, or the amplifier might become very unstable and cranky. The rf path from the "bottom" of L6 back to the cathode must be as direct as possible. Notice that the rf path is through C12 to the chassis, along the chassis to C9 and onto the cathode.

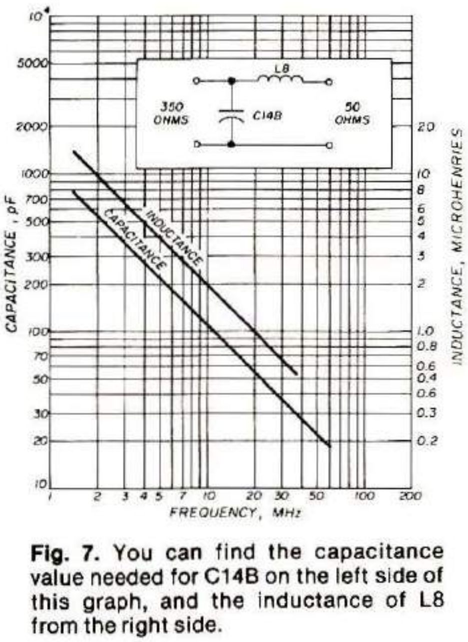


Fig. 7. You can find the capacitance value needed for C14B on the left side of this graph, and the inductance of L8 from the right side.

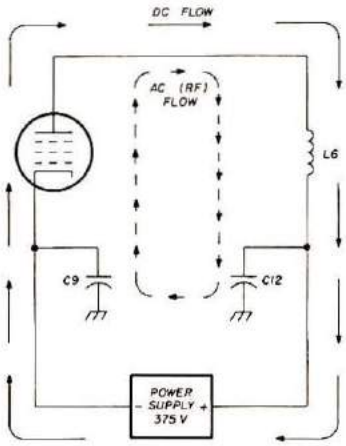


Fig. 8. The direct-current electron flow through the amplifier tube and power supply must be complete, and the rf energy must be given a path that does not go through the power supply. The capacitors, C9 and C12, provide a path through the chassis (ground) that *bypasses* the power supply, hence the name for these bypass capacitors.

This is fair warning that those two capacitors should not be "grounded" at opposite ends of a chassis. Try to keep the layout such as to minimize the distance between the grounding points, while at the same time keeping the capacitor leads short. In the rig presented here, the chassis distance was about 6 cm (2-1/2 inches). Thus these capacitors are so named because they "bypass" the long route through the power supply leads.

Feedback voltage

Capacitors C1 and C2 form a "voltage divider" for rf voltage. A good part of the output rf voltage appears across L1. This "feedback" voltage is needed to keep the crystal oscillating. However, you don't need it all, and it should be controlled so that not too much is fed back to the crystal, otherwise the crystal could actually crack — physically — or overheat to the point where the frequency would drift badly. So you can put all of that feedback voltage across C2, then use a value of C1 which has far higher reactance to cut the voltage down to just the amount

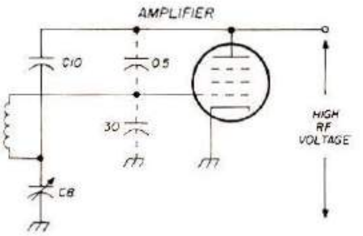


Fig. 9. The neutralizing circuit (C8, C10) for the amplifier stage is a voltage divider arrangement that counteracts the stray capacitance (30 pF) and the grid-to-plate capacitance (0.5 pF) within the tube.

needed to feed the crystal. C2 can be (for 1.8 to 7-MHz crystals) any value from 150 to 250 pF. C1 will usually be between 25 and 40 pF. You can use a 40 pF compression trimmer for C1, if you wish. As you tighten the adjustment screw to increase the capacitance, you can set it to the point where your crystals operate reliably. Don't be afraid to try a 30 pF fixed capacitor if you have no trimmer; that is a safe starting point. As a generalization, if C2 is small, C1 must be proportionately small, and vice versa. These capacitors should preferably be the molded or dipped-mica type to minimize frequency drift. Disk ceramic capacitors may be fine for bypass capacitors, but are inferior insofar as stability is concerned. Mica capacitors are typically identified by their molded yellow cases. Silver-mica types are still better, and may be identified by a molded red case.

Neutralizing

Two capacitors form the neutralizing circuit, C8 and C10. Here's how their values are determined. A 6DQ6 has 0.5 pF from plate to grid. And it has 15 pF from control grid to ground. These values are typical for the sweep tubes listed. The grid-to-ground capacitance is also paralleled with the output capacitance of the oscillator tube which, in a 6GK6, is 7-pF. In addition we have perhaps 10 or 15 pF of "stray" capacitance. This is in wiring, tube sockets, and the like. This total, about 30 to 35 pF, forms a voltage divider with the 0.5 pF plate-to-grid value in series.

Fig. 9 shows these capacitors connected with dashed lines. The junction of the voltage-divider capacitors connects directly to the control grid. C8 and C10 form a similar voltage divider, but the junction of these capacitors is at the opposite end of the tuned circuit in the grid of the amplifier tube. If at any instant, the feedback voltage on the control grid is, for instance, one volt positive, the voltages cancel. This is due to the fact that the tuned grid circuit is resonant. Any resonant circuit will have opposite polarities at its ends. To ensure that the neutralizing voltage is truly equal to the feedback voltage we merely maintain the same *proportion* between the capacitors. For example, if C10 is 5 pF, it is ten times as large as the 0.5 pF feedback capacitance. In that case, C8 must also be ten times as large as the 30 pF from grid to ground, or 300 pF. You can use a cheap "compression trimmer" capacitor for C8, and accurately set it to the correct ratio. A trimmer with 350 pF maximum capacitance will be adequate. C10 must have low rf losses, and be able to withstand high rf voltage. Small 50-Ohm coaxial cable has a capacitance of about 28 pF per foot. If you use a piece about 50 to 75 mm (2 to 3 inches)

This view is from the oscillator-tube end of the chassis. That small board just to the right of the oscillator tube holds the calibrating resistors for the plate and the screen/control grid current meters.

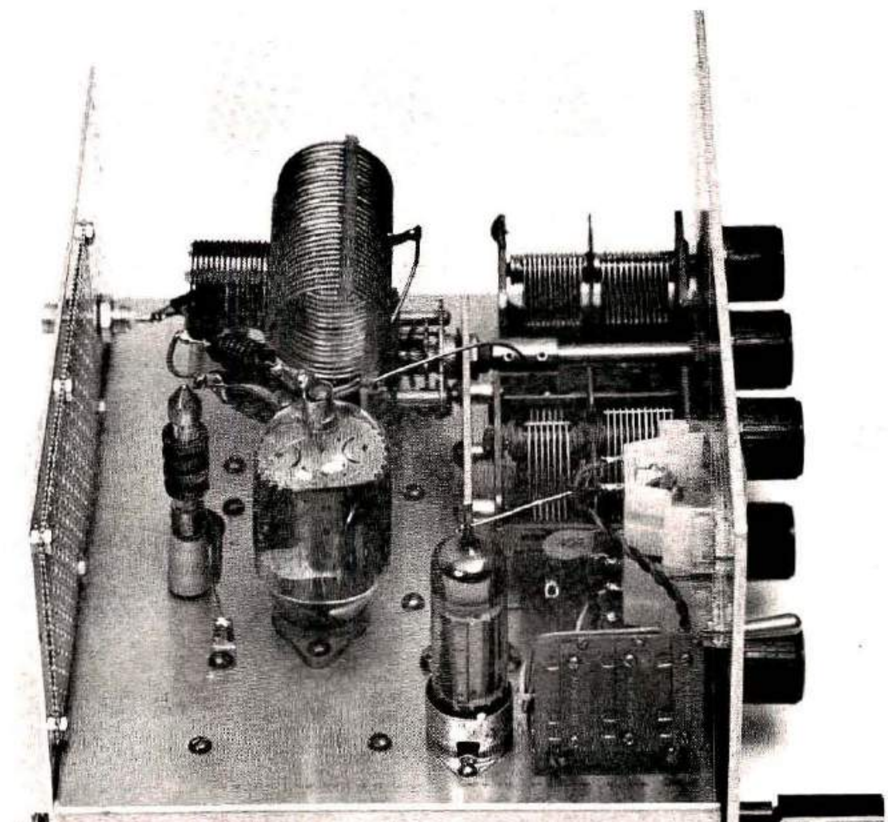


Table 3. A shopping list for components of the two-tube transmitter.

Fixed capacitors

Quantity	Description
1	30 pF, 500 V disk ceramic
1	150 pF, 500 V molded mica
2	270 pF, 500 V molded mica
1	470 pF, 500 V molded mica
11	0.001 μF, 1 kV, disk ceramic
1	0.005 μF, 500 V, disk ceramic
3	0.01 μF, 200 V, tubular paper or "Orange Drop" molded
1	0.01 μF, 500 V, disk ceramic
6	0.01 μF, 1 kV, disk ceramic
1	10 μF, 450 V, electrolytic tubular

Variable capacitors

Quantity	Description
1	480 pF compression trimmer, mica (ARCO 466)
1	2-gang broadcast-set variable, approximately 530 pF maximum

Fixed resistors

Quantity	Description
1	680 ohms, 1/2 watt
1	1000 ohms, 1/2 watt
1	4700 ohms, 1/2 watt
2	10 k ohms, 1/2 watt
1	39 k ohms, 1/2 watt
1	68 k ohms, 1/2 watt
2	100 k ohms, 1/2 watt
1	10 ohm, 1 watt, 5 per cent
1	56 ohm, 1 watt
1	100 ohm, 1 watt, 5 per cent
1	150 ohm, 1 watt
1	5600 ohm, 1 watt
1	18 ohm, 2 watt
1	15 k ohm, 2 watt

Variable resistors

Quantity	Description
1	10 k ohm, (trimpot or miniature adjustable)
3	20 k ohm, (trimpot or miniature adjustable)
1	25 k ohm, 2 watt

Inductors

Quantity	Description
3	2.5 mH, 250 mA (James Millen 34101)
1	B & W 3049 coil stock
1	B & W 3015 coil stock
1	75-120 μH rf coil, J.W. Miller 4409
1	15-30 μH rf coil, J.W. Miller 4407

Miscellaneous

Quantity	Description
2	300 μA miniature meters
1	diode, 1N914, 1N916, or 1N4148
2	NPN silicon transistors; any general-purpose, small-signal type (2N2222, 2N3394, 2N4410, 40231, HEP 53, MPS 3394)
1	1-pole, 2-position phenolic rotary switch
1	2-pole, 5 position phenolic rotary switch
1	2-pole, 2-position slide switch
1	2-pole, 2-position toggle switch
1	2-section rotary switch, each section 3-pole, 3-position, non-shorting
1	chassis, aluminum, 18x23x5 cm (7 x 9 x 2 inches) minumum, with matching bottom plate
1	enclosure to fit chassis; must be at least 15 cm (6 inches) high and include front and back metal panels
4	phone jacks

Miscellaneous

Quantity	Description
1	piece of aluminum perforated "cane metal" for screening ventilation holes in enclosure; approximately 15 x 20 cm (6 x 8 inches)
1	8-pin "octal" tube socket (power supply connection)
1	8-pin male cable connector to match power-supply socket
1	tube socket to match tube used in amplifier; for a 6JM6, use a 12-pin "compactron" socket
1	9-pin miniature tube socket
1	crystal socket
1	7-cm (2-3/4 inch) length of brass shaft, 6.4 mm (1/4 inch) diameter
1	panel bushing to fit brass shaft
6	matching knobs, 2.2 cm (7/8 inch) with 3.5 cm (1-3/8 inch) skirts
1	ceramic stand-off insulator; 9.5 mm (3/8 inch) diameter, 5 cm (2 inches) high hookup wire; no. 16 (1.3 mm) and no. 20 (0.8 mm), insulated; no. 18 (1 mm) tinned
3	8-terminal tie strips (Allied 868-0870)
1	4-terminal tie strip (Allied 868-0868)
2	1-terminal tie strips (Allied 868-0862)
	Soldering (grounding) lugs; no. 6-32 screws with nuts and lock-washers; small piece of perfboard, spade lugs, approx. 60 cm (2 ft) RG-174U coaxial cable; approx. 15 cm (6 inches) RG-58/U coaxial cable

long, it will make a capacitor of 4.6 to 7 pF. In most cases this length should be adequate. The plate end of the circuit is connected to the shield braid of the coax, and the grid end is connected to the inner conductor of the coax. At both ends of this home-made capacitor be sure the braid and inner conductor are well separated, and that the braid does not short to the chassis at the point where it passes through a hole to connect to C8.

Inductors

The reactance of L1 should be very large compared to C2, so you can use either a 1 or 2.5 mH choke. The current through this choke is small, just the combined grid, screen, and plate current of the oscillator. In this particular tube, it will be about 20 mA, maximum. If you want to save money, look for an old broadcast radio with 455-kHz i-f transformers in the large shield cans. These shield cans are 28 to 32 mm (1-1/8 to 1-1/2 in.) square. Inside you will find two coils wound on a hollow tube. Either coil will be useful as a choke, because their inductance is in the desired range. Use one coil for L1, and the other for L4.

Coils L2 and L3 tune the amplifier grid circuit to the desired band. A tuned circuit requires capacitance which, in this case, is the same as the total grid-to-ground capacitance as determined in our discussion of neutralizing. Since the value of capacitance is fixed, you must vary the coil inductance by means of an adjustable powdered-iron core. In my case I rewound coils from TV i-f stages. The 40-meter coil requires about 40 to 45 turns of 0.2 mm (no. 32) wire, and the 80-meter coil will require about 70 to 80 turns of wire of the same size. In order to be sure the coils are correct, a grid-dip check will provide positive assurance, even before the rig is turned on. This check will be covered in the tune-up portion of this article.

L5 is a small coil in parallel with a small resistance, which makes it a lossy circuit at very-high frequencies. This "parasitic suppressor" will make the plate tuned-circuit so poor at vhf that oscillation there is discouraged. A 27- to 56-Ohm, 2-watt composition resistor makes a good coil form. Wind 6 to 8 turns of 0.8 mm (no. 20) bare or enamel wire evenly spaced along the resistor. The wire can be ordinary solid hookup wire with the insulation stripped off.

The reactance of L6 should be very high compared to the tube load impedance. A 1 or 2.5 mH rf choke is suitable. In this case the choke must safely carry 250 mA plate current, so a commercially manufactured unit will be best.

There are only a few of the resistors used in the transmitter that are critical in value, and I'll tell you about them in the next part of this article. Meanwhile, you can start doing some shopping for the parts you'll need. **Table 3** is a list of the components to obtain, and **Table 4** gives you the names of places that I've found are good sources for most of the parts used to build the prototype rig. If you know of other sources, by all means use them. Don't be in a great rush to get the transmitter done, however. You want to plan each move carefully, so that you'll have a unit that not only works well but also looks great in your station.

HRH

Table 4. Some suggested sources of parts for the transmitter.

Variable capacitors, RF chokes, coil stock, slug tuned coils, compression trimmer capacitors, enclosures, crystal sockets.	G. R. Whitehouse 15 Newbury Drive Amherst, New Hampshire 03031
Variable capacitors, power transformers, filter chokes, compression trimmers, rotary switches, meters, tubes, tube sockets, power resistors.	Fair Radio Sales 1016 E. Eureka Box 1105 Lima, Ohio 45802
Meters, resistors, electro-lytic capacitors, transistors, diodes, P.C. board material	Gull Electronics 12690 Route 30 North Huntington, Pennsylvania 15642
Crystals, Crystal sockets	Jan Crystals 2400 Crystal Drive Ft. Myers, Florida 33901
Crystals, Crystal sockets	Jess B. Lebow, Jr. 355 Mower Road Pinckney, Michigan 48169
Diodes, potentiometers, sockets, meters, capacitors	M. Weinschenker Box 353 Irwin, Pennsylvania 15642
Components, hardware	Allied Electronics 401 E. 8th St. Ft. Worth, Texas 76102

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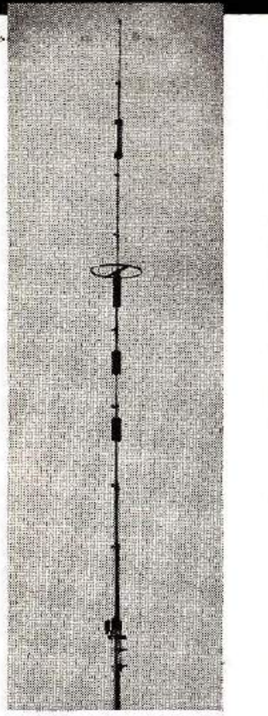

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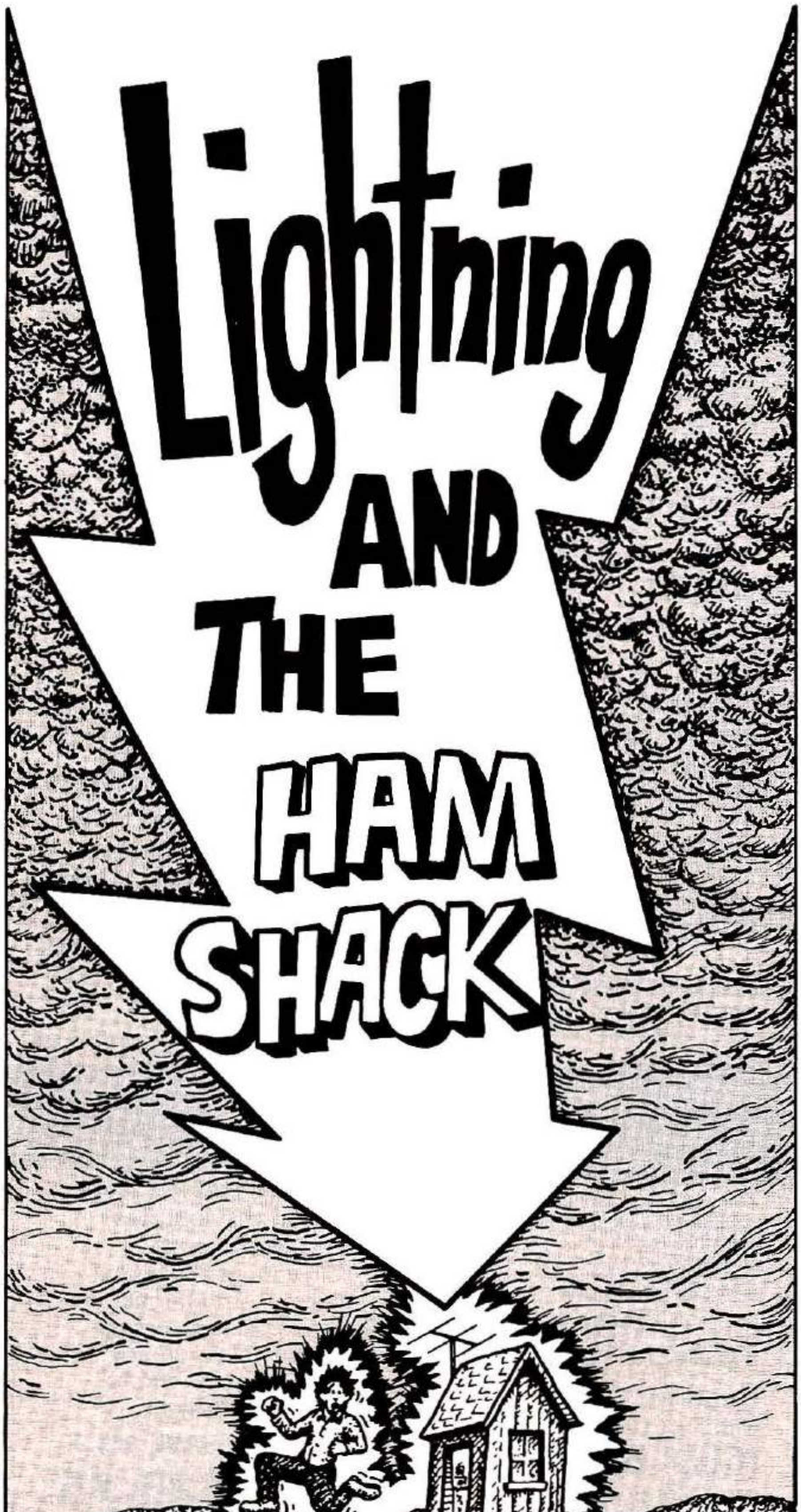


BY KARL T. THURBER, JR., W8FX

If you check your encyclopedia or dictionary, you'll find that lightning is a natural high-voltage discharge or electrical spark, usually a few miles long, that takes place in the earth's lower atmosphere. The American scientist, Ben Franklin, was the first to correctly identify lightning as an electrical discharge through his famous kite experiment in 1752.

How lightning works

These discharges may take place in thunderstorms, either between nearby clouds or between the clouds and the earth. Before the discharge, the clouds build up an increasingly strong electrical potential with respect to adjacent clouds or the earth by gradually accumulating charges through the effects of falling snow or rain. Potential differences, or voltages, of several million or even as much as *one billion* volts may develop — and the discharge may produce transient (very brief) currents up to 100,000 or 200,000 amperes!

The very high voltage buildup arises because of regions of highly charged particles developing within the clouds: negatively charged regions generally developing near the bases and positively charged areas near the tops. The intense fields created cause surrounding molecules to become *ionized*, and the lightning strokes attempt to equalize the potential by moving along the highly conductive paths between these oppositely charged regions. Usually, this happens within a cloud but often occurs from cloud-to-cloud or from cloud-to-ground. When this happens, we see visible lightning.

Thunder is the audible sound wave generated by the lightning stroke. The sound of thunder appears to lag behind the lightning because of the relatively slow speed of sound compared with that of light;

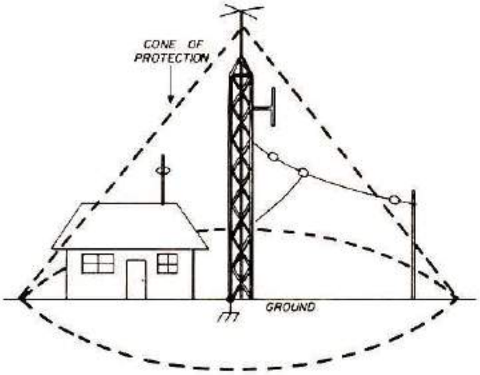


Fig. 1. Dramatization of the theory that a properly grounded antenna and tower can create a "cone of protection" around nearby buildings and other structures, which shields them from lightning damage. The diameter of this cone is said to be equal to tower height (drawing is not to scale).

first you *see* the lightning and then you *hear* it.

You can see and hear the result of many different forms of lightning such as sheet, ribbon, bead, and ball lightning. Each of these types produces unusual and often spectacular visual effects. As amateurs, we're usually concerned less with the visual displays than with the effects that lightning can have on our equipment and homes, which brings us closer to the heart of this article.

Why is lightning so dangerous

Ninety percent of lightning discharges are of the intra-cloud type; the discharge harmlessly occurs within a cloud. This kind of lightning doesn't cause much of a problem. But when lightning seeks its path through the earth, its power to destroy is indeed awesome. Each year, lightning kills or injures several hundred persons in the United States and causes more than 10,000 fires.

The lightning discharge, packing currents as high as 200,000 amperes, reaches its peak usually in less than 80 microseconds. The discharge declines only slightly less rapidly, normally in less than 200 microseconds. Very common, too, are multiple strokes, with up to 40 discharges extending over periods up to a full second. Although the discharge peaks out and is over in a fraction of a second, that short period of time is long enough for the high current generated to exact its toll on buildings, trees, poles, houses, antennas, a-c lines, and anything else in its path.

Feedthrough tube for bringing coaxial cable into a building. The metal bracket should be grounded using a length of no. 10 (2.6 mm) or larger wire to a ground rod.

Tall buildings and towers can induce lightning discharges, as can aircraft flying through storms. However, a so-called cone of protection sometimes exists around a structure (such as a house), which is overshadowed by a taller antenna tower or mast (**Fig. 1**). Observers of lightning strikes on antenna towers have noticed that an electrical leader sometimes appears to originate in and around the top of the tower, traveling upward into the cloud, with its streaked fingers pointing upward rather than downward, as is usually the case in lightning discharges to ground.

Contrary to the old wives' tale that lightning never strikes twice in the same place, lightning will, in fact, show an affinity for striking the same point or object if the object hasn't been removed. Actually, this makes sense because the object that attracts the lightning discharge in the first place probably has a high, prominent position.

The lightning discharge core diameter is only 25 to 50 millimeters (1-2 inches), while the strongly electrified area surrounding this small core is probably several meters (feet) in diameter. In any case, lightning is dangerous to you and your equipment! The average lightning discharge involves a potential difference of 100-million volts, packing nearly 300 kilowatt-hours of energy — enough to make anyone consider its potential for damage!

Protecting your antenna

The kind of damage and havoc caused by lightning to

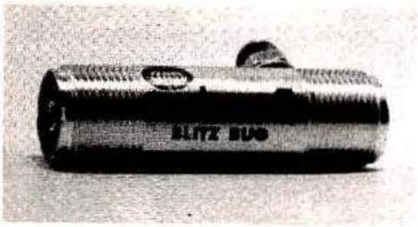
Glossary of Terms

Balun is a device that provides a transition between an unbalanced (to ground) feedline, such as coaxial cable, and a balanced line or antenna, such as twin-lead or a dipole. Balun derives from *Bal*anced-to-*Un*balanced.

Grounding Circuits are used to dissipate unwanted electrical energy into the earth. Protector grounds for communications circuits need to be no more elaborate than the familiar water-pipe ground, providing that ground resistance is minimized. Ground resistance decreases with the number of ground rods, their diameter, and material makeup. Ground resistance also decreases with the depth of driven ground rods and varies with soil conductivity, which may change with the seasons.

Ionization is the process by which one or more electrons are added to or removed from an atom. When lightning occurs, the tremendous force created by the electrical discharge changes the atomic structure of the immediate atmosphere so that its natural balance is temporarily disturbed, thus ionization is said to occur.

Low-Impedance Ground is essential for circuits that require a direct route to earth (or ground). Impedance is the opposition in an electrical circuit to the flow of an alternating current. Impedance is analagous to the electrical resistance of a circuit to direct current.



Coax-cable lightning arrester known as the "Blitz Bug." Device contains a spark gap through which lightning discharges may be bled to ground (*photo courtesy Cushcraft*).

amateurs whose antennas or towers have been struck by lightning doesn't mean that an outside antenna invites disastrous consequences during electrical storms. A properly installed and grounded antenna system creates a "cone of protection," whose diameter is approximately equal in height to the antenna itself. Many amateurs have operated for years with antennas that were the highest objects in the vicinity without lightning damage. **Fig. 1** shows this cone of protection. The tower offers some protection to nearby lower buildings and structures, but only when it has a good, direct, *low-impedance ground*.

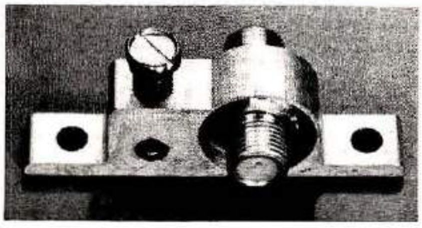
If there's a secret to protecting antennas, towers, and your station, it's in providing a direct path from the antenna to ground so that the electrical charges picked up from the atmosphere during an electrical storm will be discharged harmlessly to the earth, rather than cutting a swath through the radio equipment and transmission lines. Bear in mind that the main purpose of installing lightning rods or of grounding roofs and other tall structures is to protect the building if a strike occurs; and while the tower may provide some sort of cone protection, no one has yet determined that any form of protection can *prevent* a lightning strike.

Protection from lightning

For good antenna protection there are a number of things you can do. First, you should ground all towers, including structures mounted on roofs or atop buildings. Metal towers are usually well grounded; but with wooden towers, you should run a *heavy* ground wire to the hardware on top of the tower supporting a horizontal antenna. If the horizontal antenna is all that the wooden tower supports, extend this wire above the level of the antenna so that it acts as a lightning rod. A commercially available lightning rod, such as those installed on barns and rural dwellings, can also be used. Not to be forgotten is protection for the ground-plane antenna. When this antenna is elevated above the ground, be sure to run a *direct* ground wire to its radial system. Don't rely on the coax shield to provide grounding and lightning protection.

Even with the vertical that's ground-mounted ("worked against ground"), there is a difference in the ground systems for lightning protection and for rf grounding purposes. The former uses long ground rods buried deeply into the earth; the latter uses a number of radials buried a few inches below the earth's surface. For good lightning protection, ground rods should be connected at the center of the radial pattern. Installing additional ground rods at the radial ends won't hurt, either, for added protection.

Tower-mounted rotary beams using either T or gamma matches, and having each



Another form of coax-cable lightning arrester. The assembly must be grounded using heavy copper or aluminum wire (*photo courtesy Radio Shack*).

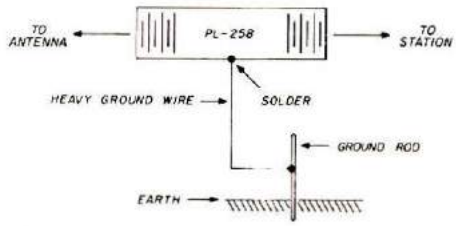


Fig. 2. Coaxial-cable feedthrough connector for lightning protection can be made from a type PL-258 device. It should be inserted into the coax cable before the cable enters your station and the outer shell must be connected to a good earth ground.

element connected to the boom, can be grounded through the supporting metal tower in most cases. From a protection standpoint, it's a good idea to run the coax and rotator control lines from the antenna down inside the metal tower, then underground to the station if possible.

Unfortunately, grounding a multiband trap antenna (whether horizontal or vertical) at the feedpoint doesn't adequately protect the traps from damage during a lightning strike; sometimes induced currents from nearby discharges may cause damage. It's possible to construct a wire spark gap across the traps, but this is likely to detune them and otherwise upset their operation. From a practical standpoint, traps can remain unprotected and are best replaced if struck.

Watch that transmission line!

Although the antenna may be well grounded, the transmission line can be struck by lightning and cause damage to your house or equipment if not protected. The best place to protect the coax line is where it enters the building. You can install a type UG-363/U or 83-1F coax bulkhead adapter on a sheet metal bracket on the outside of the building where the cable enters, either through a wall-through tube or window. The metal bracket should be grounded using a length of no. 10 (2.6mm) or larger wire to a ground rod. You can also

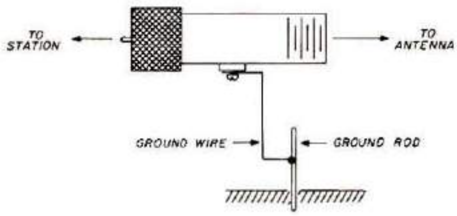


Fig. 3. Representation of a typical commercially available lightning arrester manufactured by Amphenol, Cushcraft, and others. When installed outdoors and solidly grounded it will protect equipment from lightning damage through antenna and transmission line. Various combinations of male and female connectors are available.

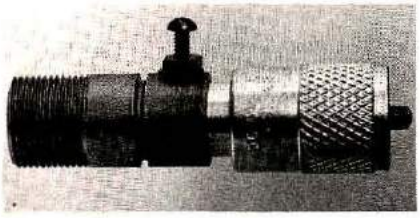
fabricate your own self-grounding feedthrough connector using an Amphenol 83-1J (PL-258) connector — the kind used to splice coax sections together — by soldering a heavy ground wire to it and mounting it outdoors at a convenient spot as shown in **Fig. 2**.

The bulkhead adapters aren't easy to find these days, and you may not want to roll your own. A much easier method is to install a commercially made static discharge unit or lightning arrester in the feedline where it enters the building. These units contain a small spark gap that won't arc or short out at normal power levels used by amateurs but will allow all high-voltage discharges to bridge the gap and be diverted to ground. A number of manufacturers make these handy gadgets, which are available from Cushcraft, Radio Shack, Hy-Gain, and Amphenol (**Fig. 3**).

