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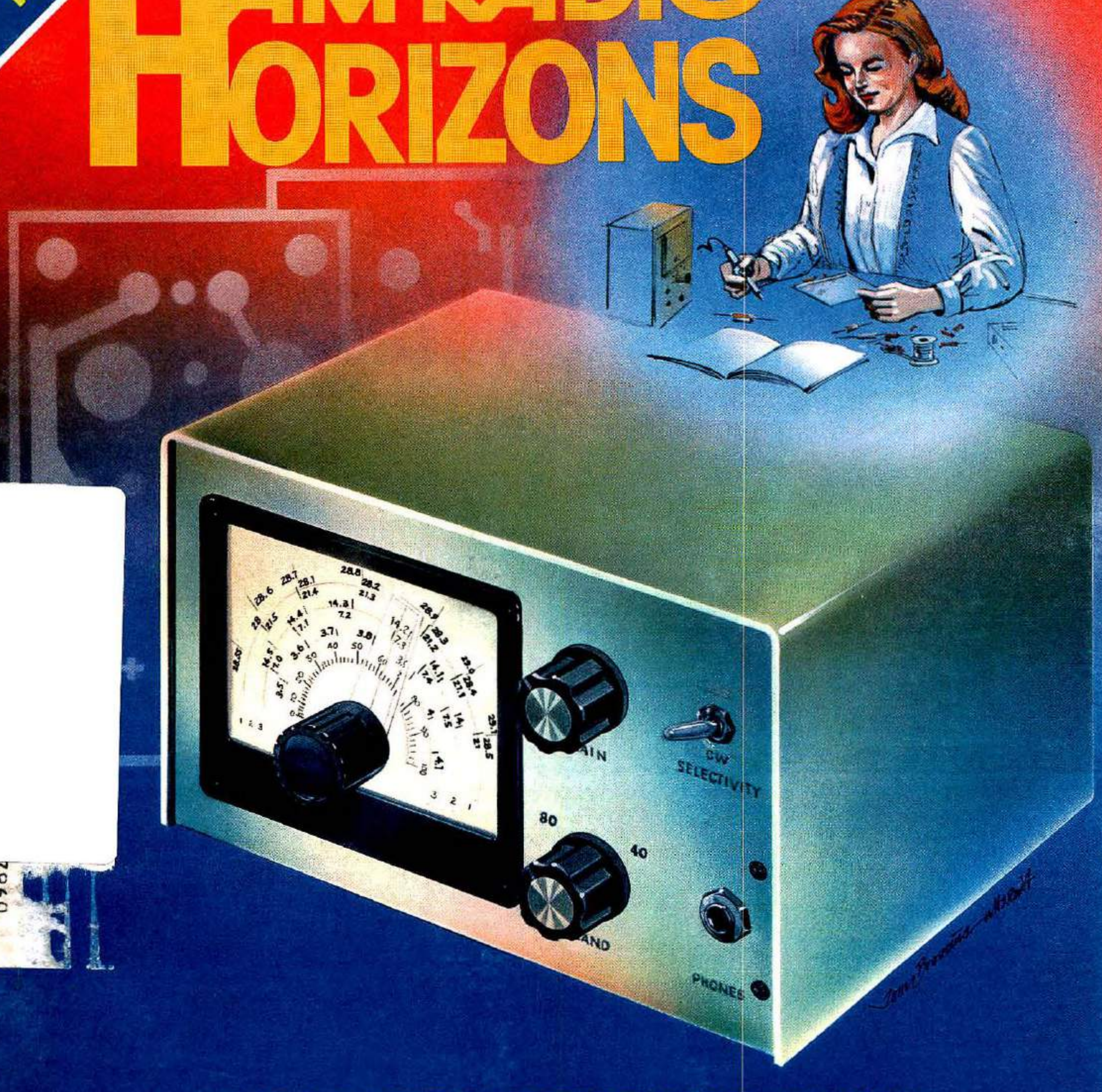

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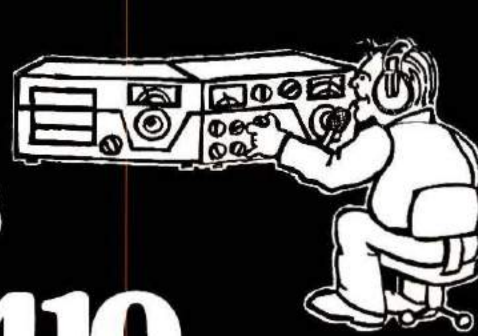