While nothing can guarantee complete protection from a direct lightning strike, these units can head off problems from nearby lightning discharges that might induce high voltages and currents into your transmission line (which can damage receiver front ends and transmitter tank circuits) by bleeding off the charges to ground. For added protection, you can mount one arrester near the antenna or on the tower and another near the entrance point to your station.

You should be aware that if the antenna is at dc ground potential — as is the case with a gamma-matched beam — the arrester isn't strictly necessary. You need only ensure that the coax shield is grounded at the tower and where it enters the house or station. Normally, grounding the shield at this point won't have any effect on the line's performance so long as you're not trying to operate with a very high standing wave ratio. If you *do* operate with a high swr, introducing an additional grounding point may change the effective swr presented to the transmitter. In any case, as previously mentioned, installing lightning arresters is simple and offers some extra protection against stray static electricity.

While coaxial cable is the most popular transmission line in use today, open-wire line or twin-lead can also be protected, as shown in the arrester circuit of **Fig. 4**. Don't try to use a TV-type lightning arrester except for very low power levels. In any case, you'll find that coax is a lot easier to work with than parallel-wire feeders. But if you want to use a folded dipole or other antenna that requires a balanced 300-ohm feedline, consider using a 4:1 impedance-matching balun mounted at the antenna. The balun, or balanced-to-unbalanced transformer, converts from the unbalanced coax to a balanced output by transformer action. Most baluns put the antenna at dc ground potential, offering a degree of built-in lightning protection. You can easily build your own baluns from details given in the *ARRL Handbook*, or you can purchase them readymade and waterproofed from Palomar Engineers, Kaufman Industries, Greene Insulator, and several other manufacturers.



A coax-cable lightning protector made from male and female connectors. The shell must be grounded using heavy wire run to a ground rod.

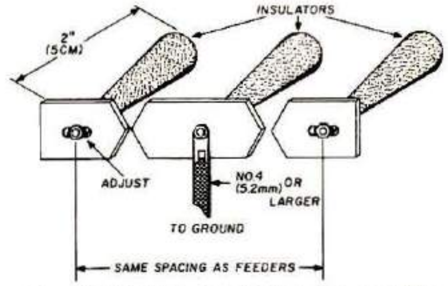


Fig. 4. Lightning arrester for parallel-conductor feedlines. It can be made from three feedthrough or standoff insulators and three sections of copper or brass strap material. It should be installed at a point convenient to the antenna tower or main outdoor ground, preferably close to where the feedline enters the station. The spaces between the straps can be adjusted so that arcing doesn't occur in normal transmitter operation. The idea is that lightning discharges will shoot the gap and pass to ground.

Ground it!

There's an old radio axiom that says, "When in doubt, ground it." Nothing could be more true when it comes to effective lightning protection. But not just any old ground will afford good protection. For example, the main ground conductor shouldn't be any smaller than no. 8 or 10 (3.3 or 2.6mm) wire and should be copper, bronze, aluminum, or copper-clad steel. While the ground lead may be either insulated or bare, or even heavy copper braid, it should be protected from mechanical injury (lawnmowers, digging, gardening) and should go to the ground electrode or rod through the shortest possible path with no sharp bends. If bends are in the ground run, the heavy current flowing through the wire during a lightning strike may ionize the air at the bend and jump the conductor at that point to seek its own shortest path to ground — leaving your equipment unprotected.

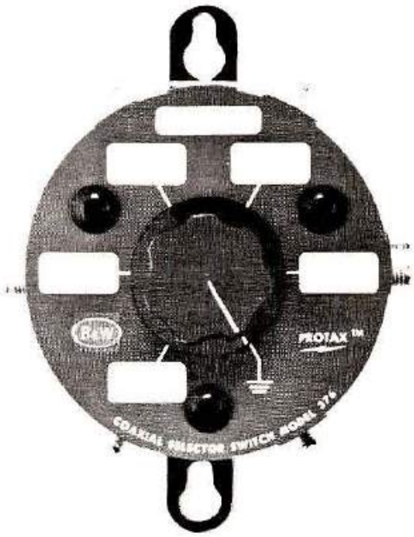
You can use a metal underground water pipe for the ground electrode, regardless of its length. It's a good idea to supplement the water pipe with a ground rod or electrode, which can be a galvanized iron, steel, or copper-clad pipe at least 19 mm (3/4 inch) in diameter; or you can use a 13 mm (1/2 inch) solid copper rod or other sturdy ground electrode driven into the earth at least 2 meters (6-8 feet). The rod can replace the water-pipe ground if the latter isn't conveniently available.

If your soil is dry and sandy, for best protection you should use at least *two* ground rods spaced at least 2 meters (6 feet) apart and bonded together by heavy wire or copper ground braid. Whatever arrangement you use to make a good ground, all grounds should be *bonded together* (paralleled) to lower the ground resistance as much as is possible. Doing this will also improve the performance of any vertical antennas you may use which are worked against ground. This is true because, by making your connection to ground better (lowering its dc resistance), you also lower the rf ground resistance and present the vertical antenna with a much better mirror or ground plane in the form of the Earth.

As for materials, inexpensive TV-type grounding hardware is probably the lowest-cost source. The heavy no. 8 or 10 (3.3 or 2.6mm) aluminum wire sold for grounding TV antennas is good, as are TV-type ground clamps. Be careful, however, in using the standard TV ground rods, as they are usually shorter than they should be to be really effective. If you can't locate longer rods, you can drive several of the shorter TV-type rods into the ground, spaced 2 meters (6 feet) or so apart, bonding them together as one ground — as in the case with sandy soil mentioned earlier.

Saving the station

Besides the potential for physical damage to your home (or possibly its total loss), even a nearby strike that leaves the home intact can wreak havoc with your ham gear. For example, some tubes, transistors, and integrated circuits can be destroyed from the effects of nearby lightning



Coax-cable selector switch for transferring your equipment to different antennas. Control knob should be set at the ground position when not in use (*photo courtesy Barker & Williamson*).

discharges. Capacitors and diodes, particularly those in antenna or power-supply circuits, can blow; receiver and transmitter antenna coils can melt or fuse; and contacts on rf switches can become welded together. Not infrequently, the rotator and rotator control box can be wiped out, and electrical fixtures and house wiring can be reduced to a sickening shambles.

There are a number of things you can do inside your station to minimize the chances for such unspeakable things to happen to your equipment. For example, to be safe, you should connect *all* microphones, key leads, metal cabinets, control boxes and shielded cables to a common ground bus, or wire, which, in turn, should be connected to the main station ground system (cold water pipe, ground rods) and the house's electrical ground system. Use an ohmmeter or multimeter set on a low-resistance scale to check that station grounds are *actually* connected to one another. If your home uses the three-terminal wall outlets that have the third wire grounded, use three-wire power cords whenever possible, which *automatically* ground all the equipment chassis and cabinets whenever the power plugs are in the wall sockets.

Lightning in the ac mains

While you may have done all you possibly can in protecting your antenna system and grounding your equipment, there's still another problem: the very real possibility of lightning surges on the ac power mains, which may enter your distribution transformer and be coupled to the ac circuit serving your home, even though the power company may have installed lightning arresters on the primary circuits. There's not much you can do about this problem, although you can buy 115-Vac lightning arresters and have them installed in your service line. From a practical standpoint, the best bet is to *remove* all of your equipment from the ac lines whenever a storm is brewing; or better still, disconnect them whenever you're not using them. This can be done be either physically removing the ac cords or switching them out of the ac lines using heavy double-pole, single-throw switches.

Needless to say, any piece of gear you value should be fused in its ac circuitry — or, as a minimum, you should have a special master fuse switch or circuit breaker for the station equipment. (Clocks and other equipment that require power at all times will have to be left connected.)

When storms are imminent

Another axiom is that during a storm, the only safe conductor is a grounded conductor. This means that antennas should be disconnected and grounded whenever a storm is developing. It's a good idea to purchase an antenna selector that automatically grounds all the antenna positions except the one in use. Just turn the antenna selector to an unused position whenever you're not on the air. For a few dollars more, you can buy a coaxial switch that has an extra position that grounds *all* antennas (Barker and Williamson's Model 376 *Protax* coaxial selector switch is an example).

An example of what can happen

A gruesome example of what lightning can do to your station is shown by what happened several years ago to a Midwestern amateur when lightning took a fancy to his station, which suffered a direct hit.

Lightning destroyed the pole supporting his rhombic antenna, and caused all the wire in the antenna to vaporize. Since he had, fortunately, disconnected and grounded all his antennas, the rf stages of his receiver and the transmitter tank circuits weren't damaged, but the stroke packed enough power to knock the ac-power pole transformer to the ground! All ac supplies that were left connected to the mains were burned out (unless they happened to be fused in *both sides* of the line), and *all* the ac wall outlets in the house and most of the electrical wiring were damaged. As if this weren't enough, many of the switch and relay contacts in various household appliances were either burned out or fused together!

Though fortunately a rare incident, this sobering experience illustrates the tremendous potential for damage that lightning possesses. While nothing you can do will guarantee 100 per cent protection from lightning's destructive effects, following a few simple precautions is very cheap insurance.

HRH

nostalgia with a vengeance

BY IRV GOTTLIEB, W6HDM

It was during spring-cleaning of the attic under dire forebodings from my wife that it happened. For it was thusly, while investigating a pile of boxes situated in a long undisturbed corner, that I discovered the bottles. Antiquated bottles they were; mellow in their peaceful hibernation with thick coatings of dust.

Envisioning a sweet rendezvous with cherished brew of Ohmar's squeezings, I deftly brushed away the dust. Alas, the bottles were devoid of the coveted spirits! In fact, the bottles, though of ancient vintage, were quite empty except for the insolently protruding gizzards of primitive electron tubes. Closer inspection revealed enumerations such as 211E, 210, and 250.

Tempus fugit and shades of hades, how time flies! (In the manner of greased lightning, OM.) Shutting my eyes to black out the eerie illumination, sweet reminiscence conveyed me, dream-like, to days of yore. Ah, sweet days of yore . . .

In the wee small hours of a misty morning, I deposited the belle of the senior class on her doorstep and bestowed the usual prolonged kiss in the usual tender fashion. Then, not being overly-desirous of a QSO with her OM, I leaped into the waiting Essex.

With effervescent gusto I coaxed the last rpm from the protesting connecting rods. Soon, I was home with my first and true love, the 80-meter Hartley with one 211E, three 210s, and two 250s coordinating more-or-less in parallel.

I reached up and yanked the handle of the main switch. Fondly, I beheld the glowing filaments. (Brother, you too would glow with double voltage on your filaments.) Trembling with anticipation of a hot DX contact, I appraised the performance of the rig in the usual professional manner.

I pressed the key for a few brief moments. A 500-cycle roar of defiance shattered the ether. The motor-generator tugged in agony at the half-inch bolts which secured it to the four-by-four support, then resigned to its torment by dropping speed. The lights in my room dimmed by an amount deemed proper.

I picked up a pair of binoculars and observed the light bulb in my neighbor's garage, some fifty yards due south. The intensity of its glow indicated healthy antenna radiation. I released the key just as the filament of one of the 250s became visible through the plate. Feeling well rewarded for my efforts, I turned my attention to the receiver.

The receiver, though completed only ten days previously and not completely de-bugged, had already revealed itself as a signal snatcher *sui generis*. It was, in fact, the reception of a VK from Australia that motivated the DX quest about to take place.

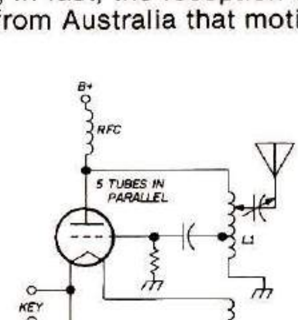


Fig. 1. Salient features of the transmitter. Abundant harmonic generation assured a response on some band. L1 is copper-tubing tank from a Hoyt automatic water heater. Plate voltage was 1200 volts on spaces, 1000 volts on dots, and 850 volts on dashes!

The design, my own, consisted of a regenerative rf stage, regen detector in a reflex arrangement which resquirted the signal back into the rf stage, which now functioned as an audio amplifier. This was followed by two stages of conventional audio amplification, or almost so.

The slight departure from the "run of the mill" involved the use of Model T spark coils as inter-stage transformers. The tubes, chosen after much deliberation were 201As.

I placed the 8000-ohm Baldwin phones over my noggin and turned on the receiver. It was, verily, full with the joy of life. As I advanced the various controls, a terrific howl sallied forth from the cans and reverberated within my tortured head like a freight train stalled in a tunnel! Quickly, I jerked the phones off and backed down the regen controls, lest the OM burst into the shack with an R9 lecture about the need of sleep for growing boys, etc. Swearing with R9 fervor, albeit in hushed breath, I resolved to be more careful with those very, very critical knobs.

Using the utmost caution to maintain regeneration just on the threshold of oscillation, I searched the endless kilocycles for a voice lost in the wilderness. It wasn't long in forthcoming. Somewhere in the depths of Boltzman's constant, all but buried in the crackle of shot noise, shot capacitors, thermal agitation and ionized soldering paste, I heard it . . . yes I heard it, a weak CQ!

Carefully, ever so carefully, I

advanced the you-know-which controls, a tiny bit more, a shadow here, an Angstrom there. The results were no less than magical. The signal, except when fading obliterated it entirely, now was R3 in any ham's lingo. Only thing was, the fading was somehow mysteriously synchronized with the announcement of the station's identity.

Carefully, ever so carefully, I trimmed the other controls with my left hand, while my right maintained vigilance with the detector regen control. Waiting in suspended animation for the final station identification, I arose from my chair. I leaned over the receiver to provide the nth degree of trimming by means of body capacity. A bead of perspiration dripped from my brow and landed dangerously close to the grid terminal of the detector tube. I blew the saline droplet away from the socket.

Then it happened . . . I caught the call just before he signed off. It was none other than the VK recently logged! Shades of hades, could I work him?

I laid the earphones on the operating table and promptly went to work with the home-spun bug. This was constructed from materials distinctly out of the ordinary, among which were the innards of a Pocket Ben, ignition breaker points, and a segment of corset stave donated by the belle of the senior class. Between the bug and raucous note, I was certain my signals had that spark of personality needed to attract the attention of DX ops.

For the first minute or so, my sending fist trembled and threatened to freeze. However, the bug gave unselfishly of its dots and I soon regained poise. I settled down to a fifteen minute grind of three VK calls interspaced by two of my own.

The dit-dahs were now oozing with the solid self confidence that I pounded into them. My enthusiasm mounted until I could scarcely contain myself. Finally, I repeated my call eleven times and culminated with a stately "K"!

I climbed into the phones and listened. Amidst the playful electrons, I heard nothing, absolutely nothing. Ever so carefully, I applied torque, one part physical, nine parts psychic, to the detector regeneration knob. The impending fringe howl was lurking in the infinitesimal depths of perception, intent upon springing out at me, tiger-like. Precariously, but nonetheless skillfully, I held it at bay.

Within the innermost realm of consciousness, I became aware of minute fluctuations in the background noise having the characteristics of dots and dashes. I copied it mentally: "SURE GLD TO WRK THE WEST COAST OM. UR SIG FB HERE IN MELBOURNE. PSE GIVE MY REPORT . . ." The signal faded out but I could sense he was signing over.

I prepared to acknowledge his message. So intoxicated was I with the prospect of bettering my previous DX record by some seven thousand miles that I had to deliberately pause a few seconds before tickling the bug.

Then, boom, like a bolt of lightning did the terrible catastrophe strike! The phones, still on my head, became the forerunners of the present day dynamic speaker. Unmerciful decibels assailed my burning ears. Between the jack-hammer thumps, the fringe howl lashed out with tongues of sonic flame.

I tore the phones from my head and threw them on the table. The thumps were saying, "VK3 — DE W6 — TNX FOR FB REPT. UR COMING IN QSA 5, R6."

"R6! Shades of hades," I muttered to myself, "All he has is a superhet with no regeneration and he has the gall to call a signal R6 which I can just barely pick up."

W6- resided in the high-falutin section of town because his OM was well heeled, the owner of a chain of shoe stores. W6- attended private school, owned a brand new Model A Ford, and had a 5-kW rig full of store-bought components. What with all this, he now runs away with my DX station!

So what? Did I begrudge his monied pop? Was I envious of his classy rig? Did I resent his swiping my VK? Shades of hades, no. After all, it was I who was the steady of the belle of the senior class. But OM, that is another story altogether . . . anyhow she's mighty anxious that I get this attic cleaned up, pronto! **HRH**

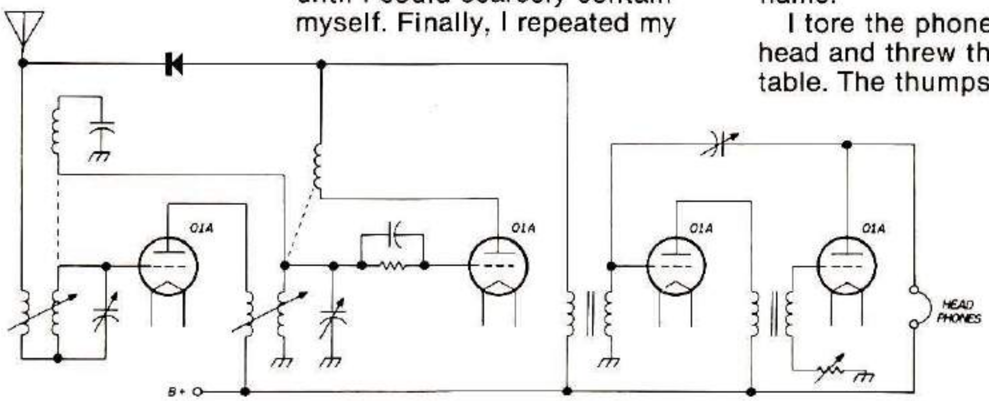
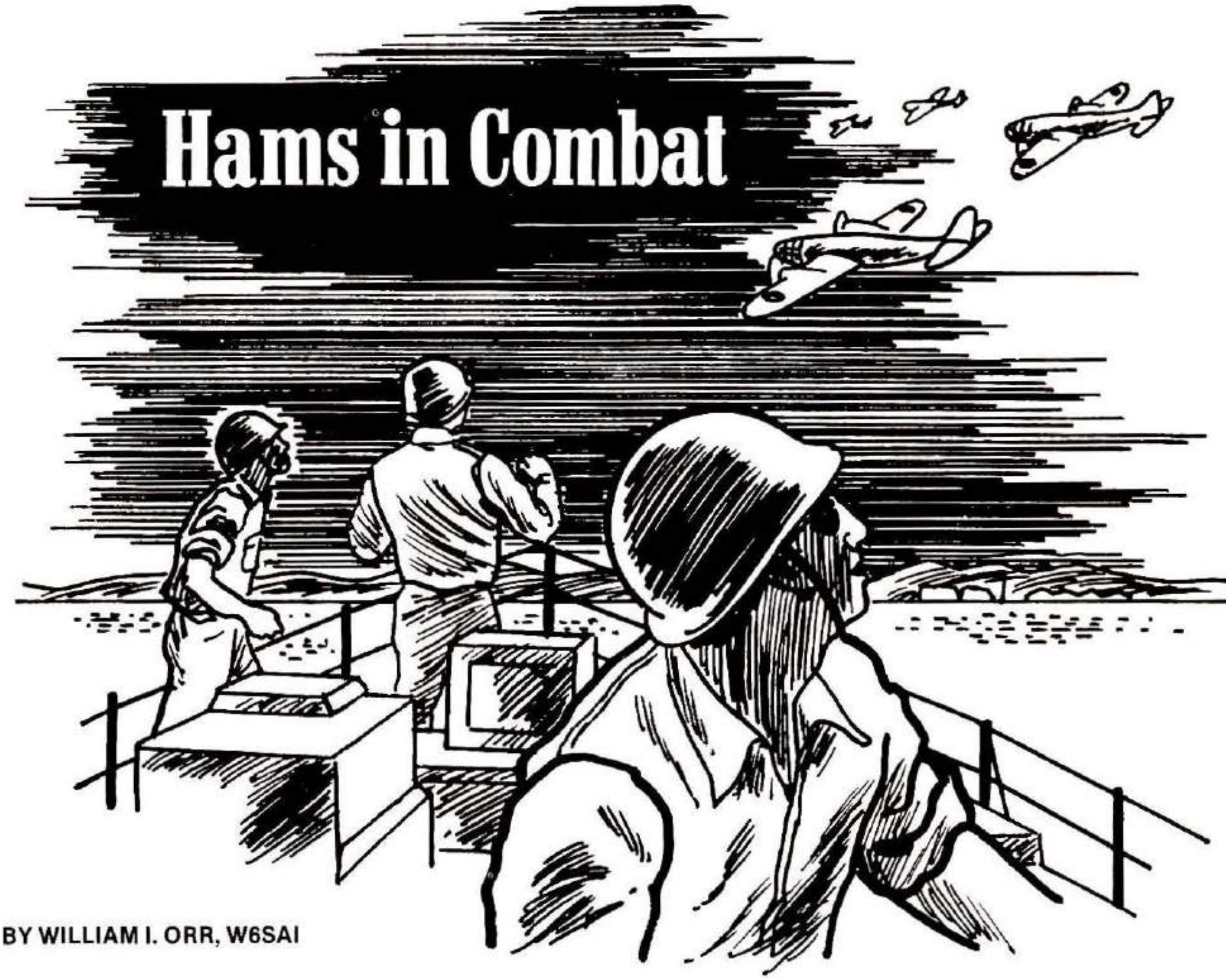


Fig. 2. Schematic depicting general idea of the receiver. This set is regenerative to the nth degree; it should not be confused with workable schemes.

Hams in Combat



BY WILLIAM I. ORR, W6SAI

It was a breathless, clear winter morning. The island of Oahu, Hawaii, sparkled in the sun, which had just cleared the horizon. From the air, the island looked like a large, damp, green jewel. Flying along the coast, the occupants of the little sport plane could see the adjoining islands on the horizon, the white sand beaches below them, and the blue-green ocean, breaking in white, frothy waves upon the coast. To their left was the large United States Naval Base at Pearl Harbor. Little ground movement was apparent as the plane bobbed and weaved in the air currents.

Off to one side, a thin column of pale smoke indicated someone was burning trash; otherwise all was quiet. Below, and right ahead, the Naval Air Sation lay quiet, with planes drawn up on each side of the main runway, as if on parade. To young co-pilot Martin Vitousek (later to be KH6CIY and VR3I), it was a picture he would long remember.

Martin's father, the pilot of the plane, banked the small ship and headed back towards his landing field. It was nearly time to land and he had plans for December 7th that were soon to be set aside in a hail of bullets and falling bombs.

Suddenly Martin felt his father tap him on the shoulder and turned to see him staring over the side of the craft at a strange sight. He was looking at Hickham Field, about six-thousand feet below their left wing. The senior Vitousek banked the ship for a better view of the field; below there was a sight to remember! A swarm of small, low-wing planes had appeared, as if from nowhere, and were cris-crossing the field as well as the battleship anchorage near Ford Island at Pearl Harbor!

It was clear an attack was in progress as the two flyers could see machine-gun bursts from the planes, bombs dropping on the runways and parked planes, hangars exploding in great blasts of flame, and ant-like figures running about on the ground. Over at Pearl, great clouds of black smoke were arising from some of the battleships.

Stunned by what they were seeing, the Vitouseks circled back and forth, uncertain what to do. Landing was out of the question, as the battle was going on directly below them. It was apparent that the ground forces were firing at the attacking planes, and also at *them*! Ominous puffs of smoke announced antiaircraft fire beneath them.

The carnage was quick and brutal and the involuntary observers in the light plane saw it all: The torpedo plane attacks on battleship row; the sinking of the giant ships in clouds of black, oily smoke; the planes bursting into flames on the Hickham runway — they saw all of it, and only when the ground was left in smoking ruins and the planes had departed to the north were the shaken observers able to land. In the space of a few hours, on that clear, cool morning when the earth trembled and the sky burned, all had been changed and nothing would be as it was before.

"You were damned lucky," said the base commander, knocking the ashes from his pipe into a handy tin can on the corner of his desk. "We thought your light plane was a Japanese spotter plane for the raid. We threw everything at you we could, which wasn't much. Too much excitement on the ground, I guess. But you had better watch out next time! We won't miss."

There was great confusion in and around Honolulu for hours after the attack. By December 8th, certain steps were taken to insure that spies and saboteurs were fully under control. All amateur radio equipment was seized by the military, working with the police, and radio amateurs of Japanese ancestry were quickly taken into custody. On the outer islands, security measures advanced at a more leisurely pace, but by the end of the week the Hawaiian amateurs were off the air, most of their equipment confiscated, and some of them in holding areas, as the authorities pondered the problem of the Japanese-American radio amateurs. Luckily, common sense prevailed and the amateurs were soon released.

On the mainland, radio amateurs continued to operate Sunday, December 7th, and Monday, December 8th. By late Monday, amateur radio had been suspended "for the duration," though some operators continued to handle Civil Defense traffic for a few days thereafter under the questionable authorization of local officials of the Office of Civilian Defense. The January, 1942, issue of *QST* (on the newsstands about December 20th, 1941) contained a special yellow insert announcing the closedown and hinting that some amateurs would soon be back on the air to provide emergency communication for Civil Defense.

FCC Order No. 87

At a session of the Federal Communications Commission held at its office in Washington, D.C., on the 8th day of December, 1941:

Whereas a state of war exists between the United States and the Imperial Japanese Government, and the withdrawal from private use of all amateur frequencies is required for the purpose of the National Defense;

IT IS ORDERED, that except as may hereafter be specifically authorized by the Commission, no person shall engage in any amateur radio operation in the continental United States, its territories and possessions, and that all frequencies heretofore allocated to amateur radio stations under Part 12 of the Rules and Regulations BE, AND THEY ARE HEREBY, WITHDRAWN from use by any person except as may hereafter be authorized by the Commission.

By Order of the Commission:
T. J. Slowie, Secretary

The lights start to go out all over the world

Radio amateurs in Europe had been closed down for some time. The DX column in *QST* reported that British and Danish amateurs were closed down on October 1st, 1939, with Cuban, French, and Haitian amateurs as of September 1st. At the same time, Austrian amateurs were being issued German calls as the result of Hitler's *anchluss* of that forlorn country.

By the winter of 1939 almost all the European countries were off the air, with the exception of a few Russian hams and one or two German stations. South African amateurs were shut down and many South American countries either closed down their amateurs, or restricted them to contacts on phone in the Spanish language. Asia and the Pacific, however, were jumping with activity during 1939-1940, with DXers working AC4JS on the border of Tibet, XU8MI in Shanghai, and KH6KKR in American Samoa.

However, on June 4th, 1940, FCC Order 72 prohibited amateurs in the United States from engaging in foreign communications; DX was dead. The DX column lingered on in *QST* until the February, 1941, issue, but there was little to report, aside from sparse amateur activity in the American possessions in the Pacific.

The War Emergency Radio Service

Shortly after December 7th, the FCC, at the request of the Office of Civilian Defense, began work on a new plan to reactivate a few amateur stations for war emergency communications. Immediately after Pearl Harbor some amateurs had been specially licensed to return to the air for emergency traffic, but the system of authorization was spotty and security problems remained unsolved. Finally, a complete set of new regulations (Part 15 of the FCC Rules) authorized the *War Emergency Radio Service* (WERS). Under this plan Civil Defense radio stations and state guard stations were licensed to operate in the 112-116, 224-230, and 400-401 MHz amateur bands, with a maximum power input of 25 watts. The rules of conduct were strict, and the operation of these stations resembled the present-day MARS drills. The WERS callsigns were unique: a four letter combination, followed by a unit number (such as WUXA-29). The pallid substitute had to satisfy most amateurs until after D-day when amateur radio once again blossomed forth.

Hams at war

The unique abilities of the radio amateur were urgently needed by the Armed Forces as well as by countless civilian agencies and war plants. Transformed overnight from a depression into a war economy, the wage scale of the country soared. Under a new column, "USA Calling," *QST* listed many job openings for qualified amateurs at salaries as high as $150 a month. College graduates in electrical engineering, with experience, could earn as high as $3600 per year in the war industry. This was a far cry from the pre-war depression days, when a salary of $20 a week was considered to be a good wage!

Many amateurs joined the Armed Forces and *QST* ran long lists of amateurs in the various services. Feature stories on interesting amateurs, such as Captain Elliott Buckmaster, W6SNL, the Commander of the carrier *Yorktown*, lost in the battle of Midway, were of great interest. "Hams in Combat", a regular *QST* feature told part of the story; "Prisoners of War" and "Silent Keys" told the rest of it.

The end of the war was signalled in *QST* during the summer of 1945 when the magazine ran a long article entitled, "Captured Enemy Radio Equipment," plus a three-part article explaining the theory of radar, heretofore a closely guarded military secret, not mentioned in *any* of the radio magazines!

Amateurs on the air!

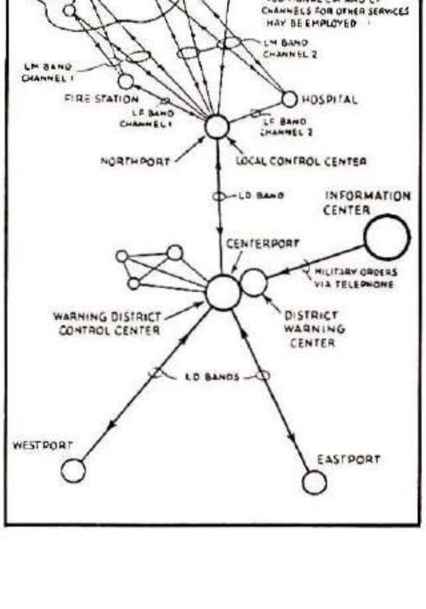
In spite of the war, amateur radio in the early 1940s continued active in some unusual ways. A few South American countries, such as Argentina, Paraguay, Chile, and Uruguay permitted amateur radio to continue on the high-frequency bands during the war, although under tight control. German and Austrian amateurs suddenly appeared on the DX bands in 1942 swapping contest numbers! And hams in the United States found various ways of getting on the air too!

The vast aircraft industry on the west coast that was ultimately to provide the air-power punch that ended the war in the Pacific had countless hundreds of radio amateurs working in the plants from Boeing in the Pacific Northwest to Consolidated-Vultee in San Diego. Many of these amateurs worked with communication equipment. The aircraft, of course, were all radio equipped and — until about 1943 — all of the airborne radio gear was designed for high-frequency operation. The fallout of those days was the famous flood of surplus equipment that reached the market from 1947 until the early 1960s: the SCR-274N Command radios, the BC-375 transmitter, the BC-348 receiver, and the BC-221 frequency meter. This conglomeration of radio gear was usually ground-tested on 3105, 6210, or 7050 kHz during the final flight test days of the aircraft.

The temptation was too great for the hotbed of avid radio amateurs in the Los Angeles area who worked for the large aircraft companies. In addition to these amateurs, hams from the Air Force, Army, and Navy were also in the Southern California area, and some were in positions of considerable influence in the military hierarchy. Repeated requests to the FCC to allow some form of amateur radio to return to the air were repeatedly denied, so it was not long before quasi-military stations sprang up on the three test frequencies, using ground-based aircraft equipment and military tactical calls issued by the local military officers in charge of frequency allocations. Additional frequencies were added to the net, with the master control station, a 500-watt a-m phone on 7050 kHz, controlling the net. The tactical call "Twenty-Two X-ray Two" was used.

Just before V-J day the net extended as far east as

Proposed War Emergency Radio Service network making use of both high and ultra-high frequencies. Permission for high-frequency WERS operation was never received.



U.S.A. CALLING!

In time of emergency, amateur radio steps forward and applies its specialized knowledge to the task of replacing and restoring and supplementing the normal communications system. That is our traditional responsibility — a tradition we have ourselves built and a responsibility we have ourselves sought. War is the gravest emergency of all, and it is now our duty to discharge that traditional responsibility in the war emergency with discipline and patriotic devotion.

Since December 7th, amateur radio has been operating under wartime controls. Eight hours after the first bomb fell in Pearl Harbor, amateur radio as we have known it in peacetime was suspended for the duration. In its place, in the past five days, the volunteer communication system upon which the civilian defense of these shores will be built has begun to take form.

1000 RADIO OPERATORS NEEDED

The Army Airways Communications System, which operates airways communications services for the Army Air Forces, has an urgent need for 1000 high-speed radio operators at once.

This is an organization which should prove attractive to many young radio operators as this system, among other communications services, provides airways communications for air ferry routes which operate throughout the four corners of the globe.

ARMY COMMISSIONS IN U.H.F. WORK

Commissions from civil life have become tough to get—except for men qualified for work with the new secret devices. The Electronics Training Group of the Signal Corps continues in need of more and more officers. If you can qualify for this work you will probably find it the most important thing you can do in the war, its instruction the most interesting and having the greatest post-war value to you.

WAR DEPARTMENT OPERATORS

There is a continuing and urgent need for high-speed radio-equipment operators in the fixed service of the War Department. Over 200 positions paying $1620 a year are now open at various Army posts throughout the United States and territories. These are Civil Service jobs called Junior Communications Operator, High-Speed Radio Equipment, and are covered by Announcement No. 20 and an amendment thereto. Particulars and forms may be had from major post offices or the Civil Service district offices: see page 28 of November *QST*.

QRT METERS

Believe it or not, so swell has been the response to our plea for meters on behalf of the Signal Corps that a sufficient number for the present program has been received and no more can be accepted at present. So please QRT; do not send any more meters to ARRL unless the appeal is renewed.

RADIO ENGINEERS AND PHYSICISTS

While tens of thousands of enlisted men are being trained in the armed forces in the employment of radio, so complex is the nature of the special radio equipment being used in this war that highly skilled engineers and physicists are necessary at the top of the picture to deal with the problems of design and application. Engineers are needed in civilian capacities, and are very badly needed. Any engineer qualified for such work unquestionably is already employed in industry or research, but the national need is now so great that such engineers should consider whether they are absolutely essential to their present programs and how essential those programs are to the victorious conclusion of the war.

There must be many engineers and physicists

TRANSMITTING TUBES WANTED

On behalf of the broadcasting stations of the country, we renew the appeal of the National Association of Broadcasters to amateurs who are willing to sell tubes suitable for use in broadcast transmitters. (We do not register tubes in the ARRL ApBu.) Tubes for civilian uses, of course, are difficult to obtain and every time a ham tube goes to work in a b.c. station a new bottle is spared for military use. It is particularly hoped that amateurs entering the armed services will make their tubes available before their departure. Hams willing to sell their power tubes are asked to address the National Association of Broadcasters, attention Howard S. Frazier, Director of Engineering, 1760 N St., N. W., Washington, D. C., listing the type, age, and price

Hamfest in North Africa

By Lt. Harry Longerich,* W2GQY, and M/Sgt. Arthur Hansen,* W8MTE

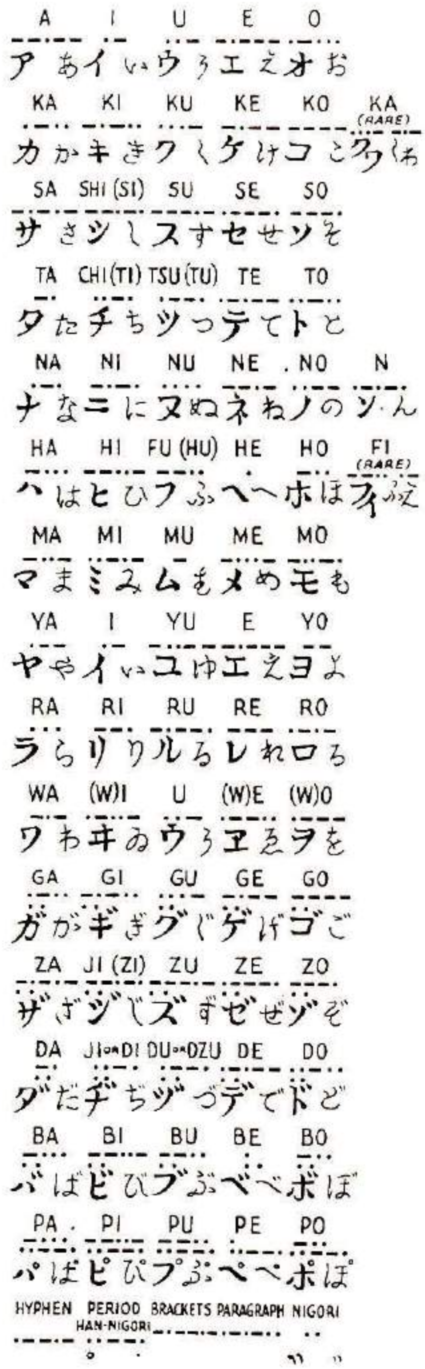
During a routine inspection of a radio system by several officers of the U. S. Signal Corps somewhere in North Africa, the officers, all of whom were hams, were swept off their feet to learn that their erstwhile guide was none other than G6ZO, formerly from Scotland and an ardent DX man. Of course, as every ham knows, the conversation soon drifted to the subject nearest and dearest to their hearts. G6ZO proved to be a genuine ham in all respects, even to the extent of lugging copies of *QST* and his logbook all over the Dark Continent.

The following week an informal hamfest was held under his sponsorship. All U. S. Districts except W1 and W3 were represented, and several

HAMFEST IN CHINA

P. O. Box 172, Sar-Pin-Bar, Chungking, China
Editor, *QST:*

We have great pleasure to inform you that we (the China Amateur Radio League) are going to hold our fifth convention on May 5, 1943, in Chungking, our war capital. Every section of our League will participate, through our radio network. This is what we have done during previous conventions. May 5th is now known in China as the "China Amateurs Day." The annual convention is to be observed on that day throughout China.



In the Navy Department's report of personnel lost on the *Reuben James*, a destroyer recently sunk up Iceland way, was the name of J. F. Baurer, Chester, Pa. Om Baurer was a CRM, USNR, and W3ATK, a member of the Chester NCR unit called to active duty in December, 1940. So far as we know, he is the first Navy ham to be lost in the current emergency.

We regret also to report the death on November 17th of Major R. E. Pirtle, K6OAY and ex-W9SZ, as a result of a bomber crash near Salt Lake City.

☆ ☆ ☆

REOPENING!

AH, BUT IT is good to be back on the air! — a humble reopening, to be sure, but a start from which great things will quickly come.

In a shrieking crescendo of events that still tax comprehension, the war is over. The appalling expenditure of blood and treasure is ended. We are back in the ways of peace.

No major nation has ever acted so rapidly in its reconversion processes. President Truman announced the Jap acceptance on the evening of August 14th. Next day ARRL moved with BWC and FCC for amateur reopening. On the 16th, BWC told FCC it had no objection to the temporary restoration of amateurs in the 112-Mc. band; there was not time to do more but that would serve as a starter. On the 21st, slashing through miles of red tape, FCC put us back on the air on that band — as a beginning, and until more can be done and things regularized. Like that! we were going again!

Chicago, with several amateurs sporting military radios in their autos, with their own military tactical call signs. Since the whole operation was under the benign eye of the Armed Forces, the FCC had little say about the goings-on, although it was understood they kept a close eye on the frequencies.

The ban is lifted!

Finally, on August 21st, 1945, the FCC lifted the ban on amateur radio in the United States and its territories and possessions! The frequencies from 112 to 115.5 MHz (The old 2-1/2 meter band) were authorized for operation, as well as permission for ARRL's station W1AW to start special broadcasts to radio amateurs on the high-frequency bands. Eventually, on November 9th, 1945, amateur operation was authorized on the 5- and 10-meter bands, as well as the new vhf band at 144-148 MHz. Hams were once again back on the air!

The office of Civil Defense was quickly disbanded and the WERS stations faded into limbo. Almost simultaneously a large number of radio amateur licenses were issued to individuals who had taken their amateur examination during the war but who had not been issued call signs. This group of *LSPH* (Licensed Since Pearl Harbor) amateurs were the first to receive new post-war calls.

And, finally, the large ninth district comprising the whole central area of the country was broken into two call areas, and newly issued WØ calls started showing up on the amateur bands.

The one stain on amateur radio occurred on the night of April 1st, 1946, when the FCC authorized operation in the 3625-4000 kHz portion of the 80-meter band, beginning at 0300 EST. Countless eager beavers jumped the gun, and by the early evening hours the 80-meter phone band was chock full of ham signals, all signing fictitious calls — shades of modern CB radio!

By now the memory of those exciting days thirty years ago has faded, and most of today's radio amateurs weren't licensed yet. In those days broadcast television was still essentially a laboratory curiousity, and the fm broadcasters had a new band and no transmitting (or receiving) equipment; amateur single sideband, OSCAR satellites, moonbounce, RTTY, and vhf fm were not even on the horizon. What new modes of radio communication will amateurs be using in the next thirty years? Will we be using compressed bandwidths so we can fit more stations into the amateur bands? Wireless matter transporters? Holographic three-dimensional television? Laser communications? It's an interesting question to contemplate.

Postscript

Today Dr. Martin Vitousek (KH6CIY) is at the Institute of Geophysics at the University of Hawaii. His present interest is in the Northern Pacific Experiment (NORPAX), a part of the International Decade of Ocean Exploration which is designed to record weather and ocean data to be used in forecasting climate changes a year or more in advance. He is the manager of the research station on Fanning Island and

RUSSIAN RADIOTELEGRAPHIC CODE

ENGLISH LETTER	RUSSIAN LETTER	RUSSIAN SOUND	FORMED AS
A	А	AH	·—
B	Б	BEH	—···
W	В	VEH	·——
G	Г	GEH	——·
D	Д	DEH	—··
E	Е	YEH	·
V	Ж	ZHUH	···—
Z	З	ZEH	——··
I	И	EE	··
J	Й	EE	·———
K	К	KAH	—·—
L	Л	LLL	·—··
M	М	MMM	——
N	Н	NNN	—·
O	О	O	———
P	П	PEH	·——·
R	Р	ER	·—·
S	С	S	···
T	Т	TEH	—
U	У	OO	··—
F	Ф	EFF	··—·
H	Х	HAH	····
C	Ц	TS	—·—·
MN	Ч	CHEH	———·
MM	Ш	SHEH	————
Q	Щ	STCH	——·—
Y	Ы	OUI	—·——
IM	Ю	U(YOU)	··——
AA	Я	YAH	·—·—
X	Ь		—··—
UI	Э	EH	··—··

flies his own twin-engine Piper Aztec to Fanning Island every five or six weeks for a two-week stay. A twice-yearly Australian freighter is the only other regular transport there.

As part of Dr. Vitousek's project, which has been underway since 1972, researchers have set up four automated weather stations and will have three more going by the end of the year. Three of the stations are on uninhabited islets.

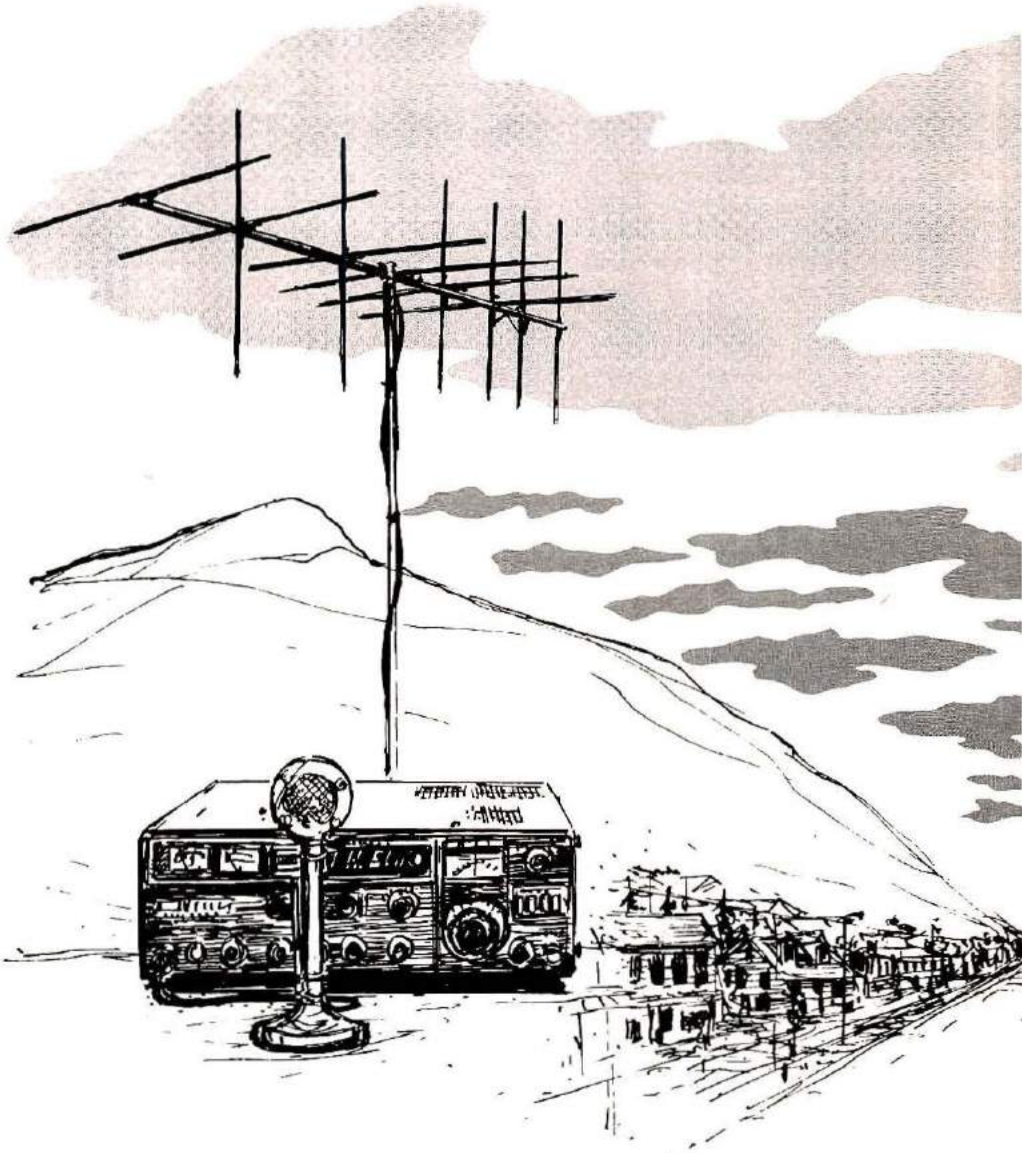
KH6CIT visits each station at least once every six months. The farthest from Fanning is on Maulden Island, 500 miles (800km) or three days by tug, and another is on Palmyra Island 200 miles (320km) from Fanning in the opposite direction. The trip is made in an old Navy tug with a native crew. **HRH**

Drawings and news items for the war period taken from various issues of *QST* magazine, published by the American Radio Relay League, and reprinted with their permission.

2-Meter SSB

Stretch your communications path without repeaters

BY GORDON WEST, WB6NOA



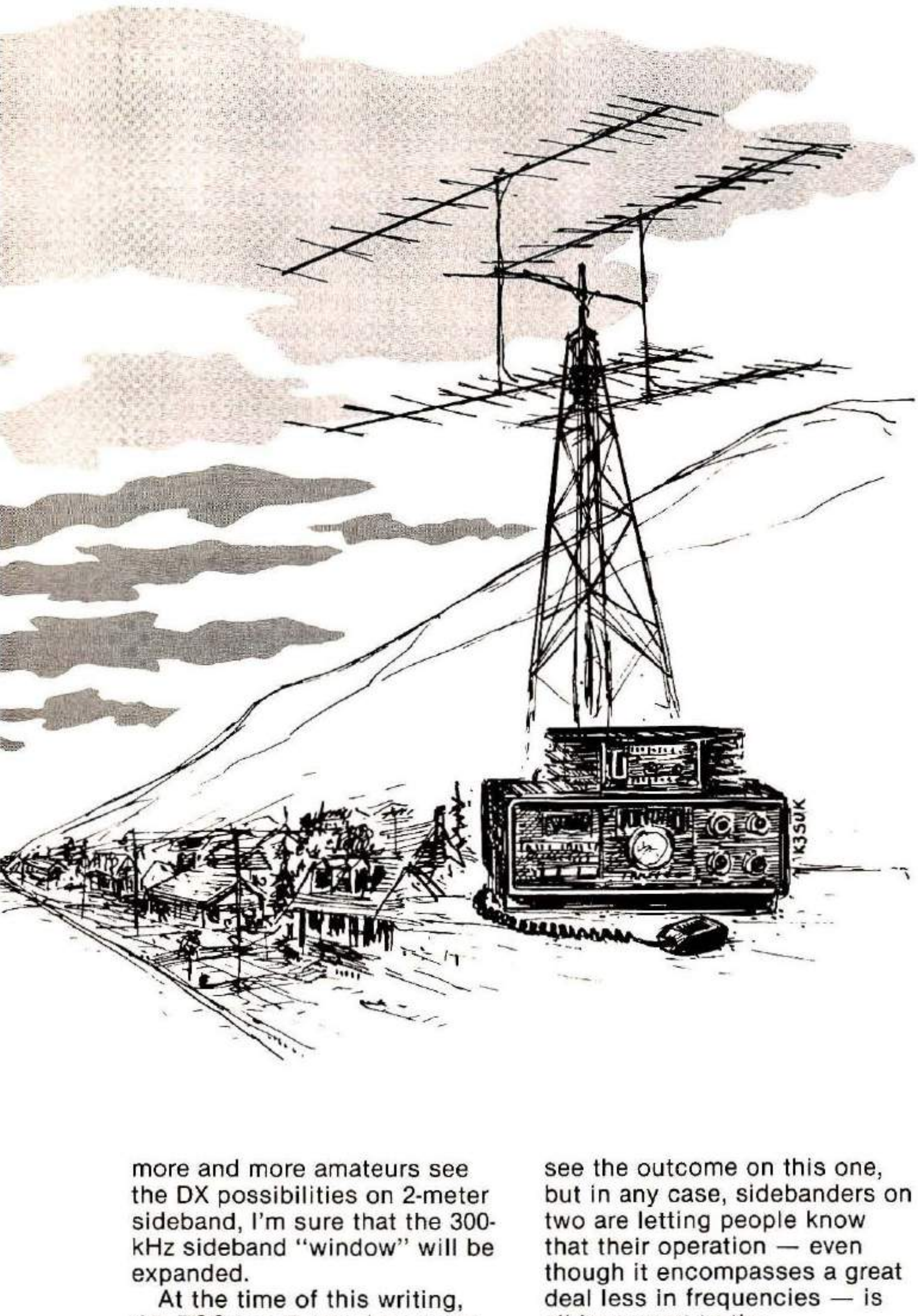
Many of you know the fun and operating convenience of 2-meter fm. These transceivers are compact, relatively inexpensive, require no tuning, and a small amount of power output can go a surprising distance. After a few months on the 2-meter fm band, you're probably searching around for a repeater that offers you more than just "local" coverage. It's always a great feeling of accomplishment to be able to access a repeater over 160 km (100 mi) away and talk to another mobile station who might be the same distance in the opposite direction — a real DX hook up.

But 2-meter repeaters are always crowded, and as you communicate with another mobile or base station, several other stations are patiently (or impatiently) waiting so that they may use the repeater when you're finished. Many amateurs have tried operating fm simplex, and found that they could communicate over surprisingly long distances without the use of repeaters. Two base stations many times may communicate up to 160 km (100 mi), and mobile-to-mobile fm simplex range often exceeds 80 km (50 mi). But for those amateurs presently on vhf who want to communicate even farther, 2-meters single sideband is definitely the way to go for everyday DX contacts.

The type of communications I'll talk about on 2-meter side-band for this article will not use repeaters, I might even classify OSCAR , the Orbiting Satellite Carrying Amateur Radio, as a type of space-born repeater. Let's talk about direct contacts from base-to-base or base-to-mobile, as well as those QSOs where 2-meter signals are reflected off nearby mountains and buildings, as well as the moon and meteor trails.

Two-meter sideband frequencies

A very active spot for sideband operation on 2 meters is centered around 145.1 MHz. This frequency is recognized by 2-meter ssb enthusiasts, and the ARRL, as the national DX calling frequency. If you connect up with a local, say within 160 to 300 km (100 or 200 miles), you would generally move up or down in frequency, relieving the DX calling channel of local chatter. The lowest frequency that Technician Class amateur radio operators may presently use is 145.0. The highest frequency for 2-meter ssb operation is about 145.3. As



more and more amateurs see the DX possibilities on 2-meter sideband, I'm sure that the 300-kHz sideband "window" will be expanded.

At the time of this writing, the FCC has delayed repeater expansion on two meters until more comments are available, from both FMers as well as sidebanders, concerning a suggested band plan. Additionally, the ARRL has filed a petition with the FCC, seeking Technician Class privileges on the entire 144-MHz band. We'll have to wait to see the outcome on this one, but in any case, sidebanders on two are letting people know that their operation — even though it encompasses a great deal less in frequencies — is all important to the advancement of the art of talking over long distances with low power.

A considerable amount of activity is present on 2-meter sideband through net operations, and this is a good way to tell if the band is "open" to a distant city. Most nets operate at 145.150 or lower, and a list of their frequencies and times is included at the end of this article. With some careful tuning and listening when a net is scheduled on the air at a distant city, it's quite possible to check into these nets consistently up to 500 km (300 miles) away, using only low power and a single Yagi antenna.

Equipment

There are countless 2-meter transceivers with sideband capabilities on the market today. Designated "multi-mode" transceivers, these units are almost always left in the fm mode by the operators who use repeaters. Is the sideband mode only for those who have huge 120-element collinear arrays for moonbounce work?* Definitely not! By switching the multi-mode rig to sideband and listening around 145.1, I think you're going to hear a lot more stations than you anticipated! These multi-mode transceivers offer extremely good results on 2-meter sideband. The sideband addition to what appears to be an fm rig was not an afterthought by the manufacturer, and you may be assured of sensitive and stable operation. Generally, the sideband-only transceivers give you a slightly more expanded tuning dial and possibly 1 or 2 dB more in sensitivity because they are specifically tuned for the 144 through 145 part of the band. This certainly does not preclude you from "tuning up" your multi-mode transceiver so that its hottest reception is going to be at 145.1, where weak signal work sideband is accomplished. A slight bit of degradation to the receiver on the repeater frequencies would never be noticed.

If you are choosing new

*Moonbounce is the vernacular for Earth-Moon-Earth communications, wherein two stations communicate by bouncing their signals off the moon. It generally requires a power *output* of 500 or more watts, an antenna of 20 to 22 dB gain, and a preamplifier with an extremely low noise figure.

Many of the new transceivers for two meters provide all the features that you might need for that band. This one allows you to use ssb, CW, a-m, and wide or narrow fm. It also has a noise blanker for use in noisy locations, and offers a choice of high- or low-power output.

equipment for two meters, the multi-mode transceiver is an excellent way to go, in that it offers you the fun of fm for short range contacts, and the thrill of ssb for long range contacts.

Transverters

Another good way to get on 2-meter sideband from the high-frequency bands would be to purchase a transverter. The transverter will automatically convert your present transceiver to a sensitive 2-meter transceiver with about 10-watts output. Since most high-frequency transceivers are electronically engineered to accept strong signals with high selectivity, the transverter attached to them will work very well, often just as good as conventional 2-meter ssb gear. The initial cost of a transverter alone is generally less than a 2-meter sideband transceiver. If your hf rig has been performing flawlessly, and has such features as speech compression and noise blanker, all the better for 2-meter work through a transverter.

Preamplifiers and amplifiers

Most 2-meter sideband transceivers have excellent sensitivity, and a preamplifier is not necessary in the receiver's "front end." For moderate-range work — 300 to 500 km (200 to 300 miles) away — signals are at a usable level on your present rig. However, if you want to really get involved in weak signal reception, a preamp can make that slight bit of difference between copying a signal and not hearing it at all. Choose only preamplifiers designed for two meters. Not all "general purpose" preamplifiers exhibit good intermod rejection at these frequencies, and, although their gain figures may look impressive, their intermod rejection definitely may not be! An easy way to add a preamplifier to your present 2-meter sideband rig is to purchase one of the new preamplifier/amplifier packages available from a few power-amplifier makers. On receive, the preamp may be switched in or out of the circuit, adding 5 to 10 dB weak signal reception, while keeping the noise figure down to 2 dB or lower. When you transmit, your 10 watts output, which is typical of most 2-meter transceivers, is amplified from 40 to 160 watts. There's no need to wire this preamplifier into the receiver side of your transceiver — it's all done automatically through rf switching.

Since we're talking about amplifiers, 10 watts will go a long way on 2-meter ssb; many stations have worked well over 500 km (300 miles) with that power level. However, sometimes it's necessary to break into a conversation from a great distance, and higher power is desirable. Many 70-watt amplifiers are available, and anything over 50 watts seems to be the magic number for making long haul DX contacts. The largest solid-state amplifier presently available yields just under 200 watts; ten watts drive — 200 watts out. Its price tag is about $1 a watt. For those of you who want to go the full route, several high-performance kilowatt amplifiers are available for the maximum legal power output. These are generally used only by amateurs interested in meteor scatter and moonbounce (EME) work.

Most solid-state amplifiers require 12 volts for their operation. Here is a chart that will assist you in determining the current rating of the power supply you will need for that power amplifier:

Drive Power, Watts	Power Output, Watts	Amperes at 12 Volts
1 to 4	25	3
1 to 4	70	10
5 to 15	40	5
5 to 15	70	8
5 to 15	80	10
5 to 15	140	18
5 to 15	180	24

An inexpensive way to get around the power-supply problem is to purchase a 12-volt battery and a small battery charger. By keeping your battery fully charged, and in a well ventilated area — preferably outside the shack, you'll never have to worry about burning up your 12 volt dc regulated power supply, and I think you'll find the cost a great deal less than a high-current supply. That car battery also can double as an emergency power source for ssb or fm operations in case your ac power should fail. Most multimode or 2-meter ssb rigs have provisions for both 110-volt ac as well as 12-volt dc operation.

Choose only recognized power amplifiers. What I mean here is that *poorly constructed* home brew power amplifiers can create a great deal of TVI, and may only put out about half their rated power. Well-constructed 2-meter amplifiers are either of stripline or modular construction, and offer good TVI elimination through good filtering. Make sure the power amplifier you choose is rated for sideband operation — some aren't and may only be used for fm. Sideband power amplifiers are linear and generally have a built-in time delay so that they don't switch off between words.

If you have a power amplifier in use now, avoid over-driving it. By increasing the drive power from 15 watts to 20 watts you will generally obtain only 1 or 2 more watts output but with considerable more distortion. If you want to squeeze a few more watts out, check your dc input voltage. When on transmit, if it drops below 13 volts, then look for a better dc supply or a better battery. Power output is quite proportional to dc power input, and a power supply that dips below 13 volts when the unit is on transmit, on voice peaks, will generally not let the amplifier operate at its rated output. Most power amplifiers are about 60 per cent efficient, and they need adequate ventilation during long conversations.

Feed lines and antennas

RG-8/U is most often used for feed line on 2 meters. The loss is only 3 dB for a 30 meter (100 ft) run. On runs of over 60 meters (200 ft) you should consider 7/8-inch Heliax, which will give you a 2 dB loss for that length. Few 2-meter operators choose anything other than RG-8/U for their coax runs. Avoid using the smaller RG-58/U — save that for use on the high-frequency bands.

If you have a low-powered transceiver you can obtain an external amplifier that will boost the output to 140 watts. Some amplifiers are made to be linear in operation, specifically for a-m or ssb use. Be sure to obtain the right type for the operation you engage in. Some amplifiers have a switch to select either linear or Class-C (for fm and CW).

Antennas for 2-meter sideband work are generally Yagi beam antennas or collinear arrays. Ground planes, and other types of vertical antennas may be used, but you're going to experience a severe loss in signal reception because of cross-polarization. Almost everyone on 2-meter sideband has horizontally polarized antennas. If you're presently using a beam for your fm work on two meters, a quick trip to the roof can easily solve your problem. Simply loosen up the hardware that attaches your boom to the mast, and rotate the boom 90 degrees so that your coax connection point is on the bottom side. Tighten all the hardware, and you're ready for some good long-haul contacts. If you use the same antenna on fm, where signals are quite strong, you'll probably find that you will have no problem at all in accessing that repeater several miles away with your antenna horizontal rather than vertical.

The most popular type of 2-meter DX antenna is the Yagi. A gain figure of 10 to 15 dB is adequate to work moderate DX and band openings. Stacking two Yagis will increase the gain by 3 dB. However, if that additional 3 dB gain will allow you to work that distant station that you can barely hear with a single Yagi, then by all means, go to it.

Although height is important in selecting the best location for your antenna, going to great effort and expense to elevate the antenna 20 to 30 meters (60 to 100 feet) in the air may not be necessary. Moderate DX on two meters can easily be worked, providing the antenna

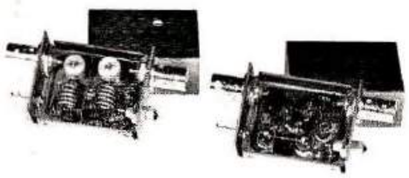
Some power amplifiers are available with a built-in preamplifier to help in receiving weak signals. The preamplifier is automatically switched out of the line when you transmit.

is above nearby trees and buildings. Many 2-meter sideband DXers mount their antenna on simple TV antenna-mast tubing. Towers are ideal, but not all that necessary for good range.

In a recent test in Southern California, only 3 dB gain was achieved by elevating an antenna from 9 meters (30 feet) high to 27 meters (90 feet) above the ground. However, when the antenna was lowered to 6 meters (20 feet) — in direct line with trees and buildings — the loss was greater than 7 dB. Try to get your horizontally polarized beam higher than the surrounding foliage.

Four Yagi antennas in an "H" arrangement offer pinpoint transmission and reception paths, with considerable gain, for the serious DXer. However, the beamwidth and bandwidth of most large arrays are quite narrow. Collinear arrays are generally not as critical in either bandwidth or direction, and allow for the reception of several DX stations that may be separated by several hundred miles. Many moonbounce (EME) enthusiasts (you'll hear them on CW near 144 MHz) prefer the collinear because its alignment directly to the moon is not as critical as with a large array of Yagis. I prefer the quad array of Yagis because of their exceptional characteristics in cancelling noise and QRM originating from the side of the array.

Circularly polarized antennas have been found to reduce the signal fading commonly associated with long-haul 2-



Small preamplifier modules can be added ahead of a receiver or converter that needs help with weak-signal work.

meter DX. Signals that travel great distances will begin to change in polarization, and a circularly polarized Yagi will keep reception constant. However, there is about a 3 dB overall signal reduction when a circularly polarized antenna is compared with a horizontally polarized antenna.

If you want to get on the air quickly and reliably, choose an inexpensive 12 or 14 element Yagi for excellent results. In the horizontal plane, there is no need to worry about the type of mast — metal or wood — that the horizontal Yagi is mounted on. Since they are extremely light weight, there's also little worry about heavy-duty guy wires. "Our most popular antenna is our 16-element beam," comments Mike Staal of KLM Electronics. "It's light weight, fast to put together, and offers exceptional directivity and gain. It's about the maximum gain that anyone can achieve for such a small antenna that requires no boom bracing. And when they choose this type of an antenna, they generally want the most powerful amplifier — in our case a 160 watt amplifier. For under $300 they're getting an antenna and amplifier that will reach out well into DX land with just about any kind of band conditions present on 2 meters."