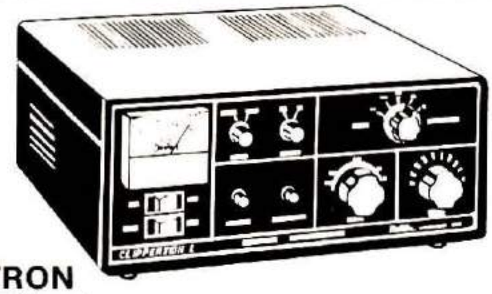

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160 thru 15 meters, 2000 watts PEP on SSB, 1000 watts DC on CW, RTTY, or SSTV, covers most MARS frequencies just outside Ham bands, and easily changed 117V or 234V AC 50-60 Hz.

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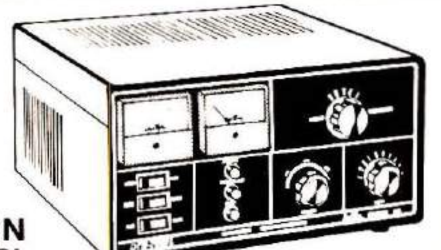

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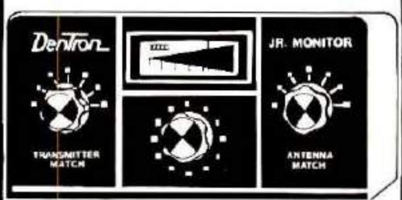

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More details? Ad Check page 86.

THIS MONTHS HORIZONS

Beginner's Receiver

Building a simple receiver is easy. Building a simple receiver which performs well takes just a bit more planning and more hardware, but the improvement is well worth the effort. W8YFB has a design that requires no apologies for performance, cost, or ease of construction. It's an 80- and 40-meter unit, and later there'll be a converter for the higher bands. Part one starts on page 12, so get out your note pad and pencil and make your shopping list.

How a Successful Ham Club Works

If you're not involved in an Amateur Radio club, you're missing a lot of fun and personal satisfaction. If you *are* involved in a club, you can benefit by the experiences of one of the most active organizations of this kind in the country — the Lockheed Amateur Radio Club of Burbank, California. Its call sign is W6LS. It has done much to promote the image of Amateur Radio. Perhaps you can adapt some of the ideas presented by author W6DDB to further improve your club activities. It's good reading for those who care about the future of Amateur Radio.

VHF Propagation

At one time Amateurs were relegated to the "useless" short waves, where "they'll never do much." Later, Amateurs had most of the "useless vhf territory" as an experimenter's domain, because "it's line-of-sight, and what can they do with it?" Author Buscemi calls upon his years of operating experience to show that Amateur life is not at all dull and restricted on our vhf bands — if you know what to look for and how to interpret what's happening.

Calibrate Your Calibrator

Most of the modern amateur equipment on the market has a calibrator built in, or at least it has provision to add on as an accessory. Circuits and kits are available to connect a calibrator to older equipment as well. How many of you have checked the accuracy of your calibrator recently? Just because the manufacturer intended for it to be at 100 kHz, or 1 MHz, or 10 MHz, doesn't mean that it will stay there; aging and temperature changes will have their effect. W8FX tells you how to obtain the utmost accuracy from your equipment — and you can do it without investing in a whole shackful of equipment.

A Project For The Inquiring Mind

Radio amateurs have contributed much to science by sheer persistence and the will to experiment. Author Jim Gray presents an example of how you can help to resolve a riddle that has been around for many years. It's a story of a machine using electronic circuits invented to detect the makeup of materials. But many questions remain to be answered. Perhaps they can be resolved by an experimental approach — it's a challenge for those willing to try.

Amateur Transmitters And Power Ratings

Claims by advertisers for transmitters and transceivers can be confusing. Author G3LLL provides some help in choosing the type of equipment that will give you the power you need.

The Saddlebag Communicator

"That thing is sure not a CB," said the old cowhand. He was right — it wasn't, and it saved the day when an emergency developed on an otherwise beautiful trail ride in the arid Southwest. The story is a true one, told by N5KR. Bill was one of the participants in the ride, and he believes in always having Amateur Radio communications within reach.