Lou, WB6NMT, of Lunar Electronics comments, "I prefer collinears over long Yagis in that they are slightly more efficient when it comes to losses. They tend to pick up stations more easily off their center of aim, and are not all that more complicated to erect. They just take up a wider space — or about the same width as a Yagi is long." Both Lou and Mike are experts when it comes to engineering and manufacturing antennas, and, although they have different opinions, both hold many records in long-haul DX contacts on two meters.

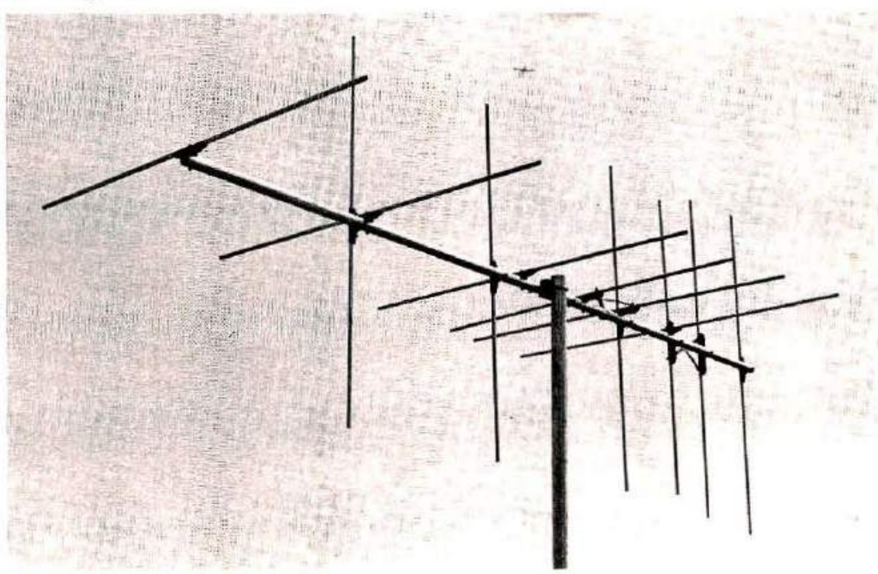
Two-meter mobile operation is accomplished with a horizontal antenna affectionately called the "egg beater." This unique array offers omnidirectional circular polarization with surprisingly good results. Just last week I was able to work a mobile 70-watt station with this type of an antenna; he was 600 km (375 miles) away! Another popular mobile antenna is the "big wheel." It, too, offers good range, is small, and is horizontally polarized. If you plan to go mobile with a horizontally polarized antenna on 2 meters, just accept the fact that everybody in the world is going to stare at your car and ask what in the heck you've got on the roof!

Range and propagation

Before we'll talk about this, let's set some norms. Many stations working DX on 2 meters run no less than 70 watts, and often no more than 150 watts. These stations generally employ a single Yagi, or a pair of Yagi beams, or a single "curtain" of collinear antennas. The gain of their arrays is usually in the order of 15 dB. The antenna height of most stations on 2-meter sideband is often no greater than 12 meters (40 feet). Now there are many stations on the air with tremendously more powerful antennas and transceivers, but I'm talking about those interested in 2 meters for long haul work, but not necessarily the meteor scatter or moonbounce buff. You can hear it on the band on almost every contact . . . "Nice signal, OM, I'm running 10 watts out of my transceiver into a 70-watt amplifier, with a 14 dB gain antenna at 40 feet up." That's the kind of station, as an average, that's on the air working DX.

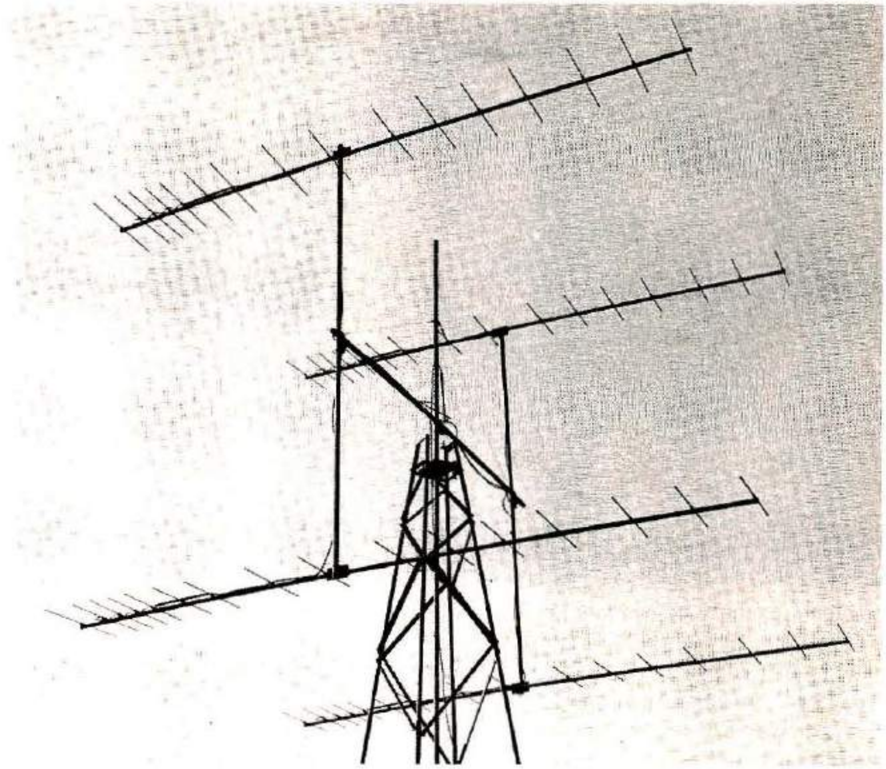
Since most of the DX normally encountered on 2-meter sideband is from base stations, we'll confine our range expectations to base stations only — but remember, mobiles can many times do the same job. Reliably, two stations with the average equipment and antennas just described should be able to communicate *all the time* up to

Crossed Yagis can be used individually for either weak-signal DX work (horizontal) or fm and repeaters (vertical). They can be connected with circular polarization, which works well on either polarity, and which tends to reduce some fading that is noticeable on DX signals.



150 miles away. This would include paths over mountains, in cities, or from low-altitude locations and flatlands. Local mountain ranges tend to reflect 2-meter radio waves, making non-line-of-sight contacts possible. Many times two sideband stations who cannot communicate with beam antennas pointed toward each other will choose a high peak to act as a reflector for their radio waves. Just as soon as both stations point their antennas at that peak, communications magically appear. It's been found that hillsides bare of foilage make better reflectors than do mountains covered with trees. Tall buildings are also good reflectors.

The next range-extending phenomenon of 2-meter sideband is the thermal inversion. Normally, air temperatures decrease as altitude increases. Occasionally, local weather conditions will create "thermals" — a horizontal band of warm air trapped between cooler air on the surface of the earth and cooler air at higher altitudes. In large cities where smog is prevalent (where isn't it!) you can literally see the thermal inversion layer approximately 300 meters (1000 feet) above land surfaces. The thin band of warm air traps 2-meter signals and carries them a considerable distance, allowing for short-range DX contacts. Sometimes these conditions will last several days if an associated high pressure system is stationary in the area. Along the seacoasts of the Atlantic, Gulf, and Pacific regions, thermal inversions are quite common. Texas stations commonly work Florida stations over the Gulf via the inversion. Stations in Massachusetts easily converse with those in the Chesapeake Bay area through the inversion. San Diego stations freely communicate with San Francisco stations via inversion layers. The inversion layer acts so well as a radio pipeline on 2 meters



If you want to stack antennas for more gain and greater DX, you can buy the feed harness from the manufacturer of the antenna. This set of four KLM Yagis will do a good job of reaching beyond the horizon for consistent DX.

that many times only 1 watt of power is necessary to communicate over distances beyond 300 km (200 miles)! Take a look outside — you might see an inversion layer right now!

The next range extending element that affects 2 meters is tropospheric ducting. High-altitude jet streams carve channels into the atmosphere that literally trap the 2-meter waves and sends them up to 5000 km (3,000 miles) away. The ends of the ducts are quite sharp, and may terminate at different altitudes. Recently, in California, there was an excellent duct between the Hawaiian Islands and Southern California. To "access" the duct in Southern California, we needed to follow it north at about five miles an hour, slightly above sea level. A Pacific Coast Highway for mobile 2-meter sidebanders was the answer! When the signals got weak, we simply drove farther north. However, whenever we started to drive up a hill, we found that we were out of the duct!

On the Hawaiian end of the duct, the exit elevation for the California signals on 2 meters was about 3200 km (2000 feet). Anyone higher or lower didn't hear any trace of the signals coming in from the states! This duct finally worked itself north to San Francisco, and then finally disappeared — after giving 2-meter sidebanders two and a half days of real DX!

Tropospheric ducting is a common occurrence on 2 meters, and once the "path" is established, less than 10 watts of power is all that is necessary to keep the communications going. At times fm simplex contacts are possible via one of these ducts.

Every month some reports are heard about two stations communicating over great distances via a tropospheric duct. You simply have to be patient and do a lot of listening, and wait for the right conditions to happen at your end of the circuit. Both tropospheric ducting and thermals can occur any time of

Members of the Side-Winders On Two (SWOT) organization get together for a visit, and to check into a distant net to see how other sections are doing.

the year, generally peaking in the early morning and early evening hours.

The next propagation characteristic to extend the range of 2-meter sideband stations is E skip and F skip. Although not as common as atmospheric refraction and reflection of radio waves, sporadic E skip, which you are all familiar with on lower frequencies, may many times reach a MUF (maximum usable frequency) beyond 145 MHz. Generally, summer is the best time to expect E skip, and as we approach the peak of solar cycle 21 in 1981, we possibly might encounter some intercontinental skip. With sporadic E skip, it's easy to work up to 5000 km (3000 miles) away. We might even be able to communicate overseas during an intense opening. Keep tabs on the solar cycle and the current sunspot count, and when 10 meters opens up solid, take a listen up on 2. You might catch some good skips. For those of you in the northern latitudes where you can see the spectacular Aurora Borealis, try aiming your antenna at this electronic radio reflector for some interesting contacts many thousands of miles away.

The ultimate in 2-meter DX is via meteor scatter and moonbounce. Here is about the only case where you'll need that kilowatt and directive arrays with gain figures of better than 20 dB. Although CW is a great deal easier to copy via meteor and moonbounce contacts, sideband has been used. There's probably no greater thrill as an amateur radio operator than to aim your antenna at the moon, transmit a series of dits, and hear the dits echo from the moon two and a half seconds later!

Organizations and awards

"Side Winders on Two" is the largest organization of its kind, dedicated to 2-meter weak-signal reception, the study of propagation on 2 meters, and the growth and development of 2-meter simplex communications. Barely over a year and a half old, SWOT has well over 1500 members and publishes an extremely informative newsletter each month. This newsletter reports the latest band openings between different points in the United States, the current news about fm activity and how it could effect the single sideband band plan, as well as other timely subjects on how to improve your own

An array of two-meter Yagis, with the smaller 432-MHz antennas inside, can be tilted to follow an OSCAR satellite or the moon.

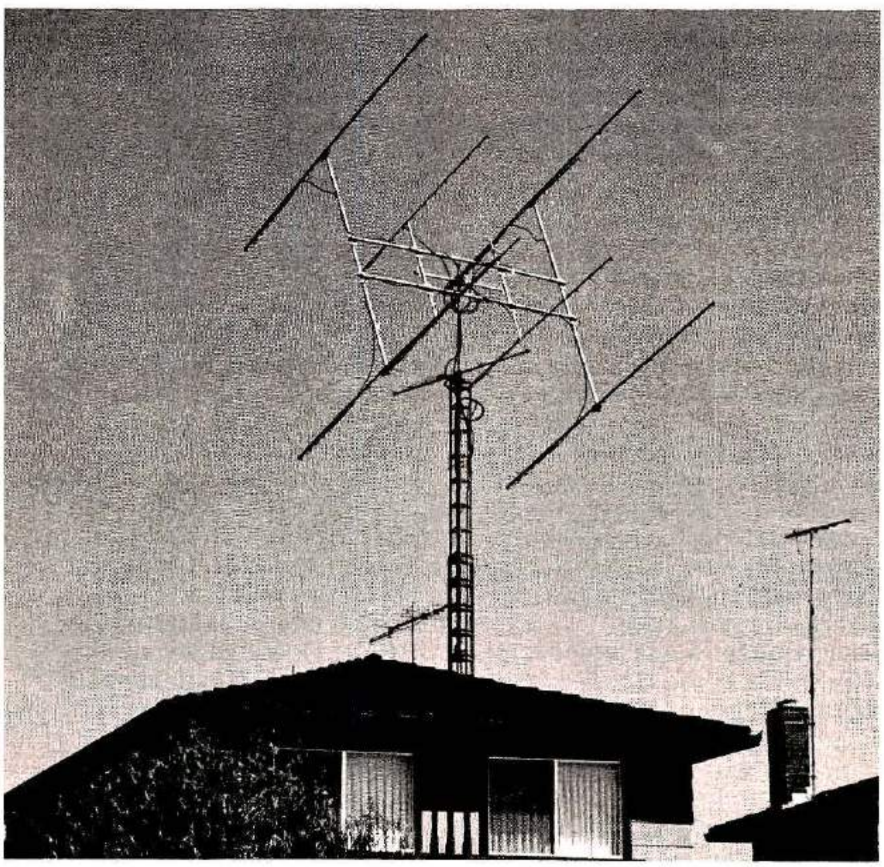


Table 1. Times, frequencies, and locations of 2-meter nets held by members of the Side Winders On Two (SWOT) in various parts of the country. You can join them, or you can listen for the distant stations as an indication that the band is open.

Day	Net Name	Net Control		Local Time	Frequency	Area
Sunday	Kansas SWOT	WBØRIN	(WBØNRV)	9:00 AM	145.150	Wichita
	South Tier NY SWOT	WA2GBG		11:00 AM	145.100	Western NY
	Arizona SWOT	K7CVT		8:30 AM	145.100	Arizona
	Iowa SWOT	WBØNZA		8:00 PM	145.150	Central Iowa
	Kansas SWOT	WBØNRV	(WBØRIN)	9:30 PM	145.150	Wichita
	Minnesota SWOT	WØKRX	(KØOK	10:00 PM	145.150	Minneapolis-St. Paul
Monday	South Texas SWOT	W5DN	(W5UWR)	9:00 PM	145.150	Houston
Mon-Wed-Fri	Sandlappers Net	WA4MVS		9:30 PM	145.110	South Carolina
Mon-Wed-Fri	West Tennessee SWOT	W4CRU		9:00 PM	145.100	Memphis
Tuesday	Nebraska SWOT	KØPAY		8:30 PM	145.150	Lincoln-Omaha
	North Carolina SWOT	K4CAW		8:00 PM	145.100	North Carolina
	NORCAL SWOT #1	K6PXT		8:00 PM	145.150	North Bay Area
	SOCAL SWOT	WA6OPX	(K6WK)	8:00 PM	145.050	So. California
Wednesday	Michigan SWOT	WB8UZR	(WB8NSI)	8:00 PM	145.100	Central Michigan
	Lake Ontario Intn'l	WB2ELB		9:00 PM	145.100	Northwest New York
	Kansas City Area	WBØWFY	(WBØBOE)	8:00 PM	145.150	Kansas City
	Headquarters SWOT	K5ASZ	(W5JTA)	9:00 PM	145.150	Dallas/Ft. Worth, Texas
	NORCAL SWOT #2	W6GGW		8:00 PM	145.150	Sacramento-San Joaquin
Thursday	Gulf Coast SWOT	WB5LBT	(W5UCY)	9:00 PM	145.100	New Orleans
	E. Oklahoma SWOT	K5SW	(K5CM)	9:00 PM	145.150	Muskogee
	NORCAL SWOT #3	W6WOY		8:00 PM	145.150	South Bay Area
Friday	SEKAN SWOT	WØQOA		8:00 PM	145.100	Southeast Kansas
Saturday	Early Bird SWOT	WB5PTT	(WB5NLB)	7:00 AM	145.150	Dallas/Ft. Worth, Texas
	Headquarters SWOT	K5ASZ	(W5JTA)	9:00 AM	145.150	Dallas/Ft. Worth, Texas
	Miss-Lou SWOT	WA5TUD	(W5JTL)	8:00 PM	145.150	Mississippi & Louisiana
	Central Florida SWOT	W4YYS		9:00 PM	145.100	Central Florida
Daily	Local	WB5JWL		Midnight	145.100	Houston, Texas

2-meter ssb set up.

The SWOT organization, dedicated to 2-meter sideband operation, is *not against* 2 meter fm activity — but rather they are concerned with the possible spread of repeaters in the lower half of the 2-meter band. SWOT members simply want to avert any confrontation between SSBers and FMers. Technician Class amateurs are recognized by SWOT for their outstanding ability to find new and innovative ways for furthering DX operation and range. SWOT is *the* organization to belong to if you're interested in 2-meter sideband DX. For more information on joining, write SWOT, 3530 Livingston, Fort Worth, Texas 76110.

Another excellent organization made up of 2-meter DX enthusiasts is the Central States VHF Society. It, too, promotes an exclusive "window" for 2-meter weak-signal operation. Although the ARRL has no specific awards for 2-meter DX, they will endorse a *Worked All States* certificate for 2-meter work. SWOT also has a handsome certificate that is issued for working ten fellow SWOT members, as well as endorsements for additional multiples of 25 members worked. The Florida chapter of SWOT has a beautiful "Sunshine Certificate" for working 25 Florida SWOT members.

Some of that DX sounds exciting, doesn't it? Take a look out your window now and look for a thin line of smoke at an altitude of about 300 meters (1000 feet). Imagine your 2-meter signal travelling along that line many hundreds of miles for reliable low power DX contacts. "When I switched from fm to sideband on 2 meters, it was a quantitative jump for me," claims a New England fm operator who formerly used nothing but repeaters. "No more squelch tails; no more waiting for the machine to re-time itself in; no worry about someone else wanting to use the channel; 2-meter sideband is a blessed relief." I think you'll find most of the operators you'll meet on 2-meter ssb helpful and friendly. For those of you with multi-mode equipment, switch over to upper sideband on 2 meters and take a listen around 145.1 MHz. Even with a vertical antenna, I think you'll find a hearty welcome.

And once the sideband bug bites, jump up on the roof and swing that beam over to horizontal, and stand by for some far reaching DX. You'll find the operators polite, and most of your contacts will be armchair copy with little or no QRM. It's an exciting band and mode — so give it a try soon!

Gordon West has been licensed since 1964, and holds an amateur Advanced-class license. Most of his activity is on 2-meter sideband, and he is only two states away from WAS. Gordon originally started his ham radio career on 2-meter a-m as a Novice, when phone privileges were permitted back then! **HRH**


BEWARE OF THE BEAST
32
"Have you seen my shack?"
WD8KQN
S. GRAY '78

BY JOHN MASSON, WD8KQN

It's late in the afternoon. I'm tired after a long day. The kid down the street bicycled to my house and introduced himself.

"Hi. I'm Rob. I noticed your antenna. Are you a radio ham?" I recognized him as the local paperboy. I invited him inside.

"Oh, yeah, Rob. You've never seen my shack, have you," I said, wiping my brow.

"No, I haven't. And as far as I'm concerned, I'd rather play baseball," he said, plopping his mitt down on my dresser.

"Well, don't jump to conclusions — you've never seen a real ham shack, have you?" As I said this I pushed him toward the basement steps. (I've always liked a basement shack. It's a special blessing in the summer when the mercury can soar over one hundred. That kind of heat makes operating anywhere except the basement miserable.)

When we reached the bottom of the stairs, Rob said, "John, I have a confession to make. I'm a CBer."

He glanced at me as if to say, Oh brother, now I've done it. But relief showed on his face when I said, "Oh, good! That means you've had at least a little experience with radio."

Rob looked mystified and said, "But I thought hams hated all CBers!"

I tried to suppress a laugh. "Well, there's one thing I can clear up right now. Hams, as a group, think of CBers as a gold mine of potential hams, so we try to get as many of them as possible into amateur radio."

"Great," said Rob, without much conviction. We entered the shack.

The ham shack

"Well, here it is, Rob. Shack, sweet shack," I commented. "It's from here that all those little beeps originate that drive everyone else in the house batty."

"Wow!" exclaimed Rob. "*Look* at all this *stuff*! Without you the knob industry would go bankrupt!"

What Rob was so excited about was a vintage Heathkit DX 40, an Allied Knight receiver, and an HG 10B variable frequency oscillator (VFO). Actually, the most modern piece of equipment in the shack (except for the light bulb) was the VFO.

"What's this?" inquired Rob, fingering my old tube type CB set.

"That's a CB," I said. "I use it to monitor the emergency channel."

"Oh, neat! I've never seen one like this before."

Rob seemed intrigued by all the equipment. Good, I thought. I could tighten the net a little more. "You know, Rob, if you're really interested I can show you how to become a ham."

Rob looked incredulous. "Well, I don't know. How far can this thing go?"

"Depends on the operator and the power. We can run two kilowatts." (I said this without qualification.)

"Two watts!" he scoffed, "How far do you expect to get with two watts?"

"Two watts have been known to reach people around the world. But I said *two kilowatts*. That's *two-thousand watts*."

Rob turned pale. "Two-thousand watts! Two-thousand watts!" he kept repeating. "Two-thousand watts? . . ."

Rob seemed rather dazed and kept mumbling as I tried to explain how to become a ham. I tried again.

"Rob, it's no big deal. You don't have to be anything special to become a ham. All you have to do is pass a test."

Rob was still in shock. "Two-thousand watts! Two-thousand watts!"

"Rob," I said, "are you okay? Snap out of it!" I shoved a Pepsi into Rob's trembling fingers and continued. "As I was saying, Rob, you don't have to be anything special to become a ham. All you have to do is pass a test, and a rather simple one at that."

Rob took a swig of the Pepsi and said, "Right on! You *don't* have to be anything special to become a ham. You're one, aren't you?"

I leaned back. "Cute, very cute. But I'm serious, Rob. All you have to do is pass a Morse-code test of five words and . . ."

Rob said, "Hold it, buddy, right where you mentioned Morse code the deal is off. It took me three weeks to learn the five letters of Morse code to earn my merit badge. No thanks."

Patiently I said, "Rob, this is different. I can give you a tape that'll help you to learn code by sound. Then there's the test on basic electronics —"

"But John," cried Rob, in terrible anguish, "I don't know a thing about electronics!" He paused. "Besides, where would I get lessons?"

"Oh, gee, don't worry about that. We hams always like to —"

"Oh, great, I knew you would!" exclaimed Rob, dancing about on the floor and almost knocking over my operating table.

"Uh — leadfoot," I added, dryly, "maybe you should see your ballet teacher. Or an orthopedic surgeon. Anyway, how about going back upstairs? I don't particularly like you standing on the concrete floor of my basement with the *Beast* on. The Beast is that thing's name." I pointed to the rig.

"Why not?" inquired Rob.

"Well, you'll find out soon enough. Rob, don't touch that key — unless, of course, you like the smell of fried Rob skin." I gently pushed him out of the shack.

Ham radio

As we mounted the stairs to the ground floor, I briefly explained what ham radio was all about: the unusual thrill of DX (which I don't really know all too well, never having worked any); the thrill of hearing your call letters come back to you from some distant shore; the satisfaction of tracking down your own rig's problems and being able to put them right. I also discussed about the just plain *fun* of Field Day, where you are out in the middle of nowhere.

When we had reached the living room I could see the glimmer in Rob's eyes, a sign that I had perhaps hooked a live one.

Rob settled himself in my favorite chair. "All right," he asked, coming to the point in the blunt fashion that was all his own, "where do I start?"

I said, "Well, you can start by getting a couple of books. The one I liked best is called *Tune in the World with Ham Radio**. The American Radio Relay League puts it out, and it costs about seven dollars. It comes with a —"

I was interrupted by an astonished cry. "Seven bucks? That's ridiculous. Just for a book? Where am I going to get that kind of money?"

"Rob, it's not just a book, and even if it were I would still pay seven dollars for it. It's got to be the best publication you can get for breaking into amateur radio. And it consists of a tape, a book, and a map with the numbers of the various call-letter zones, or ham licensing areas, in the United States. The map's just to get you moving, because what are you going to do with a map of the United States that has all the numbers of the call zones if you don't get your ticket?"

"Well, maybe you're right, it *is* worth it. If it could teach a dummy like you how to become a ham, it can teach *anybody*!"

"Ah, yes, cute kid . . . Have you ever thought of going on Johnny Carson's show? Look, why don't you just go up to the bookstore and get that book and another one, um, *Learning the Radiotelegraph Code*? While you're doing that I can choke down this fishstick, which is currently on fire." I ambled over to the oven, "Call me in about an hour."

Rob saluted. "Yes, sir!"

"Get out! Out!"

Rob left rather ungracefully. He tripped over the door jamb as he went, then hopped on to his ten-speed and sped off toward the bookstore. Meanwhile, I sat down to dinner.

Sure enough, one hour later to the minute, my phone rang.

"Hello?" I croaked into the receiver. I was still getting over the fishstick. "Oh, hi Robert. What? Oh, sure, come right over. Bye!"

Moments later there was a furious knocking at the door.

"Come in," I called feebly.

Rob burst into the room. "See?" he said, thrusting a pair of books at me. "I got the books you wanted me to!"

The learning process

"Good!" I cried, "Now we can get started! I've a code oscillator and key you can use — if you work, say, fifteen minutes a day, you'll be up to five words per minute before you know it."

"I sure hope so. And if I'm not, I'll go crazy trying!"

Although you wouldn't know it to look at his last grade card from school, Rob was a good student, who learned fast. After school every day Rob came to my house and I taught him basic electronic theory. I threw questions at him and he threw Jujubes at me. Ah, the joys of friendship!

Eventually I felt Rob was ready to take the Novice amateur test. It got to the point where I would ask questions in so many different ways I wondered if I, when asked the same questions, could answer them correctly. I doubted seriously whether the FCC could come up with a test as difficult as the one I gave Rob the day we ordered his test papers.

I had another ham friend lined up to give Rob the amateur test. (I have a few years and one class of license to go before they'll let me give a Novice test!)

The big day arrives

My phone buzzed persistently, jarring me into consciousness. It was early in the morning — *really* early, about 5 AM. "Hello?" I said, "Whoo zis?"

The voice at the other end was (you guessed it) none other than that of dear old Rob. I said, "Why are you calling me at this ungodly hour? I know this is the big day, but . . ."

Rob was really hyped. He said, "Well, you know how it is. Man, I've been thinking about the test. I didn't sleep a wink! I was too busy trying to figure out what the test is like."

*Available from Ham Radio's Communications Bookstore, Greenville, New Hampshire 03048; order AR-HR, $7.00.

"I wouldn't worry too much, Rob," I said. "You had me for a teacher, so how can you possibly fail?"

An inarticulate noise at the other end of the line: "Why did you have to say that?" moaned Rob, "Now you've destroyed all my confidence!" The conversation was cut short rather hastily by a harsh bark from upstairs.

Later that morning I was in the shack, trying to work some DX, when the phone rang again.

I rushed upstairs, grabbed the phone, and heard Rob's voice.

"Hello, Rob," I said in a monotone, "What is it now?"

"Well, I have two pieces of good news. Glen (my ham buddy, who was giving Rob his test) told me I was a cinch to pass the test. He said also he'd let me have his old rig really cheap — he's getting a new one."

"That's great, Rob!" I exclaimed. "What kind of rig is it?"

"A DX40," came the reply.

I moaned. "Oh, I don't believe it. I really don't."

"What's wrong, John"

"I think the two of us have the only DX40s left in the state, that's what's wrong!"

"Oh, yeah. I almost forgot about the Pig!"

"The Beast, Rob, the Beast. It's a nice little rig. I think you'll like it."

Rob said, "Yeah. I know how that receiver you gave me works — as well as any receiver I've ever owned. Anyway, at least we'll be equal when I beat you in the next contest."

Sputtering into the receiver, then, "We'll see about that!" I said.

Yes, we most surely would.

The waiting period

We spent a rather suspenseful six weeks waiting for Rob's license to arrive. I say we, because I was in as much agony as he. I realized now that my strangely phrased challenge was rather rash — I didn't even know what kind of operator Rob was.

I think it's true that some people are born operators. Although I certainly am not one of them, I had no way of knowing whether or not Rob

fell in that category. And if he did, I had figuratively "tied my own noose."

I figured I'd better get cracking on my general — I could imagine what it would sound like at the radio club if Rob beat me. And the fact that I had challenged him would make it doubly embarrassing. Yes, I was indeed in trouble.

Success

Rob's license finally arrived — and you can bet that he clucked over it like a chicken that's just hatched her first egg! Rob rushed right downstairs to his shack with me hard on his heels.

Rob turned on his transmitter as he screeched to a stop in front of his operating table. He chewed on his thumb as he waited for the rig to warm up. Seconds passed like hours. Finally Rob put his hand forward and grasped the big, shiny navy key, just as the book had shown him.

"Dah- di- dah- dit, dah-dah-di-dah." Over and over again, "CQ CQ CQ de WD8TOT WD8TOT WD8TOT, AR K."

Calling anybody, calling anybody. This is Amateur station WD8TOT, end of message, go ahead, please.

And the almost instant reply:

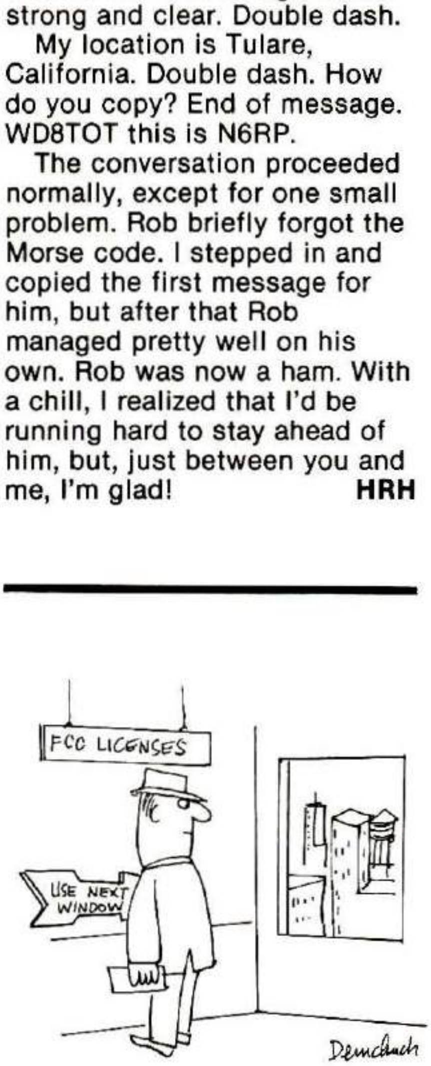
"WD8TOT de N6RP. GA OM BT NAME GEORGE, GEORGE BT UR RST 599 599 BT QTH IS TULARE, CA TULARE CA. BT HW? AR WD8TOT de N6RP K."

Translation:

WD8TOT this is N6RP. Good afternoon, old man. Double dash, my name is George. Double dash. Your signals are strong and clear. Double dash.

My location is Tulare, California. Double dash. How do you copy? End of message. WD8TOT this is N6RP.