The Cover

Here's a simple communications receiver for 40 and 80 meters which will be popular with beginners and old timers alike. Designed by W8YFB, it features a very effective low-cost crystal filter which offers excellent selectivity for CW work. Part 1 of the description starts on page 12. Original painting by Tom Broscius, WA2RWA.

HAM RADIO HORIZONS February 1979, Volume 3, Number 2. Published monthly by Communications Technology, Inc., Greenville, New Hampshire 03048. Telephone (603) 878-1441. Second Class Postage paid at Greenville, New Hampshire and at additional mailing offices. Publication number 369690. Address all editorial and advertising correspondence to Greenville, New Hampshire 03048.

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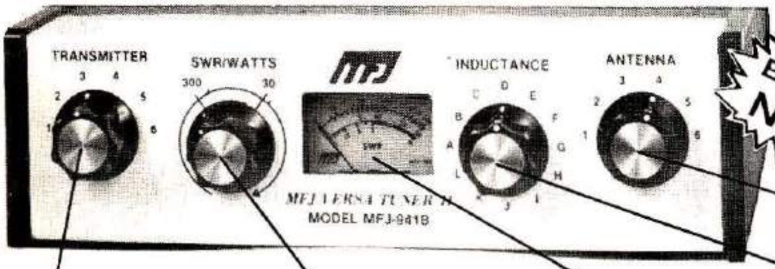


Transmitter matching capacitor. 208 pf. 1000 volt spacing.

Sets power range, 300 and 30 watts. Pull for SWR.

Meter reads SWR and RF watts in 2 ranges.

Efficient airwound inductor gives more watts out and less losses.

Antenna matching capacitor. 208 pf. 1000 volt spacing.

Only MFJ gives you this MFJ-941B Versa Tuner II with all these features at this price:

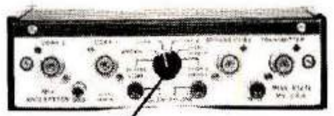
A SWR and dual range wattmeter (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

An antenna switch lets you select 2 coax lines direct or thru tuner, random wire/balanced line, and tuner bypass for dummy load.

A new efficient airwound inductor (12 positions) gives you less losses than a tapped toroid for more watts out.

A 1:4 balun for balanced lines. 1000 volt capacitor spacing. Mounting brackets for mobile installations (not shown).

With the NEW MFJ Versa Tuner II you can run your full transceiver power output — up to 300 watts RF power output — and match your transmitter to **any** feedline from 160 thru 10 Meters whether you have coax cable, balanced line, or random wire.



ANTENNA SWITCH lets you select 2 coax lines direct or thru tuner, wire/balanced line, dummy load.

You can tune out the SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, or whatever you have.

You can even operate all bands with just one existing antenna. No need to put up separate antennas for each band.

Increase the usable bandwidth of your mobile whip by tuning out the SWR **from inside your car.** Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

It travels well, too. Its ultra compact size 8x2x6 inches fits easily in a small corner of your suitcase.

This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

SO-239 coax connectors are provided for transmitter input and coax fed antennas. Quality five way binding posts are used for the balanced line inputs (2), random wire input (1), and ground (1).

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NEW MFJ-944 HAS 6 POSITION ANTENNA SWITCH ON FRONT PANEL. NEW LOWER PRICE

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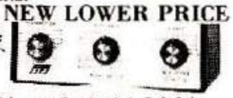

Same as MFJ-941B, less SWR/Wattmeter, antenna switch, mounting bracket. 7x2x6 in.

ULTRA COMPACT 200 WATT VERSA TUNERS FOR ALL YOUR NEEDS.

MFJ-901 VERSA TUNER MATCHES ANYTHING, 1.8 THRU 30 MHz. NEW LOWER PRICE

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Efficient 12 position air inductor for more watts out. Matches dipoles, vees, random wires, verticals, mobile whips, beams, balanced lines, coax. 200 watts RF. 1:4 balun. 5x2x6 in.

MFJ-900 ECONO TUNER MATCHES COAX LINES/RANDOM WIRES. NEW LOWER PRICE

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Same as MFJ-901 but less balun for balanced lines. Tunes coax lines and random lines.