The conversation proceeded normally, except for one small problem. Rob briefly forgot the Morse code. I stepped in and copied the first message for him, but after that Rob managed pretty well on his own. Rob was now a ham. With a chill, I realized that I'd be running hard to stay ahead of him, but, just between you and me, I'm glad! **HRH**



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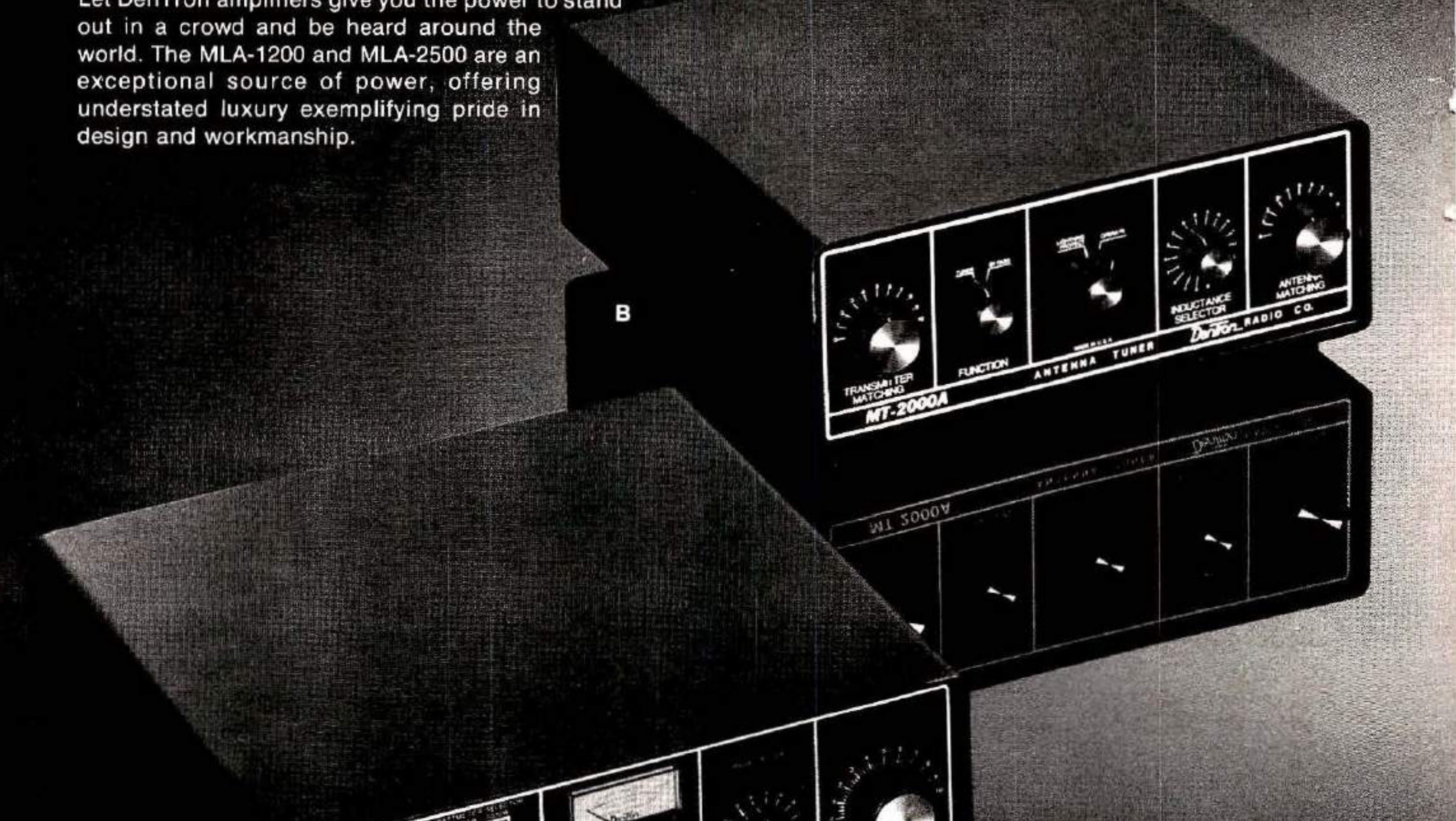

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a guide to ham slang

Barefo[illegible] Operating a low-power transmitter without any extra high-power amplifier. Amplifiers, therefore, can be called a "pair of socks," or a "pair of shoes." An amateur building his own amplifier might say he was "knitting a new pair of socks."

California kilowatt: A transmitter running in excess of the legal amateur power limit of 1000 watts.

Gallon: The legal maximum power of 1000 watts (kilowatt of kW). A "Novice gallon" would be 250 watts.

Jugs: Large high-power vacuum tubes, frequently used in pairs. A ham with a commanding signal might justifiably brag about having a "nice pair of jugs" in his amplifier.

Rockcrusher: A station which puts out an extraordinarily powerful-sounding signal, frequently due to a kilowatt and a big, efficient antenna.

Tin ear: Another telegrapher's malady, usually attributed to overwork or being hungover. Frequent errors in copying CW are attributed to having a "tin ear."

BY DOUGLAS STIVISON, WA1KWJ

With the CB boom, dictionaries and glossaries of CB terms are sprouting up everywhere — from printed paper placemats in highway greasy-spoon restaurants, to slick hard-covered books. The slang of radio amateurs, although much older than that of the CB, still seems a virtual foreign language to many short-wave listeners and beginning amateurs. While technical words, standard Morse-code abbreviations, and commonly used Q-signs are listed and explained in dozens of handbooks and pamphlets, the colorful amateur slang has seldom been committed to print.

For those of you who think that a twisted pair is a reference to Bonnie and Clyde, here is one ham's guide to hamese.

Armchair copy — effortless, perfect reception without noise, interference, or fading.

Barefoot — operating a low-power transmitter without any extra high-power amplifier. Amplifiers, therefore, can be called a "pair of socks," or a "pair of shoes." An amateur building his own amplifier might say he was "knitting a new pair of socks."

Big gun — any well-known operator who consistently puts out a commanding signal, works lots of DX, or is a frequent winner in ham contests.

Big switch — imaginary control which takes a station off the air. To "pull the big switch" is to turn the rig off in order to go to bed for the night. Some stations will actually have a master station-power switch as a safety precaution.

Bootleg — any illegal operation such as running too much power or operating without a license.

Brasspounder — a Morse-code enthusiast. Derived from the brass lever and parts used on early telegraph keys.

Bug — neither an insect nor a hidden listening device. It is a semi-automatic telegraph key which automatically forms the dots with a vibrating contact. Dashes are made manually.

Bunny hunt — an outdoor competition in which amateurs using direction-finding (DF) equipment track down a hidden transmitter ("bunny"). Also called "Fox Hunts." It is a particularly popular sport in Europe.

California kilowatt — a transmitter running in excess of the legal amateur power limit of 1000 watts.

Cans — headphones.

CW — Morse-code radiotelegraphy. Originally derived from an abbreviation for continuous wave — a major improvement over more primitive ways to transmit Morse code.

DX — amateur radio stations in foreign countries or at a great distance. Thus a "DXer" or "DX hound" is one who enjoys working foreign stations. A "DXpedition" is a trip with the goal of putting a station on the air in a rare or hard-to-work foreign country.

Fist — a telegrapher's personal style and rhythm of sending. It can be as distinctive as one's handwriting or even one's voice.

Gallon — the legal maximum power of 1000 watts (kilowatt or kW). A "Novice gallon" would be 250 watts.

Glass arm — a pain and stiffness in the arm from long hours of sending CW. A CW man whose sending is choppy or full of errors is said to have a "glass arm."

Handle — one's name.

Harmonics — an amateur's children. Derived from a pun based on the technical word for signals which are generated by, and related to, other signals.

Hearing aid — a ham's receiver.

Hilltopping — taking a portable ham rig to some remote location in order to exploit the range-boosting effects of increased elevation. Hilltopping is popular on vhf for contests or DXpeditions.

Home brew — homebuilt, as in "I home brewed the rig." A variant is, "I rolled my own receiver."

Jugs — large high-power vacuum tubes, frequently used in pairs. A ham with a commanding signal might justifiably brag about having a "nice pair of jugs" in his amplifier.

Junkbox — a ham's supply of spare parts and homebrewing supplies. Frequently, a junkbox actually describes an amateur's basement and garage filled with old TV sets and war-surplus gear, all of which will come in handy "some day."

Kilowatt alley — the lower segments of the twenty-meter phone and CW bands, traditionally dominated by the big-guns, rockcrushers, and California kilowatts. Definitely an uncompetitive part of the amateur spectrum for the less-well-equipped fellow running 20 watts and a dipole.

Landline — the telephone. Also called the "twisted pair."

Lid — a discourteous or poor operator.

Lunchbox — any small, portable rig. A "Benton Harbor Lunchbox" was one very popular early Heathkit transceiver.

MARS — Not a planet, but the Military Affiliated Radio System of amateur traffic handlers using military frequencies adjacent to the ham bands.

Mill — typewriter. Most CW operators find it much more convenient to transcribe high-speed CW on a mill than to use a pencil and paper ("sticking it").

Old man (OM), Old boy (OB) — any male radio operator. *The Old Man* refers to Hiram Percy Maxim, amateur radio pioneer and founder of the ARRL.

OSCAR — *O*rbital *S*atellite *C*arrying *A*mateur *R*adio Any of the communications or beacon satellites built and operated by radio amateurs.

Peanut whistle — any very low-powered rig.

Phone patch — a device to connect an amateur radio station with the commercial telephone lines. When international telephone service is either unavailable or prohibitively expensive, phone-patching frequently becomes the only practical way for missionaries or overseas military personnel to contact their families back in America.

Pinning the meter — making a meter give a full-scale reading. Usually it refers to a signal which is so strong that the receiving station's S-meter can give no higher reading.

Reading the mail — listening to conversations taking place over the air without actually participating in them.

Rig — one's radio equipment. Whether it describes a one-tube home built set or a collection of a dozen fancy commercial units, a ham's radio is always called his "rig."

Rocks — crystals used to control one's transmitter frequency. To be "rockbound" does not refer to the scenic characteristic of the coast of Maine, but to an amateur's inability to change frequency due to a finite collection of crystals.

Rockcrusher — a station which puts out an extraordinarily powerful-sounding signal, frequently due to a kilowatt and a big, efficient antenna.

RTTY — (pronounced *ritty*) amateur radioteleprinter. *Teletype* is a registered trade name of the Teletype corporation.

Shack — the room housing a ham station, whether a king's palace, a ship at sea, a basement corner, or a tenement kitchen.

Sked — schedule.

Sideswiper — any semi- or fully automatic telegraph key using a sideways rather than an up-and-down movement.

Sky hook — a ham's antenna.

Straight key — the traditional up-and-down type of telegraph key.

Tin ear — another telegrapher's malady, usually attributed to overwork or being hungover. Frequent errors in copying CW are attributed to having a "tin ear."

Top band — the 160-meter ham band.

Traffic — messages carried via amateur radio, generally as a public service for non-amateurs. Handling messages is a popular facet of the hobby, attracting many dedicated amateurs who get together in traffic "nets" (short for networks).

TVI — television interference. Also called "Tennessee Valley Indians," or simply "Indians." Interfering with a neighbor's TV reception causes poor public relations for amateur radio and should be avoided if at all possible.

Wallpaper — the collection of certificates, awards, and QSL cards decorating a ham's shack.

Wouff-Hong — the ultimate amateur-radio torture instrument for those causing unnecessary interference. It was originally mentioned by *The Old Man* (Hiram Percy Maxim) in a facetious *QST* magazine editorial decrying rotten QRM (interference). Other fearsome amateur-radio torture instruments are the Rettysnitch and the Uggerumph.

XYL — an amateur's wife, derived from ex-young lady. "YF" is also an abbreviation for wife.

YL — a young lady or any woman radio amateur friend, or relative, regardless of age.

Zulu — Greenwich Mean Time, GMT, Co-ordinated Universal Time. The universally-understood time system used in all international amateur and scientific work to avoid confusion due to differing local times. Based on the zero meridian at Greenwich, England.

73 — best regards. The ham's traditional way of saying goodbye or ending a message. Note that 73 is *always* singular, never plural (73s).

807 — ubiquitous transmitting tube of World War II and immediately afterwards. Today it often means a bottle of beer, as in "After we got the antenna installed we knocked off a case of 807s."

88 — love and kisses.

HRH

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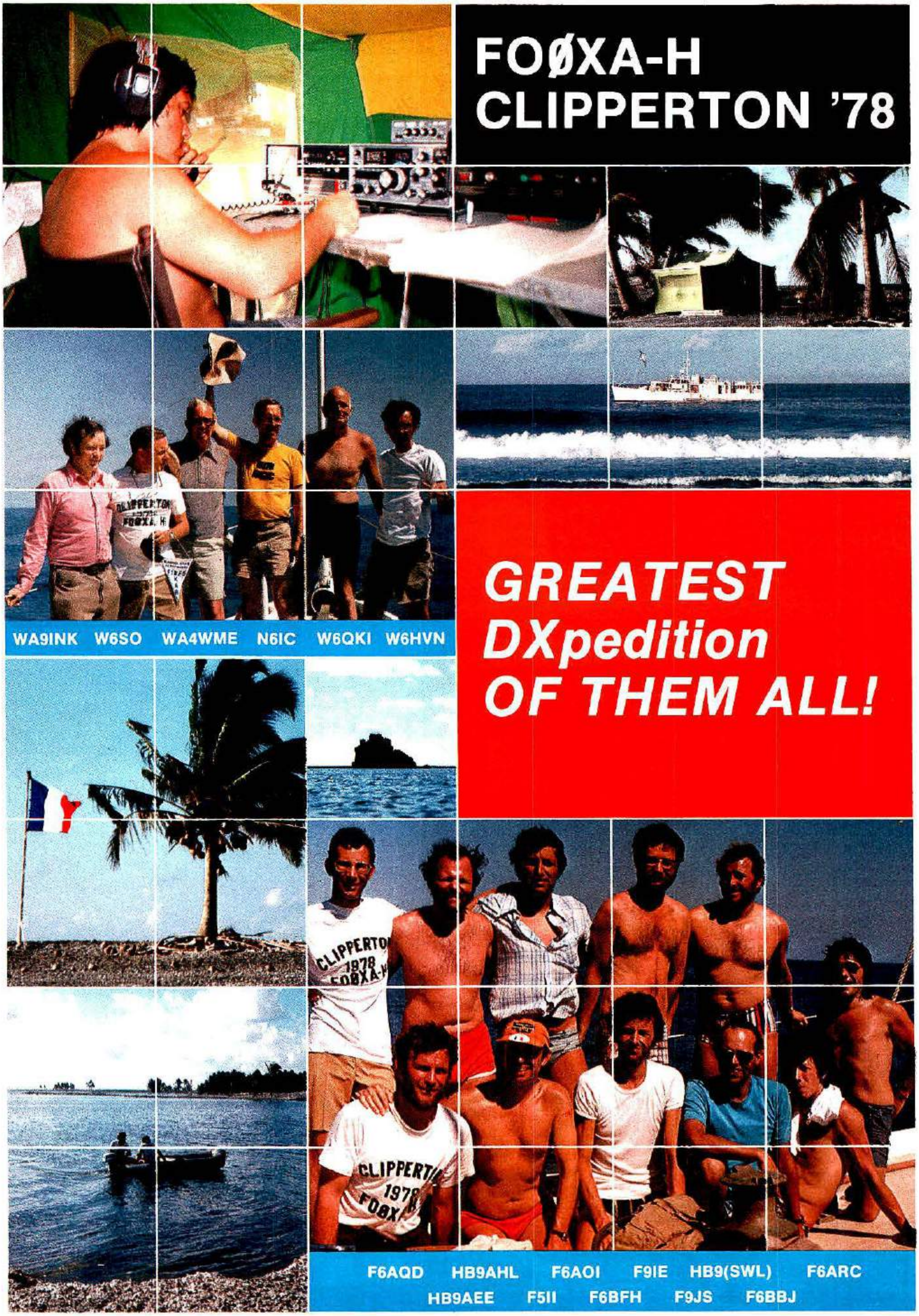
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ATLAS 350-XL
Champion of Clipperton!

If you were one of the fortunate 29,069 hams who worked Clipperton Island in March of 1978, you've worked an Atlas 350-XL transceiver. The 350-XL was selected by the DXpedition logistics team, headed by Don Bostrom, N6IC, because it had all of the necessary features required for the operation contained in one compact package. This included primary and auxiliary VFO's for split frequency operation, digital frequency display with accuracy of ± 50 Hz, VOX for SSB and full break-in for CW, sidetone, more than 200 watts output (twice that of most other transceivers), all solid state design permitting efficient operation from a storage battery if necessary. And above all, rugged design and construction that permits hour after hour of continuous operation without failure.

> ***"The 350-XL is a fine, rugged transceiver . . . even works after a salt water bath. . ." Willy, HB9AHL***

strictly 20 meters 'round the clock for 7 days, SSB and CW. It included a Dentron MLA-2500 Linear which was used much of the time to break through to Europe and other distant points. The antenna was a Wilson 4 element monobander about 30 feet high. Power was supplied by a 2500 watt Honda gasoline generator. This station ran continuously for 7 days, and made 11,158 contacts! Problems, zero!

> ***"Unbelievable performance and reliability under extremely adverse portable conditions and constant use by DXpedition multi-operators . . ." Hugh, WA4WME***

Incidentally, we took one box ashore which contained 3 fans. They were intended for blowing air on the transceiver heat sinks. The box is still on the island, unopened! Ambient temperature outside was 85 degrees F. Inside the metal building? Up to 95 degrees!

15 using a Wilson 3 element monobander. No linear was used at this station because the generator would not provide enough power.

So, if you heard Clipperton on 15 or 40 meters, it was strictly barefoot. A Dentron MT-3000 tuner was used with a KLM vertical on 40 meters. Station Number 3 ran all week on a generator that delivered 155 volts AC when receiving . . . and only 75 to 90 volts during transmit! We were unable to adjust the problem, so simply let it go. Didn't bother the rig. Total contacts on 15 meters numbered 7194, second only to 20 meters! 40 meters netted 2450 contacts.

This report hardly is complete if we don't mention 6 meters and Oscar. N6IC and W6SO were the Oscar specialists. Unfortunately, some equipment difficulty (not Atlas) limited Oscar contacts to only 20. Rather disappointing, but the best we could do, and the guys really tried. 6 meters just never produced an opening. We monitored everyday without ever hearing a signal.

> ***"I cannot say enough about the excellent performance of the Atlas equipment. Under the most trying conditions of operation the gear came through with flying colors. With 16 operators pushing switches and twisting knobs 24 hours a day for 7 days, the equipment never faltered. Truly remarkable. The success of the DXpedition was due in large to the faultless operation of the 350-XL . . ." Hoppy, W6SO***

One very important point we want to make clear . . . the Clipperton DXpedition was financed by the 16 operators who went there, and by many generous donations from DX clubs, radio clubs, individual hams, and others. Atlas Radio was not a financial sponsor, except to the extent of loaning equipment. Other manufacturers provided similar support.

> ***"As equipment logistics manager, my selection of the Atlas 350-XL proved to be the perfect choice . . ." Don, N6IC***

Needless to say, we at Atlas Radio were very pleased when the team chose the 350-XL as the transceiver for all 3 stations. At that point, how could I (W6QKI) turn down the invitation to join the team, and to share in a tremendous adventure? Did I go along to keep our radios working? Well, truthfully I brought along a box full of spare parts and pieces. Happily I can report that the box could have stayed at home. And there are 15 witnesses who will verify this. Their unanimous and whole hearted endorsement of the 350-XL is most gratifying.

Many of you will be interested in how the 3 stations were organized. Number 1 station was set up in the metal Quonset-type building which the French put up in 1957 during the IGY scientific work conducted on the island. This station worked

Station Number 2 was located about 200 feet from Number 1, and was set up in a tent. It worked 10 meters daytime, 80 and 160 meters at night. A Dentron MLA-2500 Linear was used, mainly on 80 and 160, some of the time on 10 meters. A 3 element Wilson monobander was used on 10. A doublet was used on 80 meters, later changed to a Delta loop by F6ARC, a KLM vertical with ground radials worked very well on 160 meters. A Dentron MT-3000 antenna tuner was used on 80 and 160. Power was supplied by a Sears 2200 watt generator. This station averaged 21 to 22 hours operation each of the 7 days. Problems? The digital frequency display made signs of acting up. One of the IC's was replaced. A 5 minute job. The rig had been liberally sprayed with salt water on the trip in through the surf, as also was the Dentron linear. Total contacts from station Number 2 were 6401 on 10 meters, 1644 on 80 meters, and 202 on 160 meters.

> ***"Clipperton: The best location for DXers. Atlas 350-XL: The best equipment for hardest DXpedition. Result: One of the best DXpeditions ever . . ." Jack, F5II/FO0XB***

Station Number 3 was located in a tent about 300 feet (and 5000 crabs) from Number 2. It operated on 15 and 40 meters. Foreign broadcast QRM was very rough on 40, so most operating time was on

All in all, we feel the performance record on the HF bands is something to brag about, and hope you'll pardon us for indulging. One final thing to boast about was really unexpected. The ride through the surf back to the ship was quite a ride. Everyone, and everything thoroughly soaked. Much of the gear was full submerged. But all 3 of the 350-XL's worked normally after drying out! Being very low on fresh water we could not afford to wash the gear down. All we could do was dry them out in the sun. Obviously, as soon as we got back we had to wash out the salt and clean the sets up. But, they were used "maritime-mobile" on the trip back to San Diego.

The Clipperton '78 DXpedition was undoubtedly the biggest expedition and adventure of its kind ever put together, and turned out to be a smashing success in all respects. All the gang at Atlas is mighty proud at how well the 350-XL proved itself, truly a great performer; a real classic that will set the pace for years to come.

73 Herb Johnson W6QKI

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VHF ANTENNA MATCHING

BY THOMAS McMULLEN, W1SL

The instruments, the hardware, the procedure, and the reasons

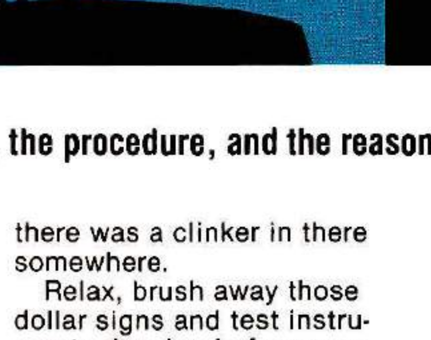
You've finally done it — you liked the looks of that multi-mode two-meter rig they had in the showcase down at your local radio emporium, and the terms offered by the salesman were too good to pass up. Besides, you've been hearing from all your buddies at the club meeting how much interesting activity there is on two meters these days: repeaters, simplex, fox hunts, OSCAR, SWOT nets, and the like. You only need a small antenna — 9 elements is considered large on this band, so they say. How big would a 9-element beam be on 75 meters? Wow!

So, you did it — you bought the package — antenna, coax cable, connectors, and of course the rig. It looks great sitting up there on your desk. Better take a look at the instruction book though — microphone connector, power supply, grounding, all standard stuff; no problem there. What does it say about antennas? Yep, 50-ohm cable, okay, but what's this . . . "adjusted for low vswr." Oh, oh — that sinking feeling — you knew there was a clinker in there somewhere.

Relax, brush away those dollar signs and test instruments dancing before your eyes, and let me tell you how to get a lot of use out of your new rig and antenna without squeezing your credit card to the limit.

Why matching?

Before I get into the discussion of how it's done, perhaps I should explain a bit about *why* you should have a match between your antenna and your transmission line. Basically, it boils down to overall efficiency. If you'll permit me to use an analogy from the mechanical world, operating a transmitter with a mismatched antenna is like driving a car with the wrong gears engaged — your engine is working, the gear train is transferring the power to the wheels, and you're moving out, but not as efficiently or fast as you would if the whole system were matched so that the maximum energy could be transferred from the engine to the load (wheels).



This noise bridge is useful up to 300 MHz for testing antennas and matching networks. The Model TE7-02 is available from Electrospace Systems, P.O. Box 1359, Richardson, Texas 75080. To use this bridge, simply connect the antenna to one input, and your receiver to the other.

Fortunately, you have a variable-speed gear box between your engine and the drive shaft, and this helps to match the power to the load by allowing you to change the ratio at different speeds. Automatic transmissions attempt to change the ratio over a wide range of load conditions instead of just at the 3 or 4 speeds of a stick shift.

High-frequency transmitters

have a sort of stick-shift arrangement, in the form of loading and tuning controls in the output circuit of the amplifier. Sometimes the range is not great enough to cover all of the conditions that your load (antenna) might present at the end of the drive train (transmission line), and an external match-box is required. However, not many modern vhf transmitters have a matching arrangement that is where you can get at the controls to cover a wide range of load conditions. Most transceivers, especially transistorized ones, have an output matching network that can be adjusted for a 50-ohm load, and then the box is closed up and left alone. There are only a couple of commercially made external match-boxes available for vhf, and they will take care of small variations in load as presented by antennas that are slightly too long or too short. The answer, then, is to have an antenna that is matched well enough that your transmitter can transfer power to it without further adjustment.

Another reason for antenna matching at vhf is that the losses of coaxial transmission line are higher here than they are on the high-frequency bands. **Fig. 1** shows the *additional* loss that you can expect with a mismatched transmission line. Remember that 1 dB is approximately 26 per cent, and that the loss shown is *added to the normal loss* that you get with a given cable if it is properly matched.

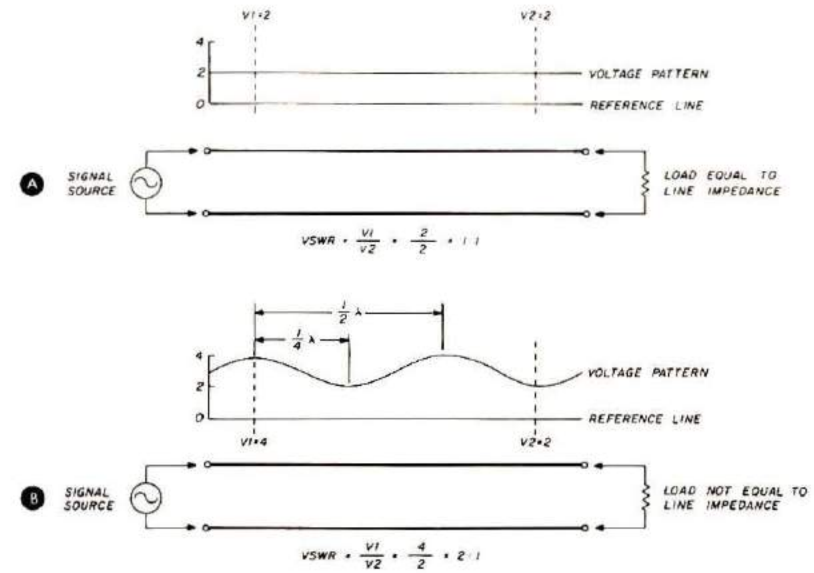


Fig. 2. When a transmission line is terminated with a load that is the same as the line's characteristic impedance, the voltage pattern is smooth along the line. This is called a "flat" line — the voltage profile is flat. When the termination is not the same as the line impedance, part of the power is reflected from the end of the line, and the phase difference between it and the voltage from the source causes it to add to or subtract from the original pattern. These voltage peaks and nulls are called standing waves. The more severe the mismatch, the greater the reflected power, and the greater the difference between peak and valley, thereby increasing the ratio between V1 and V2.

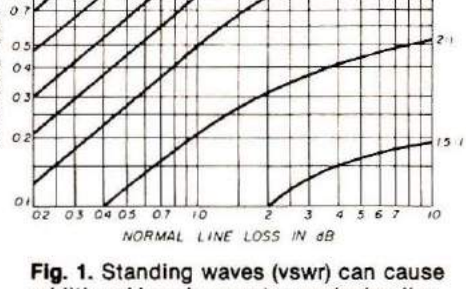


Fig. 1. Standing waves (vswr) can cause additional loss in your transmission line. This is not necessarily serious at low power levels and short lengths of line. However, at high power it can cause extra heating of the line, and if the line is unusually long the loss will be noticeable in both received and transmitted signals.

VSWR

A mismatch at the end of a transmission line causes a reflection of power, which interacts with power from your transmitter, creating what is known as vswr, (sometimes shortened to swr), which means Voltage Standing Wave Ratio. You'll hear this subject bandied about on all the amateur bands, and expounded upon by people who are absolutely sure that they know all the answers. However, if you listen carefully you'll also notice that seldom do any two of the experts agree on how important a low vswr is, how to get one, or whether or not you really have one. Many will declare that nothing less than a ratio of 1.000:1 is acceptable (even though it is impossible to measure it); others will hold forth that it is not important as long as your transmitter will deliver power to the transmission line.

There are all sorts of gadgets and meters available to monitor your transmission line for reflected power, vswr, and whatnot. Some are trustworthy, but some are only flashy gadgets that add to the cash ratio in the seller's bank account. However, I would like to point out two things here: first, when your have your antenna matched to the transmission line, it is usually going to stay that way, and the only real reason you need a vswr monitor in the line at all times is to warn you if anything goes wrong because of loose connections, wind or ice damage, and the like. An experienced operator can spot this type of trouble by noting the reaction of his transmitter, but many still like to be reassured by a meter reading. Secondly, you can use inexpensive instruments, which you can make

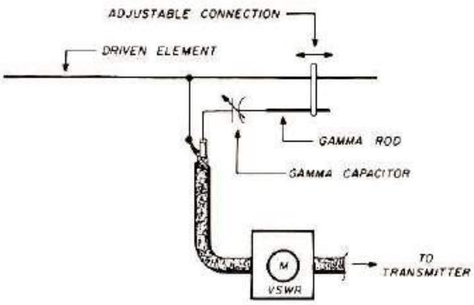


Fig. 3. Many vhf antennas that are fed with coaxial cable make use of the gamma match. The small variable capacitor in series with the feed tunes out reactance. Some builders make this capacitor a part of the gamma-rod assembly by using tubing for the outer part, and placing a solid rod inside it, insulated by plastic or teflon. Many amateurs use a small air-dielectric trimmer, mounted inside a plastic container, to do the job. Adjustment requires moving the tap point for the gamma rod, and adjusting the capacitor, until you have minimum reflected power.

yourself, to achieve a match that is good enough for all the normal operating you are likely to do on vhf. There is no need to go in for laboratory-type instrumentation unless you are going to be designing, manufacturing, and selling vhf antennas.

As to what vswr is — it is simply a series of voltage peaks and nulls along the transmission line, caused by power being reflected at the *load* end of the line. Note the emphasis on the *load* end of the line here. Learn this, if nothing else — you absolutely cannot change the vswr at the *transmitter* end of the line. Oh, sure, you can fool your transmitter into seeing a load that it likes by connecting a match box between it and the line, but that is only half the answer. The transmission line isn't fooled, and that is where the added losses come from.

Voltage peaks and nulls on a mismatched line occur at natural intervals which are determined by the wavelength of the transmitted energy. They are easy to find with an rf voltage probe and meter; a laboratory instrument that does this type of measuring is called a slotted line and probe. As I said, you will not need to be this precise, but later on I'll show you how to make a simple version just in case you are experimentally inclined. **Fig. 2** shows an example of a "flat" line (very low vswr) and a line with vswr on it.

Unfortunately for many of us, a thing called reactance rears its ugly head to make life difficult when we are trying to match an antenna. Because reactance shifts the phase of the voltage with respect to the current from the transmitter (or source), it is difficult to force power through a reactance. A pure resistance accepts maximum voltage and current at the same time, but a reactance could, in effect, shift the voltage peak far enough that maximum voltage can occur when the current is zero, therefore no power can flow through the load.

Very few vhf antennas present a pure resistance to the transmission line. Reactance is introduced by the nearby parasitic elements, which, in order to properly do their job, must be of a length that is different from the natural wavelength of the transmitted energy. The driven element also must be somewhat different from a natural wavelength, because of its proximity to other elements,

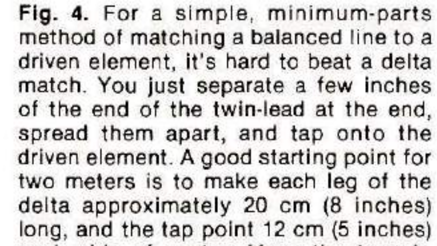


Fig. 4. For a simple, minimum-parts method of matching a balanced line to a driven element, it's hard to beat a delta match. You just separate a few inches of the end of the twin-lead at the end, spread them apart, and tap onto the driven element. A good starting point for two meters is to make each leg of the delta approximately 20 cm (8 inches) long, and the tap point 12 cm (5 inches) each side of center. Move the taps in equal amounts, by small increments, and check for reflected power or maximum radiation from the antenna.

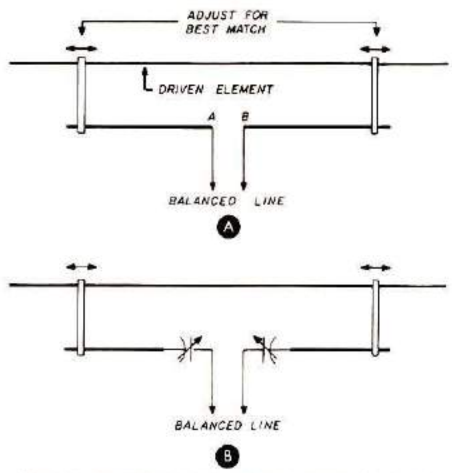


Fig. 5. Another matching device for balanced lines is the T match. In appearance and operation it is very similar to a double gamma match, and can be adjusted in the same manner. A variation, **B**, has a small trimmer in each arm to tune out reactance. This refinement may not be necessary, and sometimes can be avoided by using a shorted stub as in **Fig. 8**.

and because of the way it is constructed and fed. All of these things combine to produce some reactance, either capacitive or inductive, at the feedpoint of the antenna. This must be compensated for in the design of the feed system, and some means must be provided to allow you to "fine tune" this adjustment when you install the antenna.

Feed types

Fig. 3 shows one of the most common methods of feeding vhf antennas — the *gamma* match. It is perhaps the easiest way to match a complex feed impedance to a coaxial transmission line. The name comes from the resemblance of the matching hardware to the capital letter gamma (Γ) in the Greek alphabet. Note that there is a small capacitor in series with the arm that is used to tap the driven element. This capacitor tunes out the reactance of the gamma rod and the antenna element, thus presenting a pure resistance at the end of the transmission line. Adjustment requires that you simply move the tap point along the rod and driven element, and change the

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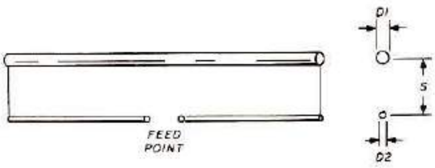

$$\text{IMPEDANCE RATIO} = \left(1 + \frac{\log \frac{2S}{D1}}{\log \frac{2S}{D2}}\right)^2$$

Fig. 6. The radiation resistance of a driven element for a Yagi antenna is very low — often in the range of 5 to 25 ohms. To match this low value to the several hundred ohms of a transmission line, you can use a ratio type of folded dipole. The step-down ratio can be calculated as shown.

capacitance slightly, until the reflected power is at a minimum. Note that here, as in all antenna adjustments, the meter or indicating device is between the coax and the feed point of the antenna. This is the only way to match an antenna — a sufficiently long feed line between the antenna and meter can completely hide the vswr, letting you think that all is well.

Delta match

This configuration (**Fig 4**) is sometimes called a Y match. It is perhaps the easiest way in which to match balanced feedline to a driven element. The gradual separation between the wires provides an increasing impedance transformation that achieves a match. Adjustment can be made by moving the tap point for each leg of the delta either closer to, or farther away from, the center of the element. Small and equal increments should be used. It will work with almost any common twin-lead transmission line, either open (ladder) wire or the enclosed type used for television lead in. The shielded type is not recommended because of the high losses incurred when you transmit through it. A few experimenters have placed reactance cancelling capacitors in each leg, but this isn't necessary.

T match

This is another type that works well with twin-lead or balanced transmission line (**Fig. 5**). It could also be considered a double gamma match. It, too, requires that you move the tap points along the driven element for the best match. The T match can be constructed in the same fashion as the gamma, with reactance-cancelling capacitors in each side to make achieving a low vswr a simple task.

Folded dipole

A folded dipole is perhaps the oldest type of vhf antenna-matching device. It consists simply of a conductor that is parallel to the driven element, and closely spaced to it. This conductor is broken in the center, and fed at that point with a balanced feedline. A match is achieved by selecting the proper ratio between the diameters of the conductors, and by proper spacing (**Fig. 6**). This is a very useful device because of the wide range of impedances that can be obtained by this step-up or step-down ratio. It is most often used as a step-down in impedance, from the relatively high value of the transmission line (300 to 500 ohms) to the low value of a driven element (10 to 30 ohms).

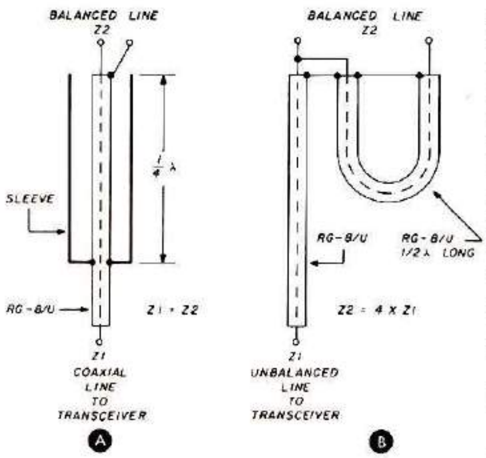

Fig. 7. A balanced system, such as a folded dipole or twin-lead transmission line, can be fed with a coaxial (unbalanced) line by using a *balun*. There are several types, but the two most commonly used are shown here. The sleeve type at **A** provides a balanced output at the same impedance as the coaxial cable. The coaxial-cable balun at **B** provides a 4-to-1 step-up ratio of impedance. If your cable is 50 ohms, the output will be 200, if you use 75-ohm cable, the balun will match 300 ohms. In figuring the half-wavelength of coaxial cable, don't forget to include the velocity factor for the cable you have. For common RG-8/U the factor is 0.66, so 1/2 wavelength at 144 MHz is 100 cm (40 inches), x 0.66 = 66 cm (26 inches); this is the length of RG-8/U needed for the balun section at **B**.

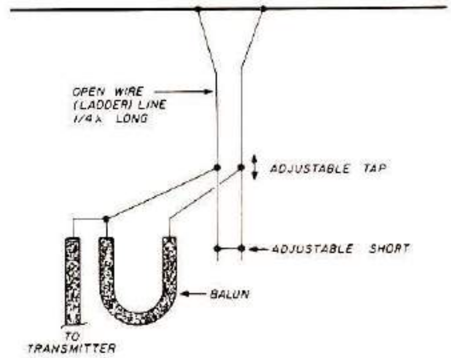

Fig. 8. A shorted stub can be used as an impedance-matching device, and if you're fussy enough in adjusting it, you can reduce the vswr on your feedline to a very low value. The position of the shorting bar at the bottom can be adjusted, and the tap from the balun can be moved up and down on the line, until a matched condition is found. A few antenna arrangements may require that the shorted line be more than 1/4-wavelength long, so if you are unable to achieve a match with the short version, try a line that is 1/2 wavelength. The line can be made from ordinary TV ladder line, and supported by the usual insulating hardware that is sold for this purpose.

Balun

This is a device with a name that is often misunderstood and much abused. You'll hear it called a *balum*, or even a *baloom*, especially by people who have no idea of why it has the name it has. It's very simple — the name is a contraction of the words BALanced to UNbalanced. Those two words describe the function of the balun as well; it transforms a balanced transmission line (or impedance) to an unbalanced one, see **Fig. 7**. For example, your transmission line from the transmitter to the top of your tower is coaxial cable — unbalanced to ground because the outer shield braid encloses the inner conductor. However, your antenna has a folded dipole type of matching arrangement, and if you connected the coaxial cable to it, one side of the driven element would be connected to the braid, therefore unbalanced. This could work, but the radiation pattern might be skewed to one side. You need a balun transformer to change the balanced impedance of the dipole to the unbalanced one of the coaxial cable, and all is well. A simple coaxial balun as in **Fig. 7B** provides an impedance ratio as well — usually 4 to 1, with the lower number being that impedance at the unbalanced end of the device. They work both ways, that is, step up or step down.

A shorted stub is a device that takes care of the occasional discrepancy between the driven element and the transmission line, even if you have a balun and a good

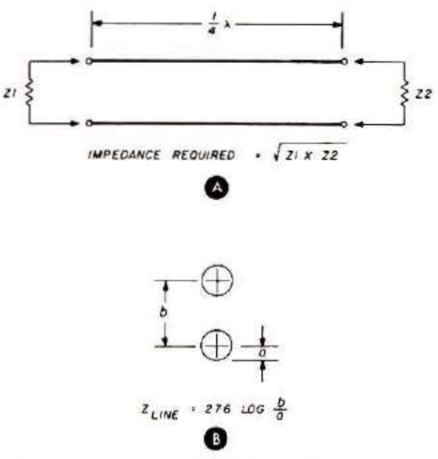

Fig. 9. This is a matching device that acts as a "go-between" for two different impedances. Called a *Q*-section, it is constructed in parallel open-line form. The insulators that hold one side are usually mounted in a slotted arrangement, which allows you to change the spacing between the lines, thereby changing the impedance of the line section. A device such as this would be very useful, for example, if you needed to match the output of a 50-to-200 ohm balun to a 450-ohm open TV line. Note that the dimension "a" is half the diameter, not the total conductor size. *Q*-sections are usually constructed of aluminum rod or tubing, and the length is 1/4 wavelength in open air.

folded dipole. There are cases where all the transformation ratios just don't come out right, and something more is needed to achieve a good match. A quarter-wavelength stub, shorted at the end away from the antenna element, appears to be an open circuit at the antenna terminals (**Fig. 8**). As you move down the stub, the impedance becomes less and less, until you reach the short circuit. All you have to do to achieve a match is to move the tap point of your balun (or open-wire line if that's what you are using) along the stub until you find the correct point for a proper impedance transformation. You can use stubs that are longer than a quarter wavelength to match very complex antenna impedances. Sometimes you have to move both the shorted point and the tap point to get a good match.

Q sections

This is perhaps the most easy-to-use, but the least implemented of the various impedance transforming devices. It consists of a section of transmission line that is one quarter wavelength, **Fig. 9**. The spacing between the parallel conductors is made variable so that the characteristic impedance of the line can be changed. It will match between two impedances when the impedance of the *Q* section is the square root of the product of the two impedances it is placed between.

Instruments

Let's take a look at some of the instruments that are available to check out antenna performance at vhf and above. One of the more popular ones is the Bird *Thruline* Wattmeter.* This is considered by many vhf enthusiasts to be *the* instrument to have for antenna work and monitoring the output

*Thruline is a registered trade name of Bird Electronics Corporation.

The Bird *Thruline* Wattmeter is perhaps one of the most versatile measuring instruments available for the vhf amateur. The connectors can be changed to match those on your feedline, and the plug-in elements can be changed for different power levels and frequency ranges. The case is rugged enough to stand portable or fixed-station use. It's a worthwhile addition to your test equipment list if you intend to do much high-power vhf work, or if you need to check the efficiency of transmitters or exciters. At early 1978 prices, you can expect to pay approximately $130 for the basic instrument, and $35 to $40 for each plug-in element. You'll see them advertised by many amateur-equipment dealers.

of your transmitter. It is versatile, rugged, reasonably accurate, and also relatively expensive. You can plan to spend in the vicinity of $150 (1978 prices) for the basic meter and one plug-in element.

The meter housing contains, in addition to the meter, a short section of coaxial transmission line which has a precision-machined hole in the side. A pick-up element (called a slug by many users) is fitted into this hole. An inductive loop in the slug extends into the rf field within the coaxial line section. All of the detecting, filtering, and calibrating components are contained in this slug, which makes the

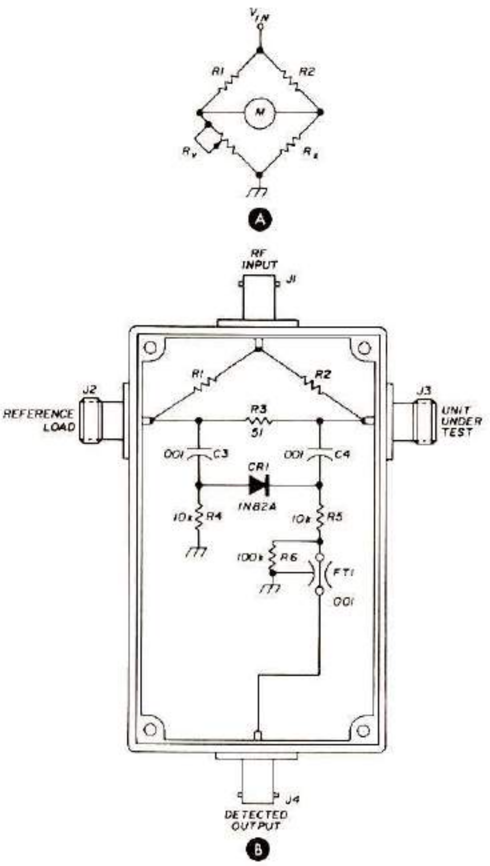

Fig. 10. A basic comparison bridge circuit is shown at **A**. When the variable resistance, R_v, is equal to the unknown, R_x, the meter reading will be zero. A bridge circuit suitable for vhf rf measurements is shown at **B**. The signal input can be from a small tone-modulated oscillator, or a signal generator. Although the detector for the output circuit can be a microammeter, the most sensitive indication will be obtained with a selective audio amplifier for an output indicator. R1 and R2 should be matched in value, between 47 and 55 ohms. All resistors are 1/4 watt, carbon composition types. From *ham radio*, July, 1976, page 52.

assembly compact and rugged. The element can be reversed in the mounting, so that power going in either direction can be monitored.

Each wattmeter element is calibrated for accuracy over a specified frequency range and power level. This means that if you want to monitor a different power level or frequency simply purchase an element that covers the required range. Many of the high-powered vhf stations use this instrument both for adjustments and continuous monitoring. When you are running very high power levels, and have many hundreds of dollars tied up in equipment and antennas, it is worth investing in a good output meter such as this.

Bridges

In spite of their claims, many of the gadgets touted as "swr bridges" are not bridges; they may indicate vswr or reflected power, but that doesn't mean that they are bridges. **Fig. 10** shows a basic bridge circuit, and how it can be modified to use in antenna work. The key to accuracy at vhf is to keep the arms of the bridge symmetrical, and reduce stray capacitance and inductance to a minimum. This is increasingly hard to do as the frequency goes up. Some bridge circuits will work at 220 MHz, but few are accurate at 420, and almost none are reliable above that band.

To use a bridge in antenna work, you connect a load of known value to one arm of the bridge, then make adjustments to the unknown load (antenna) that is connected to the other arm. When the two loads are identical, the meter or detector reading will be at, or near, zero. Obviously, the accuracy of the bridge should be periodically checked by placing two known loads on the arms, and swapping their positions to be sure that they are identical and that the bridge is working right.

There are mathematical methods which can be used to determine, after one or two measurements, just what is wrong with your antenna and what can be done to fix it. However, that type of "engineering" is considerably above the beginner's level, and would involve many extra pages of explanation. You can accomplish your purpose of adjusting an antenna well enough to use simply by using the substitute-and-tweak method. Hook up your antenna, adjust it for best meter reading, substitute a second dummy load to check the bridge, then go back to the antenna.

A well-made bridge is very handy to have around, even if you are not building antennas. After you become familiar with it, you can check components, networks, transmission lines, phasing harnesses, and all sorts of things by observing what happens when you connect an unknown to the bridge. For instance — you know that two 50-ohm resistors will give you a null or zero reading when you compare them. However, if you connect across one resistor a small capacitor of, say 2.2 pF, which has a reactance of approximately 50 ohms at 144 MHz (the frequency of the signal source), you no longer get a null. This residual reading is caused by the capacitive reactance. After a bit of experimentation, you'll be able to tell whether a device is capacitive or inductive, and by what amount, merely by the meter reading, and by the adjustments necessary to obtain a null.

Inductive pick-up devices

There are a couple of vswr

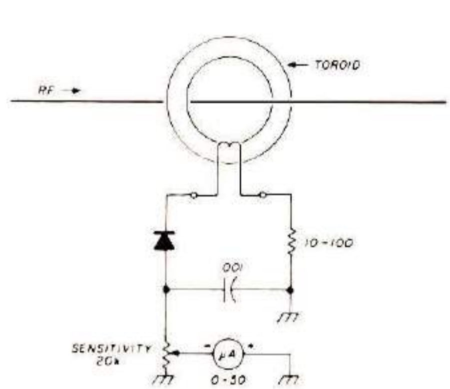

Fig. 11. An inductive pick-up device can be used to measure either forward or reflected power by reversing the input and output connections for the rf path. A more elaborate model can be made that uses two diodes and more parts to reverse the reading by flipping a switch. The toroid-core material must be a type that is made for vhf work. Equipment manufacturers sometimes use this system to develop a protective bias for transmitter circuitry. Short leads and careful layout and shielding are a must in building this type of detector.

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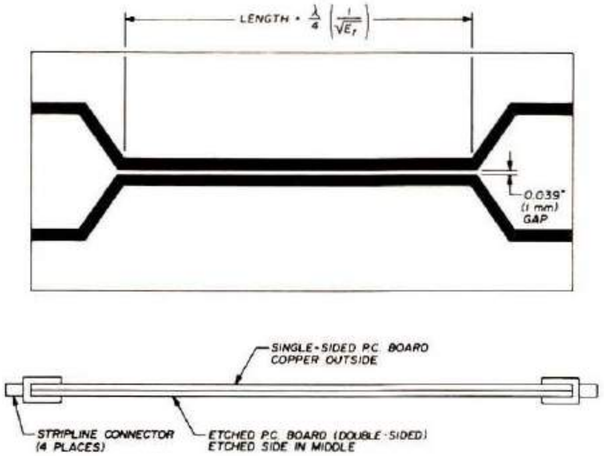

Fig. 12. Universal 20-dB stripline directional coupler uses two 1/16" (6.5 mm) Teflon-fiberglass circuit boards. Etched board is double copper clad; cover board is single copper clad. The quarter-wavelength of line is shortened by the dielectric constant of the circuit board as shown in the formula (2.5 for Teflon-fiberglass circuit board). Correct length is 4.3" (10.9 cm) for 432 MHz, 1.43" (36.5 mm) for 1296 MHz, and 1.28" (32.5 mm) for 2304 MHz. Bandwidth is about 10%. From *ham radio*, July, 1976, page 53.

monitoring devices that fit into this category. One type is used in the output of many low-power 10-, 6-, and 2-meter transmitters, and it makes use of a ferrite toroidal core with a few turns of wire. Another is a "stripline" type of instrument, which is also called a directional coupler, or sometimes a "monimatch."

The type that uses a ferrite core works on the transformer principle (**Fig. 11**). A single turn, or perhaps just a piece of wire that passes through the center of the core, acts as the primary winding, and induces current into the core material. The secondary winding senses these currents and a diode rectifies them for a dc component which can be measured with a meter. The dc output can also be used to bias early stages of a transmitter in such a manner that the output is reduced. This is the basis of many of the protective circuits I've mentioned before. This type of sensing circuit works well at 10 and 6 meters, and can be made to do well at 2 meters, if proper care is taken in construction. Things to watch out for are unnecessarily long leads, and lack of symmetry in the layout and wiring.

At uhf, the stripline variety of directional coupler is more accurate, and not difficult to build. It doesn't have to be made of printed-circuit board material, although that is a common method of construction. It consists of a conductor that carries the rf energy, and a second conductor parallel to it (**Fig. 12**). The second conductor lies within the field of the one carrying the rf and thus intercepts some of the energy flowing along it. This *pick-up* conductor behaves much as though it were a small section of transmission line itself, and therefore must be terminated with a proper load resistance so that it doesn't have standing waves of its own which would upset the readings. A nice feature of this type of line is that it will sense the direction of the energy flowing on the main transmission line, so it can be used to indicate either forward or reflected power. It is possible to use one secondary line and switch the diodes and termination resistors to make it do double duty for both directions of power flow, but the lines are so easy to construct that it is often just as well to make a separate unit for each direction.

Directional couplers such as these can be calibrated quite accurately, and, since their output in relation to the power carried in the main transmission line can be precisely determined, they can be used for very careful measurements. They can be used in conjunction with elaborate measuring devices that are calibrated in dB. If properly adjusted, they will indicate vswr with an accuracy of two or three decimal places. You'll not need to go that far, however; a micro- or milliammeter to read the current from the diode will suffice for all the antenna tweaking you need to keep your station working in good order.

Noise bridges

This type of instrument has not seen much use at vhf until recently. Perhaps the main reason is that the common ones available are not built with enough precision to be reliable at frequencies higher than 30 MHz. Recently, however, some improvements have been made, and at least one manufacturer offers a noise bridge that will work well at 50 and 144 MHz. In operation it is used in much the same manner as the rf bridges mentioned earlier, but the signal source is a wide-band noise generator. The detector can be your station receiver, see **Fig. 13**.

The noise bridge is a comparison device. That is, you compare the unknown (your antenna) with the known load, just like with other bridges. Adjustments to the antenna cause the noise level heard on your receiver to change; when

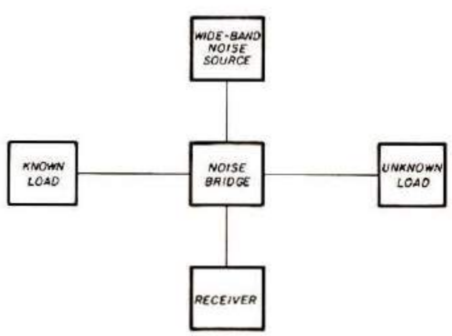

Fig. 13. A noise bridge can be used for antenna evaluation, and will give very useful indications even though it is not as elaborate as the highly sensitive rf bridge. A wide-band noise source is used as a signal, and the detector for the bridge is a receiver that covers the frequency of interest. The unknown can be adjusted until a minimum noise-reading is obtained.

you have the antenna matched, the noise should almost disappear. Another advantage of this device is that you can tune across the band and find where the antenna is performing by listening for the dip in noise level. If you are not sure of just where a new antenna is resonant, this is a fast way to find out. Further, a noise bridge does not require that you put a signal on the air — which is a good recommendation. Some units have a noise source built in, powered by a small battery; others require that you provide an external noise source. I recommend the units with a built-in source, since they most likely will be matched to the rest of the bridge and, therefore, more accurate.

Inexpensive tweaking

All of this talk about bridges, swr meters, power monitors, and the like is fine, but suppose that you just bought a new vhf rig (either fm or ssb) and an antenna, and want to put the two together with a minimum of extra cost and equipment. How do you match the antenna? Well, it's not very difficult at all. First, however, let me caution you about a couple of points. The following procedure will require that you put a signal on the air, so be sure that you can find a clear spot on the band — you don't want to create an interference problem. Also, this procedure will work only with transmitters that have some sort of mismatch protection built into their output circuit or have transistors that can stand a high vswr. This type of circuit reduces the output of the transmitter in response to the reflected power that comes back down the transmission line, thereby preventing the output transistors from destroying themselves. Be sure to read the manual to see if the unit has either a protective circuit or uses output transistors that will stand infinite vswr without harm.

The simplest method of adjustment is to go by the power-output indicator in the rig. Connect the transmitter to a 50-ohm dummy load, turn it on, and note the meter reading. Now, connect your antenna (use as short a transmission line as possible) to the transmitter and note the meter reading; if it is lower than before, your antenna is not matched to 50 ohms. The antenna should be as high and clear of surrounding metallic objects as possible, of course — and pointed away from any metal. You can place the antenna on the top of a step ladder, and point it straight up. As long as the longest element (reflector) is several inches from the ground any effect the ground may have will be small enough to live with.

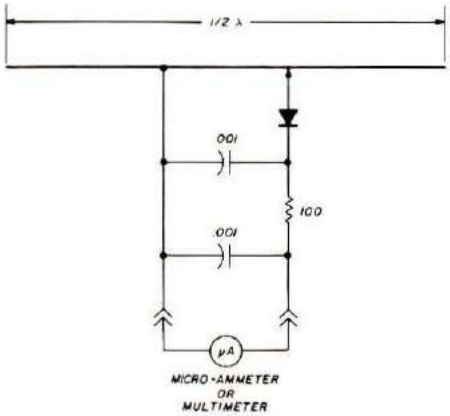

Fig. 14. To obtain an indication of how much energy your antenna is radiating, you can use a half-wave antenna with a diode and meter. The dipole can be stiff wire or rod, and the diode tap point can be 2 or 3 cm from the center. If you use a pair of tip jacks or other cable-connectors in the line as shown, you can place a length of wire between the pickup antenna and the meter, and then locate the meter near you for ease of reading. The type of cable is not critical, since it carries only dc for the meter.

Suppose that the reading is lower than before, now what? Well, you can make adjustments to the matching device on the driven element. Go slowly, and take notes on the meter readings after each adjustment. Soon you will be able to see a pattern, and plan your next move more accurately. A very small adjustment can cause a big change in results at vhf and uhf, so take it easy. The object is to get the meter reading to be as near as possible to what it was when you had the dummy load connected to the transmitter. You may not be able to hit it exactly, but you'll get close enough to use the rig and antenna without any serious problem. Turn the rig on for short periods of time, just long enough to take a reading — there's no need to overwork it.

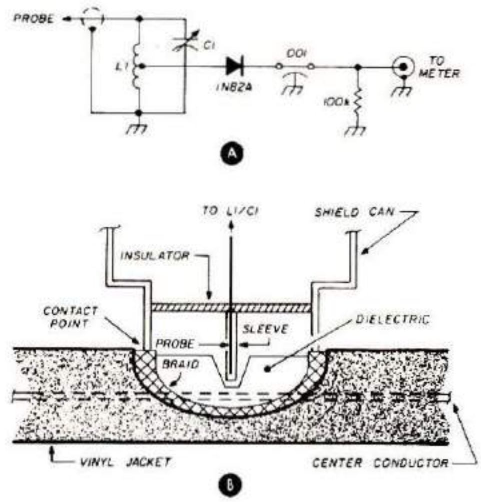

Fig. 15. You can use a tuned probe, **A**, to plot the vswr on a coaxial line. The probe tip must be insulated to prevent shorting to ground or the center conductor — a thin wrapping of electrical tape will be fine. To use the probe, prepare a section of coaxial cable by making holes through the braid and into the dielectric, **B**. Remove enough of the outer plastic covering so that you can make good contact to the braid on the cable. The shield on the probe must make good contact with the braid, and the probe tip must project into the dielectric without touching either the braid or the center conductor. Semirigid cable with foam insulation will work as well as flexible cable. A suitable length would be one wavelength at the lowest frequency you want to investigate. L1/C1 must be tuned to the signal frequency.

Another method, more accurate than relying upon the meter in the transmitter, requires the use of a field-strength meter. Sound complicated? Well, it isn't bad at all. You can make one from some wire, a diode, capacitor, and any meter that will measure microamperes or low-range milliamperes (you can even use a garden variety multimeter). A circuit is given in **Fig. 14**. The pickup antenna is simply a half-wave dipole, and a diode is used to detect the rf energy that the antenna intercepts. A capacitor prevents the rf from flowing down the leads to the meter and causing poor readings. This type of pick-up device is handy to have around — you can always check that your antenna is radiating in the proper direction, that your transmitter is working, that your transmission line is still okay, and many other things where an indication of the amount of rf being radiated is needed.

To use the field-strength method of matching your antenna, place the antenna as high and clear as you can, but where you can still reach the adjustments. Point it at the pick-up antenna, which should be several wavelengths away (ten or more). How do you know what the wavelength is? That's easy, the band you're operating on tells you (6 meters, 2 meters, etc.), but if you want to be more precise just measure the driven element. That's close enough to a half-wavelength for our purposes. Double that dimension to find one wavelength. Your pick-up antenna should be ten times that distance away so that it will have very little effect upon the antenna itself.

Now, adjust the antenna matching device for maximum reading on the field-strength meter. A very useful trick here, if you don't have binoculars or a helper, is to connect the meter to the diode circuit by means of a lengh of common zip cord or speaker wire. Don't worry about any rf losses — it's carrying only dc from the diode to the meter. The meter can be placed nearby where you can see it after you make an adjustment. Turn the transmitter on for short periods again, and *never* make an adjustment while the transmitter is on. Keep your face, and especially your eyes, away from the antenna when the rig is keyed up. Even a small amount of rf can cause a nasty burn, and the field is intense close to the elements — you've only one set of eyes, so don't use them as part of your rf-measuring system.

Here, too, the object is to obtain a maximum meter reading, which indicates that the output circuit of the transmitter is looking into a 50-ohm load. It will not hurt to switch back to the dummy load once in a while to see if all is well with the transmitter; sometimes a drop in battery voltage or the heating of components in the rig can cause the rf output to drop a bit.

The punctured line

Suppose you would like to explore this vswr thing a bit more — how could you go about it without a lot of expensive instruments? Well, I mentioned a slotted line a bit earlier, but a slotted line is a bit fussy to construct. The main difficulty comes in making the size of things in the right proportion so that your line doesn't have a worse vswr than the device you are measuring. There's an easier way, however. You can make a punctured line. If you take a piece of ordinary coaxial cable — RG-8/U will do fine — and punch holes in it with a nail or ice pick you will be able to insert a probe to measure the vswr. Make the holes right through the outer covering, through the braid, through the dielectric insulation, and almost touch the center conductor. Remove enough of the outer covering to expose the braid around the hole you have made.

Now, make up a probe as shown in **Fig. 15**, and insert the probe tip in the hole. Be sure the grounded body of the probe is making a good connection to the braid. You'll get a meter reading showing what voltage the probe is sensing at that point. By making several of these holes, equally spaced along the coaxial cable, you can plot the vswr. To test the punctured-line section, place a short circuit across the end away from the signal source (low power transmitter) and plot some readings on graph paper. The curve should be quite pronounced.

I would suggest that you make up a piece of line like this for each band that you want to experiment on, and fit it with coaxial connectors at each end. Then, you need only insert the punctured line at the end of your transmission line at the antenna, and make your measurements. For consistent readings, each hole must be as nearly like the others as possible, and you must be consistent in the way you apply the probe. Remember to keep the probe tuned to the frequency you are using. Try it — you can learn a lot about antennas and vswr, and the cost of your instruments will be less than what you would pay for a good lunch.

Conclusion

Antennas, transmission lines, vswr, and rf do not behave any differently at vhf than they do on the high-frequency bands, it's just that the instruments have to be built with more care. Also, smaller physical changes create a bigger difference in results. You might need a backyard several hundred feet on a side to play games with 80 or 40-meter antennas, but at two meters you could do the whole thing on your back porch. Even with the most simple of instruments, you can adjust your antenna so that it will perform well enough for years of use, and, once it has been checked, you'll have confidence in it. So, tweak it up, then relax and enjoy your vhf operating.

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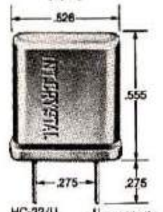

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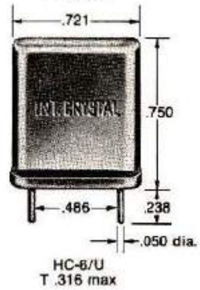

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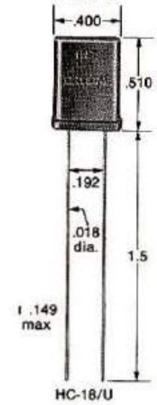

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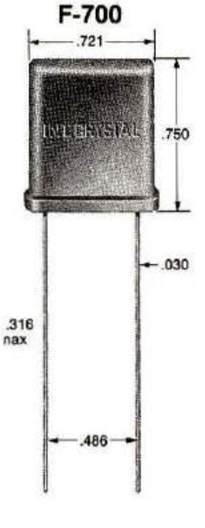

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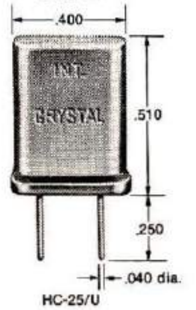

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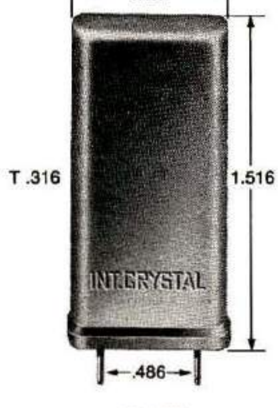

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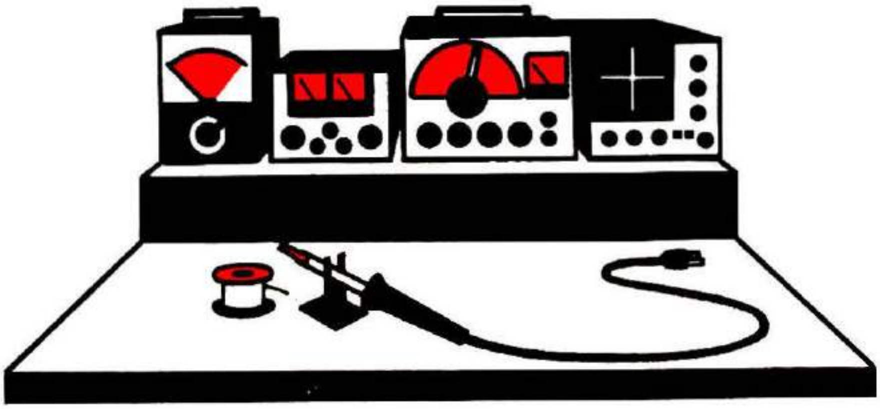

BENCHMARKS

The Volts Box

A variable ac supply that will provide 0 to 150 volts is a nice piece of gear for the experimenter. A Variac capable of 5 amps or more is a bit on the expensive side and furthermore is not too good between 0 and 30 volts. Neither is it isolated from the power line, which often is desirable at low voltages.

Multiple low-voltage-winding transformers have appeared on the surplus market at various times. Many old TV transformers have two 6-V windings plus a 5-V one. Occasionally you will even find one with four 6-V windings. Some of the 6-volt windings may be center tapped.

The size of the enclosure for the volts box will depend upon how large your transformer, meter, and switches are. If you do not have a meter, you can use a pair of binding posts and an external multimeter to set the voltage (*photo by Gary Gray*).

A transformer such as one of these may be used as a multiple low-voltage source if the secondaries are all connected in series, voltage-aiding. These secondaries may be used in series with the primary in either the aiding or bucking configuration. This will give you an auto transformer whose output voltage will be equal to the line voltage plus or minus the secondary voltage.

Perhaps there are occasions when you would like 20 per cent less than normal line voltage to reduce the power of a linear amplifier, for instance. Or the other way around, maybe you would like to boost the power. Many power transformers will readily accept 120 per cent of rated input voltage, particularly at the duty cycle of speech.

Any experimenter can think of many reasons why a variable ac supply of the above kind would be nice to have, especially if it can be derived from the junk box.

I recently fell heir to a surplus transformer with six 6.3-volt, center-tapped, secondaries. I decided to build the "volts box" of **Fig. 1**.

Operation: With the three-position tap switch (left of the meter in photo) in the AID position, and with the spdt toggle switch (below the meter) in the high voltage (HI) position, adjusting the twelve-position tap switch (STEPPER at lower left) will give an output from 115 to over 150 volts in steps of 3 or 6 volts. Throwing the three-position tap switch to the BUCK position and leaving the spdt toggle as before provides output from 115 to less than 80 volts. With the three-position tap switch to OFF and the spdt toggle on low voltage (LOW), output is anywhere from 0 to 35 volts, isolated from the power line.

Possible modifications to suit your junk box: a meter is not necessary — you could use your multimeter externally. You can eliminate all of the tap switches by wiring to banana jacks and rearranging the circuit with banana-plug patch cords. You could just plug the box into the wall without benefit of an off-on switch. An indicator light is nice but not necessary. A metal box is nice but wood will work just as well.

Some afterthoughts: don't worry about which position is AID or BUCK. Just label the switch however it turns out when you get done. Remember that your largest firm load is the current rating of your low voltage windings. However, if your load is variable like an ssb linear, the peaks could be several times this amount. A 3-A winding will easily deliver 10 A on speech peaks.

Bob Baird, W7CSD

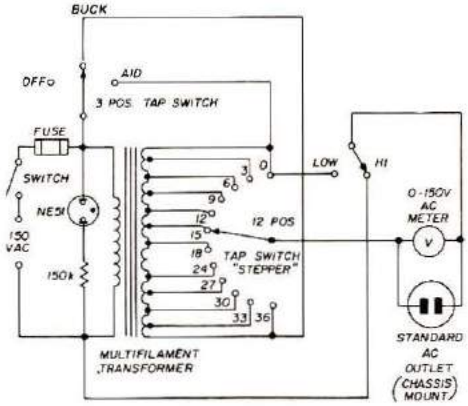

Fig. 1. The volts box provides variable-voltage output by using the multiple windings in the secondary to either aid or buck the voltage from the primary. It can also provide low-voltage output that is isolated from the ac line.

Cable Stripper

After accidentally cutting the braid of the coax cable I was working on, I decided it was time to find a better method of preparing it for my use. Thanks to my wife's idea of giving me an X-acto kit for a Christmas present, I thought I might try one of the tools on my coax.

Among the tools in the kit was a number 28 blade. This blade resembles a quarter moon — a shape which fits quite nicely around the outside of the coax. First you rotate the blade around the cable, being very careful, as a new blade is extremely sharp. Then you will find it easy to slip the point of the blade under the vinyl cover and run it out to the end. Just pull the cover off and you now have a neat and clean start on your coax. A box of five blades will cost about $1.25, and should last you several years.

John D. Adamson, W1HZH

Gain Reducing Plug

Here's a little trick to easily make your 2-meter transceiver less sensitive. You ask, "Why should I want to cut my rig's sensitivity?" The answer is simple. If you frequently monitor one repeater and have trouble with adjacent stations keeping your squelch open and your nerves frazzled, you may wish that the receiver wasn't so hot. Also, if you partake in hidden transmitter hunts, it helps to be able to cut down the sensitivity as you close in on your quarry. Sure, you could add an external attenuator or detune the front end, but the attenuator affects the transmitter and retuning is cumbersome, not to mention dangerous to the rig. Besides, you will want to easily recover the original sensitivity you paid for when you need it.

My modification was done on a TR-22, but the principle works with any rig. Just disconnect the source (or emitter) resistor of the front-end rf amplifier when you want less gain and reconnect it when you want more. This can be done with a switch but I found it preferable to use a subminiature phone socket. This circuit normally grounds R2 until an open plug is inserted, which disconnects the resistor and therefore the ground return to the amplifier. This method leaves nothing protruding from the rig during normal operation but easily allows you to kill the front end when desired.

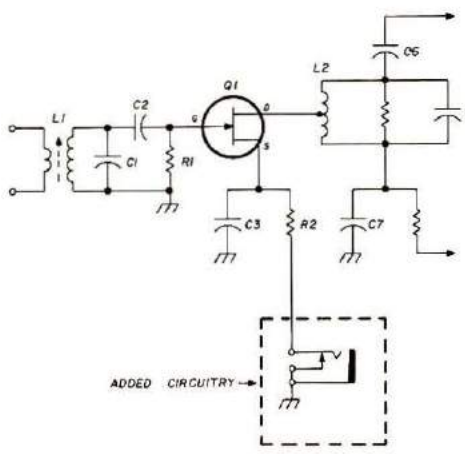

Fig. 2. A miniature phone jack wired in series with the source (or emitter) resistor of an rf amplifier will reduce the receiver gain when an open-circuit plug is inserted.

The results have been gratifying. My problem with a repeater, 15 kHz away from my favorite repeater, went away as soon as I made the modification. The attenuation depends on the normal gain of the stage, but should be about 20 dB. The transmitter is not affected, and removing the plug puts everything back to normal.

Of course, as with any modification, it's best to wait until the radio is no longer under warranty before you work on it.

Steve Kraman, WA2UMY

A First Aid Note for the Home Workshop

Only the foolhardy would operate power tools without wearing the proper safety gear, but occasionally accidents will happen, in spite of the most careful precautions. I was reminded of this by a minor accident some years ago, and in the process came up with a first aid procedure that anyone with a home workshop might benefit from.

While operating a drill press to make parts for a ham project, a metal filing flew off the work piece and lodged in my right eye. It did this in spite of the fact that I was wearing a full-length safety mask. The particle first bounced off a wall panel behind me, entered the mask from behind, then bounced off the inside surface of the mask before hitting the eye. The pain was excruciating, and attempts to remove the piece of metal by the accepted method of flushing with water were fruitless.

A few minutes later, as I was about to depart for the hospital emergency room, it dawned on me that the material I had been working with was made of steel. Quickly locating a small magnet in the workshop, I brought it close to my eye and the offending particle hopped right out. This treatment will only work with ferrous metals, of course.

A word of caution, however: Never regard eye injuries lightly. If the use of a magnet or simple flushing with water doesn't dislodge the particle, see a doctor immediately. Further attempts to remove it by yourself can lead to serious and permanent damage to your eyesight.

Bill Johnston, N5KR

Drill Stop

Any technician who has had to drill new holes in a chassis without a drill stop knows how heartbreaking it is to find out that he has just punctured a four section electrolytic capacitor underneath the chassis, or knocked some connections loose. To prevent this, use as a stop the shaft bushings that are often found in car radios. These usually have 1/4- or 1/8-inch (6 or 3mm) holes, and so can be used on many small drills without wobbling. These bushings are usually secured to the shafts by Allen or slotted set screws, and provide the advantages of small size and no protruding screw heads.

Harry J. Miller

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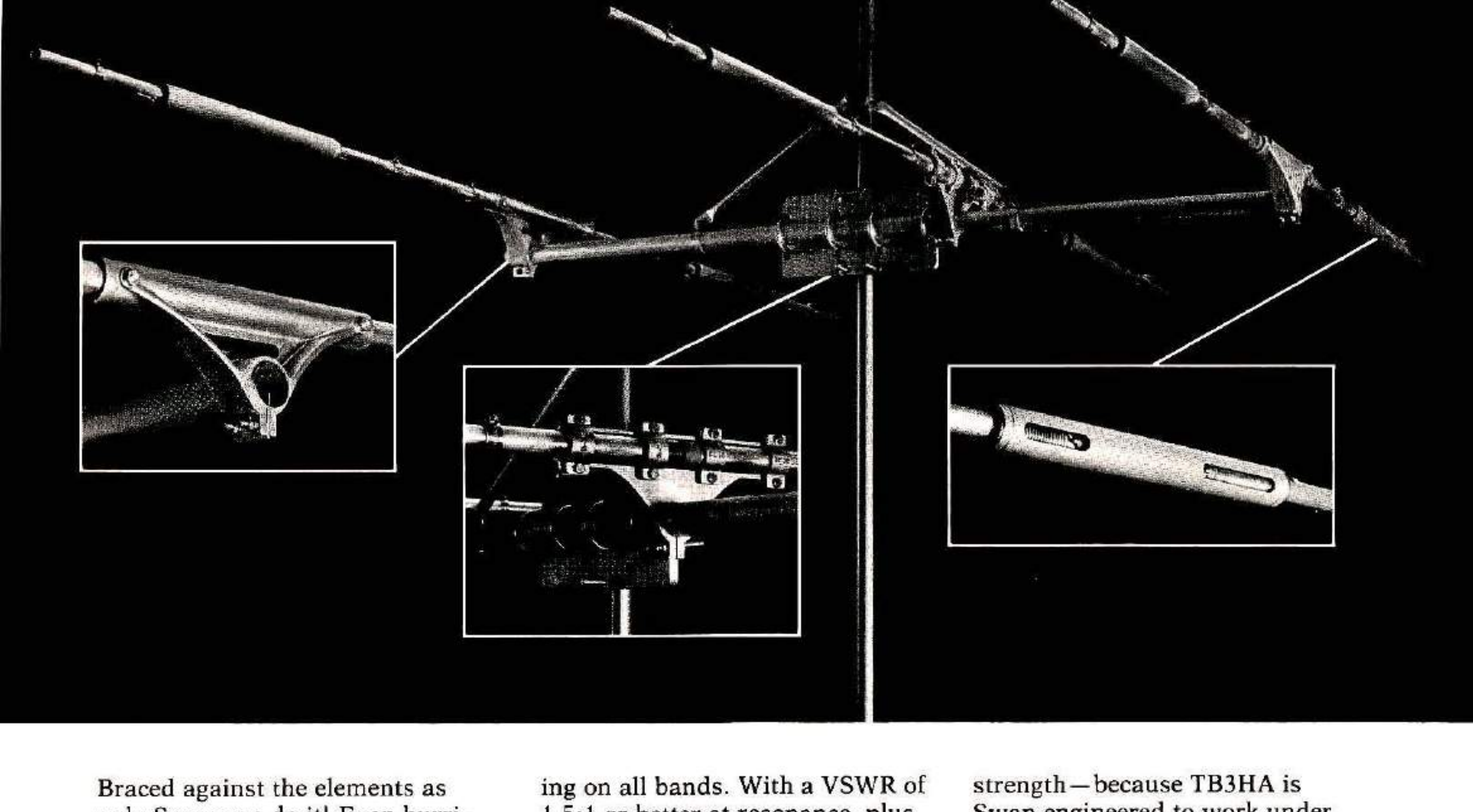

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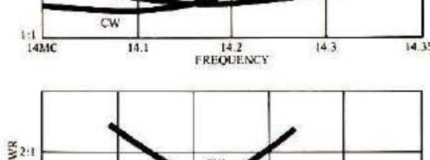

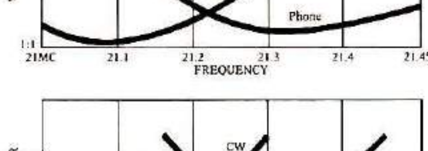

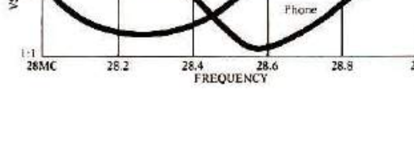

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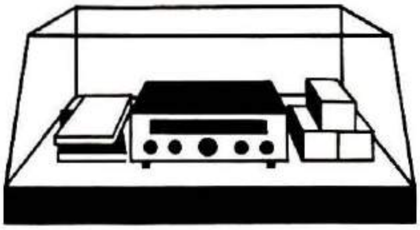
PRODUCT SHOWCASE



Bencher Keyer Paddle

Bencher, Inc., of Chicago, is producing a dual-lever, iambic keyer paddle that has a lot of features you'll find helpful for ease and reliability in CW operation. Some of these features are: dual adjustment of spring tension on the paddles to match the "feel" to your fist; precision contact adjustments with a setscrew locking feature so the adjustment stays where you want it; and, a heavy steel base, equipped with non-skid feet so you don't have to chase the paddle around the desk top.

The contact points are solid silver, for a lifetime of flawless keying. Nylon bearings are used on the keying shafts, and the bearings float on machined brass fittings for a self-aligning action. Spring tension prevents play and sloppiness, eliminating contact bounce and backlash.

The Bencher Ultimate Paddle looks as good as it works — the frame, posts, and bearing ring are all precision machined from solid brass stock, and polished and plated for durability and first-rate appearance.

You can obtain the model BY-1 (standard black-finish base) for $39.95; the BY-2 (polished chrome-plated base) for $49.95; or, Bencher will quote the price of a Gold Plated Presentation model (BY-3) upon request. The paddles are available at selected dealers, or direct from Bencher, Inc., 333 West Lake Street, Chicago, Illinois 60606; or use *ad check* on page 94.

Palomar Synthesized Transceiver

The Palomar PTR-130K is the first completely multi-functional transceiver ever made available to the public. It incorporates some of the most advanced features of logic technology. The PTR-130K is a miniaturized mobile transceiver capable of operating with 100 Hz resolution from 100 kHz to 30 MHz, in all modes of transmission and reception (ssb, CW, fm, and a-m). Instant frequency selection is available at the touch of a finger.

The transceiver has a built-in rf compressor to increase effective transmitter output by 12 dB

(16 times). Two cascaded Collins mechanical filters in the receiver provide superior selectivity, with a typical shape factor of 1:1.25 (3 dB/60 dB). These, and many other features, are packed into a small, 16.5 x 6.3 x 20 cm (6-1/2 x 2-1/2 x 8-in.) package. Power output is 5 watts on a-m, 12 watts on other modes.

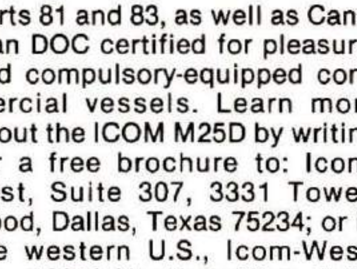
The PTR-130K is the latest in a long line of innovative electronics products from Palomar Electronics Corporation, 665 Opper Street, Escondido, California 92025. For more information, write to them, or use *ad check* on page 94.

ICOM Programmable VHF Marine Radio

ICOM has announced a new addition to its Marine VHF radio line by introducing the ICOM M25D — similar in appearance and features to ICOM's popular 25-channel M25. A key advantage of the ICOM M25D is its 25-channel diode-programmable system. The diode matrix in the M25D can be "programmed and reprogrammed" to any 25 of the commercial, pleasure, or international Marine VHF channels, thus eliminating the need to buy expensive crystals when additional channels are required.

ICOM enjoys an industry-wide reputation for producing one of the most thoroughly sealed and weather-protected Marine VHF units on the market. Like the M25, the M25D features a unique single-piece molded aluminum base construction, incorporating a series of O-ring seals and gaskets around the switches and case covers to provide maximum protection of the internal electrical components. The speaker is protected from rain and moisture by a tough, water-resistant membrane. The transceiver also features safety memory to channel 16, automatic start on 16, push-button selection for both weather and channel 16, a locking mounting system, a 5-watt audio system, an automatic night-time dimmer system, and a provision for external speakers.

The ICOM M25D, like the M25, is FCC certified under both



Parts 81 and 83, as well as Canadian DOC certified for pleasure- and compulsory-equipped commercial vessels. Learn more about the ICOM M25D by writing for a free brochure to: Icom-East, Suite 307, 3331 Towerwood, Dallas, Texas 75234; or in the western U.S., Icom-West, Inc., 13256 Northrup Way, Suite 3, Bellevue, Washington 98005; or use *ad check* on page 94.

MAX-100 Frequency Counter

A new state-of-the-art LSI counting technology has enabled Continental Specialties Corporation to offer a very competent frequency counter at a very good price. The counter, called MAX-100, delivers an accurate 8-digit display of frequencies from 20 Hz to 100 MHz. The crystal-controlled timebase features 3 ppm (parts per million) accuracy, and the counter updates the display every second.

The counter input includes a preamplifier which allows it to work with as little as 30 mV of signal. Diodes protect the input up to 200 Volts. Although it is a low-profile unit, the MAX-100 features large, bright, 15 mm (0.6 in.) digits. No range switch is necessary, because the least significant digit always represents 1 Hz. Leading zeroes are blanked, and overrange signals cause the most significant digit to flash.

The MAX-100 can be operated on internal alkaline or Nickel-Cadmium cells; or from automotive or 115 Vac power by using a battery charger or eliminator. All 8 digits flash to indicate a low battery condition, which permits extended battery life.

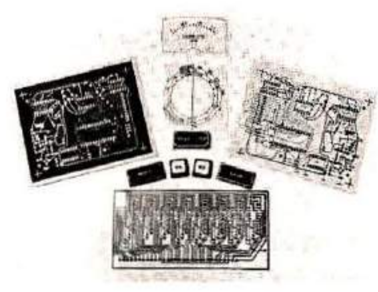
The input impedance of the counter is 1 Megohm, shunted by 56 pF. Sine-wave sensitivity is rated at 30 mV RMS from 10

Hz to 50 MHz, 100 mV RMS to 80 MHz, and 300 mV RMS above. A number of accessories are available, including a battery charger/eliminator, r-f tap-offs, a whip antenna, and a carrying case.

The MAX-100 is accurate enough for most professional field service applications; with a suggested price of $134.95, it's economical enough for personal or educational use. For further information contact Continental Specialties Corporation, 44 Kendall Street, New Haven, Connecticut 06509; or use *ad check* on page 94.

Artwork Transfer Film For PC Boards

Printed Circuit Products Company, of Helena, Montana, has produced a film that can be used to pick up artwork from printed pages and used for etching sensitized board. Called **PCP Type-A,** the film is easy to use. A protective backing is peeled off, then the clear film is pressed in place over the desired artwork. A blunt instrument is used to burnish the film into firm contact with the paper, and to remove all air bubbles. The combination is soaked in water until the paper softens and can be removed by rubbing, leaving the "print" on the film.



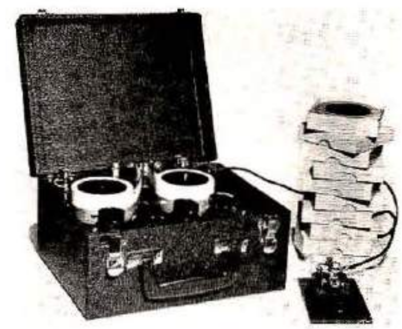
After the film has dried, the artwork is ready for use. Simply apply it over the surface of any sensitized pc board material in the normal manner, and expose, develop, and etch your own printed circuits.

The Type-A film eliminates the many photographic processes that usually accompany transferring artwork from the printed page to a form useful in etching boards. Note, however, that the artwork does not change form in the process — it remains either negative or positive, just as it is printed.

PCP Type-A film can also be used to create custom decals for your equipment, re-label meter faces, dials, or panels. For more information and prices, write to Printed Circuit Products Company, P.O. Box 4034, Helena, Montana 59601; or use *ad check* on page 94.

Instructograph Code Instructor

How many thousands of people in the commercial, military, and amateur radio services have learned to receive and send



code by using an *Instructograph* machine will probably never be known, but you would be safe in saying that a large percentage of past and present radio operators sat before one of these boxes — listening to the perfect code pour out as the paper tape wound its way from one spindle to the other.

The *Instructograph* was invented in 1924 by O. B. Kirkpatrick; it was a hand-cranked spring-wound machine with a battery-operated oscillator. Later, a tube was added to the circuitry, and an electric motor took the place of the spring. Their newest model, the Series 500, is all transistorized, and still incorporates the desirable features that made the *Instructograph* the choice of hundreds of schools, government programs, and radio clubs.

Some of the features which put the machine far ahead of most contemporary code-teaching equipment are continuously variable speed, variable tone pitch, and variable loudness. It has a built-in speaker, or you can use a headset for privacy. A key can be connected to the oscillator so you can learn to send perfectly formed code.

A large variety of tapes are available — 55 of them — so your practice need never be stereotyped. A beginner's selection of 10 tapes comes with the machine, and more may be purchased at any time. The variable-speed feature is especially useful because you can keep nudging the speed upward until you have mastered the skill needed for a particular class of license. You're not locked to a series of steps which might not fit your individual ability. Clubs and schools find the *Instructograph* especially fitted to their needs — it can be loaned to individuals or used in group sessions.

Each punched-paper tape is actually two lessons in one, because the tapes can be reversed to use the code on the other side. You cannot accidentally erase the tapes, and if one should tear, it can be taped or glued together again — you'll lose a part of a character at the most.

A book of instructions is included with the machine, which uses a method of learning the code that has proven successful over many years. The Instructograph Company slogan that headlines their brochure sums it up well, "If you want to do your best, get the best!"

For more information, write to Instructograph Company, Box 5032 Grand Central, Glendale, California 91201, or use *ad check* on page 94.

Hand-Held Tone Encoder

Standard Communications announces the availability of their new **TT-1A Touch-Call** encoder which can be mounted on the front of their Model C146A, C730L, or C830L hand-held transceivers. The unit uses the dual-tone, multiple-frequency system to enable the user to place remote telephone calls, obtain access to repeater systems, activate decoders in other transceivers, or to perform other remotely controlled operations.

The tones generated are compatible with both the Bell System and Radio Common Carrier telephone requirements. The encoder is solid state and generates two simultaneous audio tones between 600 and 1700 hertz. The digitally synthesized frequencies generated are non-harmonic and provide high immunity to false signaling. The TT-1A requires 7.5 to 15 Vdc for operation, which is obtained from the battery pack in the hand-held transceiver. These encoders may be used with the commercial versions of Standard Communications Corporation's hand helds which cover 450 to 512 MHz or 148 to 174 MHz, and with the amateur radio 144 to 148 MHz model. See your

Standard dealer or write Standard Communications Corporation, P.O. Box 92151, Los Angeles, California 90009, or use *ad check* on page 94.

1978 Electronics Catalog

A new, 168-page discount mail-order catalog is available from Fordham Radio Supply Co. This catalog has been specifically tailored as a quick reference and ordering guide for use by Radio/TV servicemen, electronic technicians, amateurs, CB users, and hobbyists. Included are test equipment, CB equipment, tools, service and repair kits, tubes, phono cartridges and needles, speakers and microphones, antennas, components, and many servicing aids from various major name-brand manufacturers. Particular emphasis is devoted to test equipment, with B & K, Sencore, Hickok, VIZ, Leader, Simpson, and many others included.

All products are shown with their discounted prices, and a handy ordering form is included. Free copies of the catalog are available on request. Write to Fordham Radio Supply Co., 855 Conklin St., Farmingdale, New York 11735; or use *ad check* on page 94.

Amateur TV Converter

A new tunable converter offered by Science Workshop provides reception of fast-scan ATV in the 420-MHz band with any TV set. By connecting a vhf antenna to the input of the converter, and the output of the converter to the vhf antenna terminals of any TV set, the operator can *see* what the local hams are doing on ATV. Features and specifications of this Model ATVC-10 converter include the following: a low-noise, high-gain rf-amplifier stage with varactor-tuned input and output, an active (transistor) mixer stage with varactor-tuned input, and a varactor-tuned oscillator stage. The rf gain is adjustable. The built-in ac power supply uses a transformer for power-line isolation. The converter tunes electrically (no moving parts) from 420 to 450 MHz. Output is on vhf-TV channels 2 through 6.

The ATVC-10 comes completely wired, tested and guaranteed for 2 years. It is housed in an attractive 2-tone (walnut and beige) finished aluminum cabinet. Price for a factory-wired unit is only $49.95. A semi-kit (critical circuits prewired and aligned) version is available for $39.95. Full instructions are included. For additional information, write to Science Workshop, Box 393, Bethpage, New York, 11714, or use *ad check* on page 94.

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Gotham beams stand out, offering championship performance at modest prices.

Adjustable to any frequency within band, at lowest SWR, these beams are built strong to resist adverse weather conditions. Each beam is full size for full size performance, not mini beams or trapped beams. Includes boom, all hardware, and gamma match. Requires 52 or 72 ohm coaxial feedline. 7/8" and 1" aluminium alloy elements for maximum strength and low wind loading.

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Formerly Glade Valley School Radio Session

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HELP IS ON THE WAY.

Notcher CW filter - Make sense out of the pile-ups! The Notcher funnels down to 150 Hz bandwidth @ -3dB to separate CW signals. Unit operates with 9 volt internal battery or 5-15 VDC external source. Also makes a great 8040-B companion! HWD approx. 2½" x 4" x 6". **$34.95**

Mobile 2 magnetic mount VHF antenna - The features and quality are here, but the high price isn't. The popular Mobile 2 magnet mount is now available in ⅝ or ¼ wavelengths for 146, 220 or 440 MHz bands. Choose any combination for the same low price. Stays put, even while passing large trucks! **$19.95**

Mobile 2 trunk mount VHF antenna - Already the best VHF bargain on the amateur market, and now we've added ⅝ wavelength to your choices! The Mobile 2 is a rugged, well-built antenna with high-lustre chrome plated base and 18 feet of coaxial cable. Specify ⅝ or ¼ wavelength for 146, 220 or 440 MHz bands. **$11.95**

Freedom VFO - Better than a pet rock! The Freedom VFO sets you free to roam from 3.650-3.750 MHz on 80 meters and 7.000-7.200 MHz on 40 meters. Designed to drive the high impedance oscillator tubes of a variety of "oldie-but-goodie" crystal-bound transmitters.

The Standard frequency calibrator - Know for sure you're on frequency. Pulsed markers are generated every 50 KHz on 160-10 meters for pinpoint calibration from band to band. No direct connections required and unit operates on internal 9 volt or external 5-15 VDC source. HWD approx. 2½" x 4" x 6". **$39.95**

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GENERAL CHAIRMAN: Sam Dear, K6BWT, 13031 Papago Dr., Poway, CA 92064
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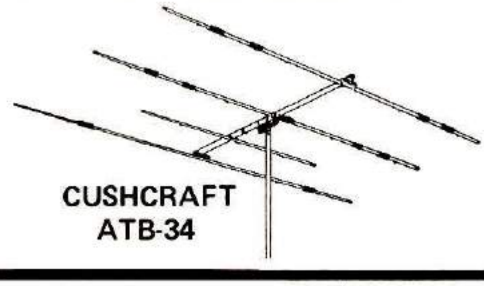

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742 MOBILE ANTENNA 75/40/20, 500W PEP, AUTOMATIC SWITCHING	109.95
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SWR-3 MEASURE SWR 1:1 TO 3, 1.7-50 MHz SO-239 INLINE	14.95
WM-2000 INLINE WATTMETER 3 SCALES TO 2 KW, POWER/SWR 3.5-30 MHz	64.95
WM-3000 A TRUE PEP SSB INLINE PEAK RMS WATTMETER/SWR TO 2 KW RMS ON PEAK BY SWITCHING	87.95
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MOSLEY

CL-36 CLASSIC 6EL 10/15/20 BEAM	310.00
CL-33 CLASSIC 3EL 10/15/20 BEAM	232.00
TA-33 JR 3EL 10/15/20 BEAM	151.00
TA-33 3EL 10/15/20 BEAM	206.00
TA-40KR CONVERSION KIT ADD 40M TO TA-33	92.00

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FINCO

A10-4 BEAM 10M 4EL	57.00
A6-5 BEAM 6M 5EL	41.95
A6-2 BEAM 6 AND 2M COMBO	68.60
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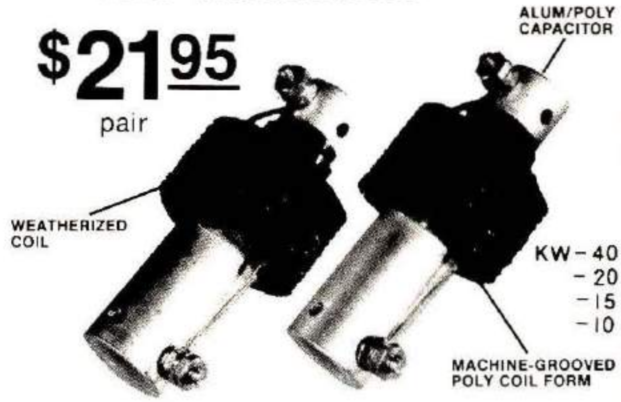

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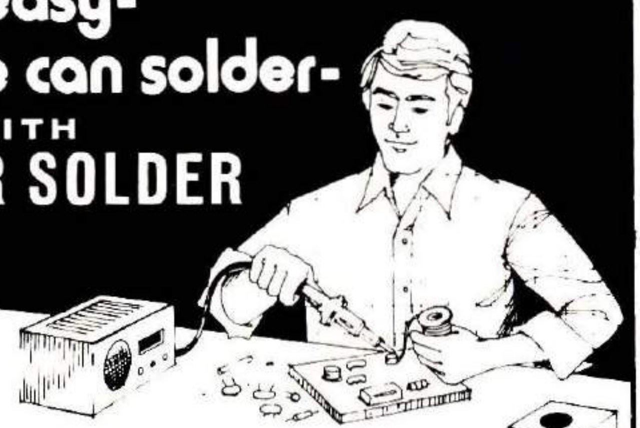

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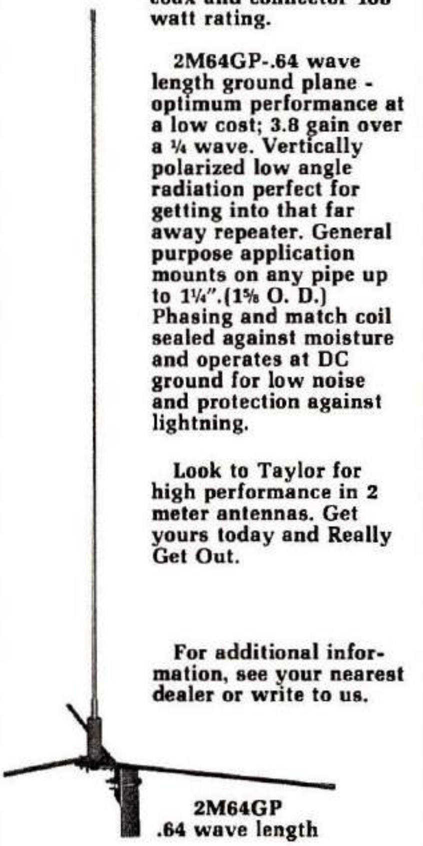

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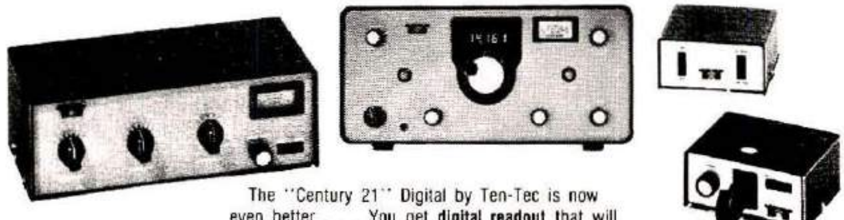

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MICHIGAN: BLACK RIVER AMATEUR RADIO CLUB will operate a SPECIAL EVENT STATION — W8IGV — at the *National Blueberry Festival*, July 20th, 21st, 22nd, and 23rd on the following frequencies: 3.975, 7.275, 14.275, 21.375, 28.675 and 29.475 (OSCAR) MHz, and randomly throughout the NOVICE sub-bands. A colorful certificate will be awarded to any ham that works the station during the festival, and will be mailed post-paid to any station that sends us a confirming QSL. Send cards to: The National Blueberry Festival, P.O. Box 224, South Haven, Michigan 49090.

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OKLAHOMA — Central Oklahoma Radio Amateurs will present Ham Holiday '78, July 28, 29, 30. Location: Lincoln Plaza Forum, 4345 North Lincoln Boulevard, Oklahoma City. Pre-registration closes July 14 with a fee of $3.00, $4.00 at the door. Non-commercial flea market tables FREE in the TEN THOUSAND SQUARE FOOT FLEA MARKET AREA. Commercial exhibitors contact K5MB, (405) 787-9545 or 787-9292. Technical programs are scheduled throughout the hamfest. Many prizes given away, including a special pre-registration prize. Mail pre-registrations to HAM HOLIDAY '78, P.O. Box 14604, Oklahoma City, OK 73113.

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CONNECTICUT: WELI ARC'S SECOND ANNUAL FLEA MARKET & AUCTION Sunday, August 20 (rain date August 27) from 10:00 AM to 4:00 PM at Radio Towers Park, Benham Street, Hamden, Connecticut. General admission 50¢, vendor spaces $5 each. For more information, contact Mike, WA1PXM, at (203) 943-1063, or Dave, WA1ZWB, at (203) 467-3258.

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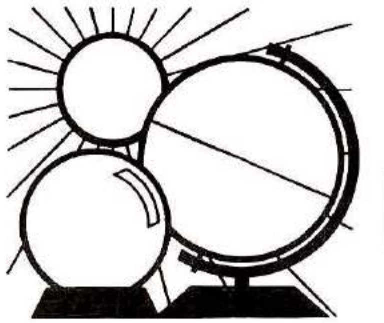


DX FORECASTER

Although DX conditions will not be quite as good as they were this spring, and certainly not as good as they will be this fall, it's been a good many years since summertime DX has been as good as it is right now! In spite of seasonal high noise levels and high absorption levels, most of the bands between 40 and 10 will yield good DX conditions at some time or other each day. The major reason for the good news is the very rapid rise in sunspot activity. Former pessimists are now revising last year's gloomy reports about Cycle 21, and some even predict that the peak of this cycle may rival that of Cycle 19 — the highest in recorded history!

Last-minute Forecast

You may expect a major disturbance sometime between July 7th and 10th, with much ionospheric and geomagnetic activity, accompanied or shortly followed by unusual atmospheric conditions. Then, between July 17th and 20th, you can anticipate another disturbance which may equal the earlier storm's intensity. The remainder of the month should provide relatively calm, typical mid-summer conditions.

Band-by-band Propagation

Fifteen and *twenty meters* will vie with each other for best DX band this month. The charts will be your best guide to where and when. At certain times *both* bands will be open simultaneously to the area of your choice. Choose the band where signal levels are best, and QRM least, by listening! Expect short skip to 1900 kilometers (1200 miles). *Ten Meters* will be exciting in July, although there are fewer DX openings than at the equinoxes. Short skip activity will be superb to about 2000 kilometers (1300 miles) on most days.

Eighty and *Forty Meters* will suffer from QRN due to thunderstorm activity, and will also suffer from high signal absorption during daylight hours. On quiet evenings DX will be available. Plan your best efforts for twilight and dawn, however, as signals travel along the terminator with surprising strength at these times. Short skip will be good on these bands between 500 and 1200 kilometers (300 to 800 miles) on eighty and 1100 and 1600 kilometers (700 to 1000 miles) on forty.

VHFers will enjoy sporadic E propagation that is largely a holdover from June. Look for openings around noon and again at sunset. Moon Perigee occurs on July 19. The S. delta Aquarid meteor shower will occur July 29th with a peak rate of 20 per hour. Happy hunting!

Tips on using the chart:

The asterisks (*) mean to look at the next *higher* band, because it, too, may be open on the path and at the time indicated. The arrows indicate general beam-pointing directions, with north at the top.

HRH

JULY

WESTERN USA

GMT	PDT	N ↑ CENTRAL ASIA	NE ↗ EUROPE	E → S. AFRICA	SE ↘ S. AMERICA	S ↓ ANTARCTICA	SW ↙ NEW ZEALAND	W ← W. AUSTRALIA OCEANIA	NW ↖ FAR EAST
0000	5:00	20	20	—	15	—	15	15	15
0100	6:00	20	20	—	15	—	15	15	15
0200	7:00	20	20	—	15	—	15	15	15
0300	8:00	15	20	—	15	20*	15	15	20
0400	9:00	15	20	20	20	20	15	10	20
0500	10:00	15	20*	20	20	20	15	15	20*
0600	11:00	20	15	20	20	20	20	15	20*
0700	12:00	20	15	20*	20	—	20	20	20*
0800	1:00	20	20	20*	40	—	20	20	20*
0900	2:00	20	20	—	40	—	20	20	20
1000	3:00	20	—	—	20	40	—	20	20
1100	4:00	—	—	—	20	40	—	20	20
1200	5:00	—	—	20	20	40	—	20	20
1300	6:00	—	—	20	20	40	—	—	20
1400	7:00	20	15	20	20	—	—	—	20
1500	8:00	20	15	20	20	—	20	20	15
1600	9:00	20	15	20	15	—	—	20*	20
1700	10:00	15	15	20	15	—	—	15	20
1800	11:00	15	15	15	15*	—	—	15	20
1900	12:00	15	20	15	15*	—	20	10	20
2000	1:00	20	20	20	15*	—	20	15	15
2100	2:00	20	20	20	15	—	20	15	15
2200	3:00	20	20	—	15	—	15	15	15
2300	4:00	20	20	—	15	—	15	15	15

MID USA

GMT	MDT	N ↑ CENTRAL ASIA	NE ↗ EUROPE	E → S. AFRICA	SE ↘ S. AMERICA	S ↓ ANTARCTICA	SW ↙ NEW ZEALAND	W ← AUSTRALIA	NW ↖ FAR EAST	CDT
0000	6:00	20	20	—	20	—	15	15	15	7:00
0100	7:00	20	20	—	20	20	15	15	15	8:00
0200	8:00	15*	40	—	20	20	15	15	15	9:00
0300	9:00	20	40	—	20	20	15	15	15	10:00
0400	10:00	20	40	20	20	20	15	15	15	11:00
0500	11:00	20	20	20	20	20	15	15	15	12:00
0600	12:00	20	15	—	20	—	15	15	15	1:00
0700	1:00	20	20	—	40	—	20	20	15	2:00
0800	2:00	—	—	—	40	40	20	20	15	3:00
0900	3:00	—	—	20	40	40	20	20	20	4:00
1000	4:00	—	—	20	20	40	40	20	20	5:00
1100	5:00	20	15	15	20	40	40	40	20	6:00
1200	6:00	20	15	20*	20	40	40	40	20	7:00
1300	7:00	20	15	20	15	—	40	40	15	8:00
1400	8:00	20	15	20	15	—	—	—	15	9:00
1500	9:00	20	15	20	15	—	—	—	20	10:00
1600	10:00	20*	15	20*	15	—	—	20	20	11:00
1700	11:00	15	15	15	15	—	—	20	20	12:00
1800	12:00	15	15	20*	15	—	20	20	20	1:00
1900	1:00	20	20	20	15	—	20	20	20	2:00
2000	2:00	20	20	—	15	—	15	15	20	3:00
2100	3:00	20	20	—	15	—	15	15	20	4:00
2200	4:00	20	20	—	15	—	15	15	15	5:00
2300	5:00	20	20	—	20	—	15	15	15	6:00

EASTERN USA

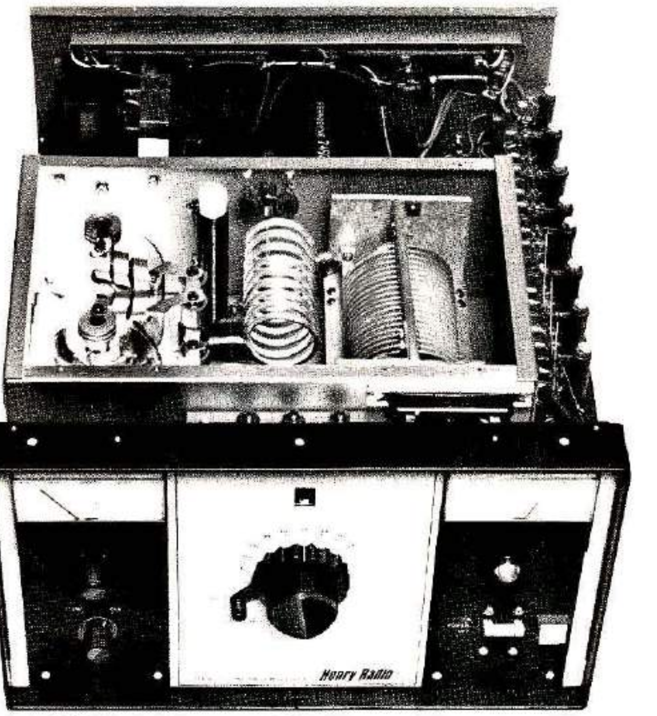
GMT	EDT	N ↑ FAR EAST	NE ↗ EUROPE	E → CENTRAL AFRICA	SE ↘ S. AFRICA	S ↓ S. AMERICA	SW ↙ OCEANIA	W ← W. AUSTRALIA NEW ZEALAND	NW ↖ AUSTRALIA
0000	8:00	20*	20	20	20	15	20	15	15
0100	9:00	20*	20	20	20	20	20	15	15
0200	10:00	20*	20	20	40	20	15	15	15*
0300	11:00	20*	40	40*	40	20	20	15	15
0400	12:00	15	40	20	40	—	20	20	20
0500	1:00	15	40	20	40	—	15	20	20
0600	2:00	—	—	—	40	—	—	20	20
0700	3:00	—	—	—	—	—	—	20	—
0800	4:00	—	—	—	—	—	—	40	40*
0900	5:00	40	20	—	—	—	—	40	40*
1000	6:00	40	20	20	20	20	40	40	40*
1100	7:00	20	20	20	20	20	40	40	40*
1200	8:00	20*	20	20	20	15	—	—	—
1300	9:00	15	15	15	15	15	—	—	—
1400	10:00	15	15	15	15	15	—	20	—
1500	11:00	15	15	15	15	15	15	—	—
1600	12:00	15	15	15	15	15	15	—	—
1700	1:00	20	15	15	15	15	15	—	—
1800	2:00	—	15	20*	20*	15	15	—	—
1900	3:00	—	20	20	20	15	15	20	20
2000	4:00	15	20*	20	20	15	15	20	20
2100	5:00	15	15	20	20	15	15	20*	20*
2200	6:00	20*	20	20	20	15	15	15	15
2300	7:00	20*	20	20	20	15	20*	15	15

HAM CALENDAR

July 1978

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
*All International events such as contests are shown on the GMT days on which they take place even though they may actually begin on the evening of the preceding day in North America		Straight Key Night 4TH OF JULY	The Black River ARC will be operating Special Event Station W8IGV during the National Blueberry Festival. The station will be on the air the 20, 21, 22 & 23rd at various times on the approximate following frequencies 3 975, 7 275, 14 275, 21 375, 28 675, 29 475 (OSCAR), and randomly throughout the Novice sub-bands. Address for QSLs is: The National Blueberry Festival, P.O. Box 224, South Haven, Michigan 49090			ARRL West Virginia State Convention — Jackson's Mill, WV — 1-2 Black Hills ARC South Dakota Hamfest — Surbeck Center on the Campus of the South Dakota School of Mines and Technology — Rapid City, South Dakota First 7-Land QSO Party — By NAS WHIDBEY ISLAND ARC, Washington State — 1200Z 7/1 - 2400Z 7/2 — Summary sheets and contest rules can be obtained from: NAS WHIDBEY ISLAND ARC, Bill Gosney, WB7BFK, 4471 40th NE St., Oak Harbor, WA 98277 1
 See July 1, 3, 4, 8, 15, 17, 20, 29 2	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31/.91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB WEST COAST BULLETIN Edited & Transmitted by W6ZF 9PM PDST 3540 kHz A-1 22 WPM 3	AMSAT Eastcoast Net 3850 kHz 9PM EDST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz 9PM CDST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 8PM PDST (0300Z Wednesday Morning) 4	5	CHN-MARAC Convention — Holiday Inn, 4545 N. Lindburg Blvd., Bridgeton, MO — WØFF — 6-8 6	7	Charlestowne Hamfest — Gaillard Municipal Auditorium — Charleston, SC 8-9 IARU Radiosport Competition — 8-9 International Hamfest — Canadian Pavilion in the International Peace Gardens — Manitoba, Canada — WAØWBU, WAØIOB, VE4RW, VE4RO 8-9 NOARSFEST — Lorain County Fairgrounds — Wellington, OH — N8DE Northern Berkshire ARC Hamfest — Cummington Fairgrounds, Cummington, MA — WA1ZNE — 8-9 **Continued below 8
Indianapolis Hamfest — Marion County Fairgrounds, S.E. Corner Indianapolis, IN Tusco RC and Canton ARC Hall of Fame Hamfest — Stark County Fairgrounds — Canton, OH 9	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31/.91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB 10	AMSAT Eastcoast Net 3850 kHz 9PM EDST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz 9PM CDST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 8PM PDST (0300Z Wednesday Morning) 11	12	13	14	HK Contest — 15-16 Ten-Ten International Net Summer QSO Party — 0000Z 7/15 - 2400Z 7/16* Tri-Club Hamfest — Allentown Police Academy — Lehigh Parkway South Allentown, PA — K3AI Wood County ARC Ham-A-Rama — The Fairgrounds in Bowling Green, OH (Just off I-75) 15
16	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31/.91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB WEST COAST BULLETIN Edited & Transmitted by W6ZF 9PM PDST 3540 kHz A-1 22 WPM 17	AMSAT Eastcoast Net 3850 kHz 9PM EDST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz 9PM CDST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 8PM PDST (0300Z Wednesday Morning) 18	19	20	21	Amateur Computing '78 — Sheraton National Hotel, Columbia Pike and Washington Boulevard, Arlington, VA — Info: AMRAD, P.O. Box 682, McLean, VA 22101 — 22-23 22
Indian Foothills ARC, Inc. Hamfest — Saline County Fairgrounds Marshall, MO Kent State ARC Hamfest — Kent State Campus — Salem, OH — W8JPG Rhode Island QSO Party — Phone & CW — By the East Bay Amateur Wireless Assoc. — 1700Z 7/22 - 0500Z 7/23 - 1300Z 7/23 - 0100Z 7/24 Two Rivers ARC Hamfest — Green Valley Fire Department Fairgrounds off U.S. Rt. 30 near East McKeesport, PA VHF/UHF Antenna Measuring Contest/Fleamarket — Trenton State College — Trenton, NJ — K2UYH 23	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31/.91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB 24	AMSAT Eastcoast Net 3850 kHz 9PM EDST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz 9PM CDST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 8PM PDST (0300Z Wednesday Morning) 25	26	27	Ft. Tuthill Hamfest — By the Amateur Radio Council of Arizona — Phoenix, AZ WB7NUV — 28-30 Central Oklahoma Radio Amateurs Ham Holiday — Lincoln Plaza Forum — 4345 North Lincoln Blvd. — Oklahoma City, OK — 28-30 28	County Hunters Contest — CW — 29-31 New Jersey QSO Party — Phone & CW — By the Englewood ARA, Inc. 2000Z 7/29 - 0700Z 7/30 — 1300Z 7/30 - 0200Z 7/31* UP HAMFEST — Co-Sponsored by the Great Northern Repeater Assoc. and the Mich-A-Con ARC of Iron Mountain — Kingsford, MI — Dickinson County Armory on M-95 — Kingsford, MI — 29-30 29
Baltimore Radio Amateur Television Society Hamfest — Howard County Fairgrounds — 15 Miles W. of Baltimore, MD 30	FLORIDA HAM NEWS — SWAP NET By the Broward ARC 146.31/.91 at 7:30PM GLENHURST RADIO SOCIETY Transmits Amateur Radio News — 222.66/224.26 MHz via WR2APG and 21.400 MHz USB 31	VHF SPACE NET CONTEST — from 6PM Saturday, July 15th to 9PM Sunday, July 16th, local times. This event commemorates the 9th Anniversary of Apollo II, man's first landing and walk on the moon. Activity will be on 50, 144, 220 MHz etc., in all modes except repeaters. Special bonus surprise for all stations working Space Net Center. Mailing of logs with deadline of August 10, 1978. VHF Space Center, K4AWS, Box 15, Sumterville, Florida 33585		CATAGORIES Class 1 - 100-500 watts; Class 2 - 25-200 watts; Class 3 - 5-25 watts; Class 4 - 1-5 watts; Class 5 - CW only, with any power; Class 6 - XYL only, with any power; Class 7 - Club participation		**Ohio Area Repeater Council Meeting — Delaware County Historical Society — Delaware, OH South Milwaukee ARC Swapfest '78 — Shepard Park — 9327 South Shepard Avenue — Oak Creek, WI — WB9TIK

Before you buy an amplifier



Lift the Lid

Before you invest your hard earned money in a linear amplifier, consider what's inside. That's where the difference in quality is obvious. No lightweight, cheaply built components...In Henry amplifiers you will find only the best quality, heavy duty components. We build our amplifiers to perform at peak level month after month, year after year. Both the 2KD-5 and the 2K-4 will operate full legal power continuous duty on all modes. We offer the amateur the linear amplifier that we would want in our own stations.

At Henry Radio we know how to build only one kind of amplifier...the best!

2KD-5 GENERAL SPECIFICATIONS:

- ✱ The 2KD-5 is a 2000 watt PEP input (1200 watt PEP nominal output) RF linear amplifier, covering the 80, 40, 20, and 15 meter amateur bands.
- ✱ Two Eimac 3-500Z glass envelope triodes operating in a grounded grid circuit.
- ✱ Pi-L plate circuit with a rotary silver plated tank coil for greatest efficiency and maximum attenuation of unwanted harmonics.
- ✱ Full legal input in all modes. 2000 watts PEP input for SSB. 1000 watts DC input for CW, RTTY and AM.
- ✱ Jumper for 115 or 230 VAC, 3 wire single phase.
- ✱ 10.5" high x 15" wide x17.5" deep
- ✱ Price...$895.00

2K-4...LINEAR AMPLIFIER. Offers engineering, construction and features second to none. Provides a long life of reliable service, while its heavy duty components allow it to loaf along even at full legal power. Operates on all amateur bands, 80 thru 15 meters. If you want to put that strong clear signal on the air that you've probably heard from other 2K users, now is the time. Move up to the 2K-4. Floor console...$1095.00

TEMPO 6N2 brings the same high standards to the 6 and 2 meter bands. A pair of advanced design Eimac 8874 tubes provide 2,000 watts PEP input on SSB or 1,000 watts on FM or CW. Complete with self-contained solid state power supply, blower and RF relative power indicator. ...$895.00

TEMPO 2002. The same fine specs and features as the 6N2, but for 2 meter operation only. ...$745.00

TEMPO 2006. Like the 2002, but for 6 meter operation. ...$795.00

TEMPO VHF/UHF AMPLIFIERS. Solid state power amplifiers for use in most land mobile applications. Increases the range, clarity, reliability and speed of two-way communications. FCC type accepted also.

Model	Drive Power	Output Power	Price
LOW BAND VHF AMPLIFIERS (35 to 75 MHz)			
Tempo 100C30	30W	100W	$159.
Tempo 100C02	2W	100W	$179.
Tempo 100C10	10W	100W	$149.
HIGH BAND VHF AMPLIFIERS (135 to 175 MHz)			
Tempo 130A30	30W	130W	$189.
Tempo 130A10	10W	130W	$179.
Tempo 130A02	2W	130W	$199.
Tempo 80A30	30W	80W	$149.
Tempo 80A10	10W	80W	$139.
Tempo 80A02	2W	80W	$159.
Tempo 50A10	10W	50W	$ 99.
Tempo 50A02	2W	50W	$119.
Tempo 30A10	10W	30W	$ 69.
Tempo 30A02	2W	30W	$ 89.
UHF AMPLIFIERS (400 to 512 MHz)			
Tempo 70D30	30W	70W	$210.
Tempo 70D10	10W	70W	$240.
Tempo 70D02	2W	70W	$270.
Tempo 40D10	10W	40W	$145.
Tempo 40D02	2W	40W	$165.
Tempo 40D01	1W	40W	$185.
Tempo 25D02	2W	25W	$125.
Tempo 10D02	2W	10W	$ 85.
Tempo 10D01	1W	10W	$125.

All of the above except the 6N2, 2002, and 2006 are available at Tempo dealers throughout the U.S.

TEMPO 100AL10 VHF LINEAR AMPLIFIER. Completely solid state, 144-148 MHz. Power output of 100 watts (nom.) with only 10 watts (nom.) in. Reliable and compact...$199.00
TEMPO 100AL10/B BASE AMPLIFIER...$349.00

Henry Radio also offers a broad line of commercial and FCC type accepted amplifiers covering the range of 3 MHz to 500 MHz. Henry amplifiers are in use all around the world. Commercial and export inquiries are invited.

Tempo solid state amplifiers are available at Tempo dealers throughout the U.S.

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Gotham *
Hal ___ 057
"Ham" Buerger *
Hamco ___ 692
Ham Center ___ 491
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JULY, 1978

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THE *ALPHA'S* ARE COMING!

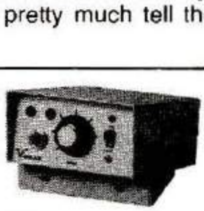
FOUR RUGGED NEW BEAUTIES . . . EACH IN A CLASS BY ITSELF

There are lots of so-called "Maximum Legal Power" linear amplifiers on the market. Why is it that so many knowledgable amateurs, after checking out (and often owning) the others, ultimately choose an ALPHA?

For one thing, "maximum legal power" doesn't begin to tell the whole story. Nearly all manufacturers' ratings implicitly assume an amateur service duty cycle much less than 100%. Even the terms "continuous" and "100%" duty have been so debased in recent years as to be meaningless unless explicitly defined. The consequence, too often, is a power transformer or tube going up in smoke during a long operating period.

Every ALPHA amplifier is unequivocally rated to run a full 1000 watts of continuous, average d-c power input, in any mode, with No Time Limit (NTL). You could leave your ALPHA (ANY ALPHA) all day with a brick on the key, at a kilowatt input (or at 2 KW PEP input, two-tone SSB) without hurting it. In fact, you could leave it for weeks: last year we ran a standard ALPHA 76 keydown at a kilowatt for 18 days without ill effect. That's ALPHA POWER. To top it off, your new ALPHA is protected by ETO's exclusive 18 MONTH factory warranty — SIX TIMES AS LONG as the industry-standard 90 days! Now that DOES pretty much tell the whole story.

ALPHA/VOMAX: SPEECH PROCESSING IN A CLASS BY ITSELF . . . for "talk power," low distortion, and ease of use, it has no equal.



These new ALPHA's are even better than their famed ALPHA 76/374 Series predecessors . . . Believe it or not!

The pleasure of owning and using a new ALPHA is enhanced by the ruggedly handsome new metal work . . . refined metering and pushbutton control systems . . . improved bandpass circuits in the no-tune-up models. One version combines the great conveniences of no-tune-up operation AND full CW break-in. Another brings ALPHA POWER to 6 meters.

We've retained the robust components and basic circuitry that compiled such an amazing record of freedom from major failures in the ALPHA 76 and '374. Why tamper with success?

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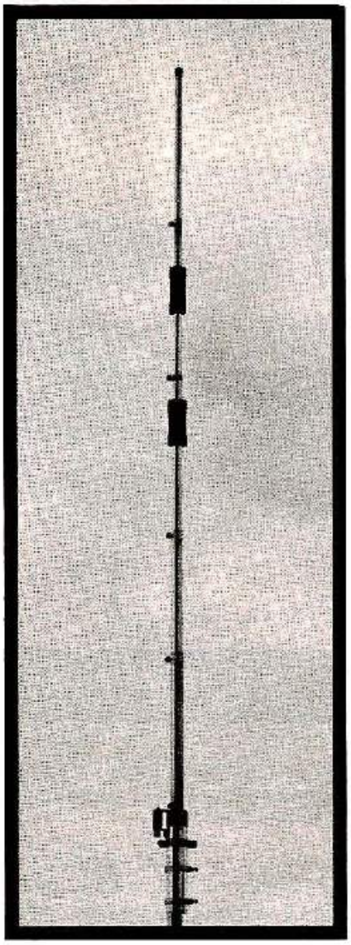
NEW HF VERTICALS BY CUSHCRAFT

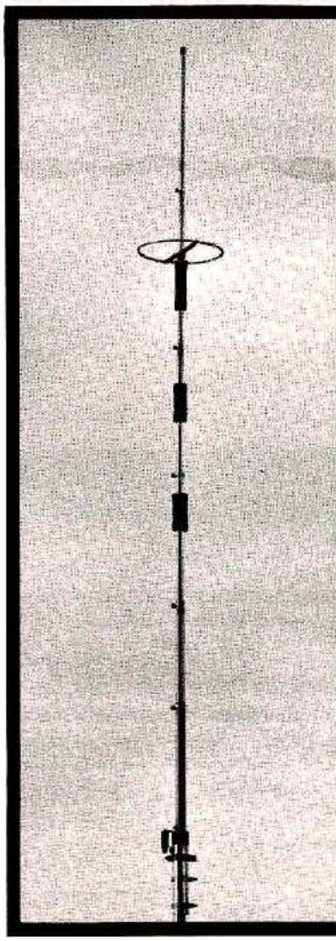
Cushcraft's new multiband vertical antenna systems have been optimized for wide operating bandwidth and provide the low angle of radiation which is essential for long-haul DX communications on the high-frequency amateur bands. The high Q traps which were designed especially for these verticals use large diameter enamelled copper wire and solid-aluminum air-dielectric capacitors, the trap forms are manufactured from filament-wound fiberglass for minimum dielectric loss and high structural strength. High strength 6063-T832 aluminum tubing with 0.058" (1.5 mm) walls is used for the vertical radiator. The massive 2 inch (50 mm) OD double-walled base section and heavy-duty phenolic base insulator ensure long life and durability. For maximum performance with limited space, choose a Cushcraft multiband vertical; all models may be roof or ground mounted on a 1¼" - 1⅞" (32 - 48 mm) mast.

10-15-20 METERS



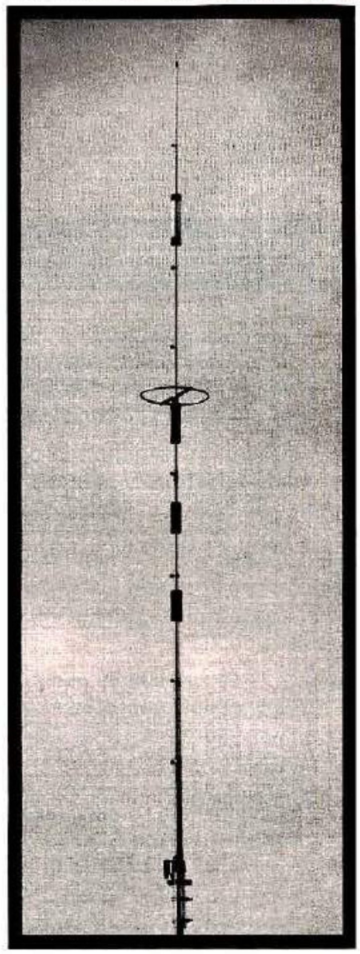
ATV-3 Cushcraft's ATV-3 multiband vertical provides low VSWR operation for both SSB and CW on 10, 15, and 20 meters. Matched to 50 ohms; built-in connector mates with standard PL-259. Stainless-steel hardware is used for all electrical connections. The ATV-3 is a compact 166 inches (4.2 meters) tall. Rated at 2000 watts PEP.

10-15-20-40 METERS



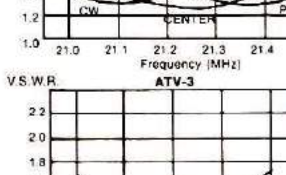
ATV-4 The Cushcraft ATV-4 four-band vertical antenna has been optimized for wide operating bandwidth on 10, 15, 20, and 40 meters. SWR is less than 2:1 over the CW and SSB segments of 10, 15, and 20. The 2:1 SWR bandwidth on 40 meters is approximately 240 kHz, may be quickly and easily adjusted to favor any part of the band. Coaxial fitting takes 50-ohm transmission line with PL-259 connector. Overall height, 233 inches (5.9 meters). Rated at 2000 watts PEP.

10-15-20-40-80 METERS

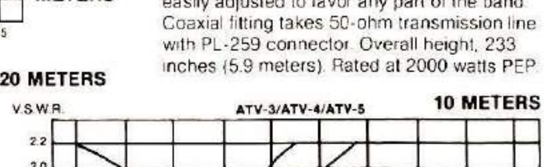


ATV-5 The ATV-5 trapped vertical antenna system has been engineered for five-band operation on 80 through 10 meters. The high Q traps are carefully optimized for wide operating bandwidth: 2:1 SWR bandwidth with 50-ohm feedline is 1 MHz on 10 meters; more than 500 kHz on 15 and 20 meters; 160 kHz on 40 meters; and 75 kHz on 80 meters. Instructions are provided for adjusting resonance to your preferred part of the band, CW or SSB. Built-in coaxial connector takes PL-259. Nominal height, 293 inches (7.4 meters). Rated at 2000 watts PEP on **all** bands.

15 METERS



20 METERS



10 METERS

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