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1.8 thru 30 MHz. Up to 200 watts RF output. Matches high and low impedances. 12 position inductor. SO-239 connectors. 2x3x4 inches. Matches 25 to 200 ohms at 1.8 MHz. Does not tune coax lines.

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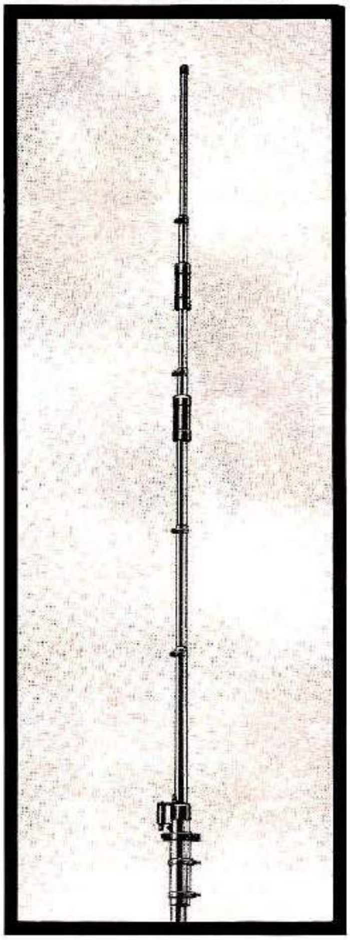
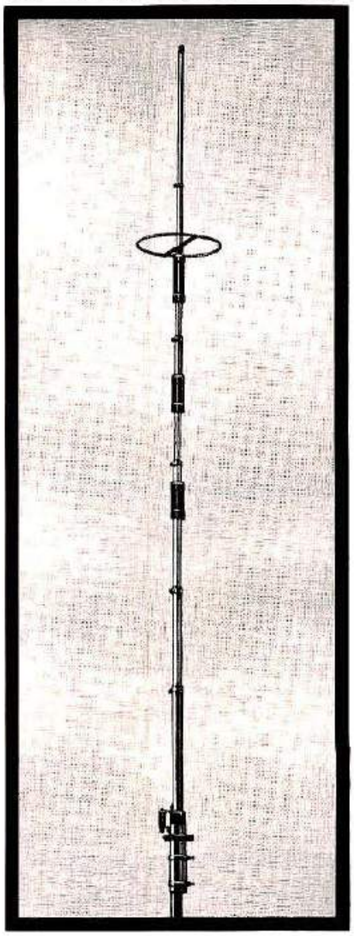
NEW HF VERTICALS BY CUSHCRAFT

10-15-20 METERS

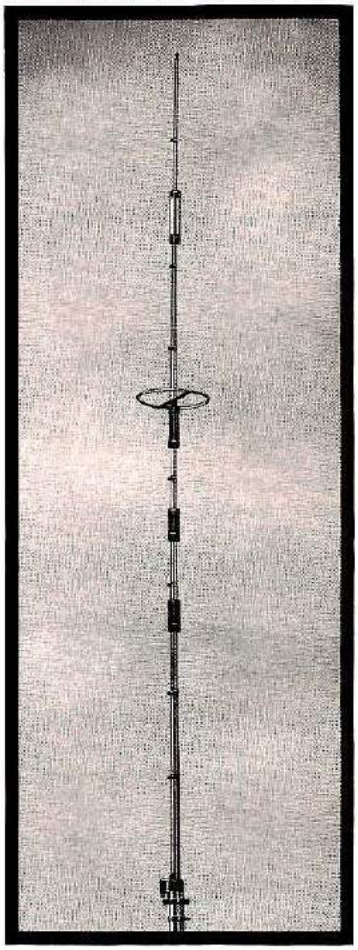


Cushcraft's new multiband vertical antenna systems have been optimized for wide operating bandwidth and provide the low angle of radiation which is essential for long-haul DX communications on the high-frequency amateur bands. The high Q traps which were designed especially for these verticals use large 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.

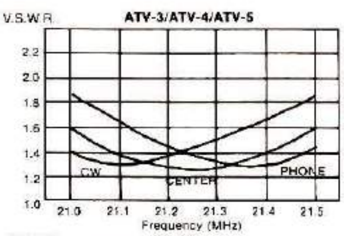
10-15-20-40 METERS

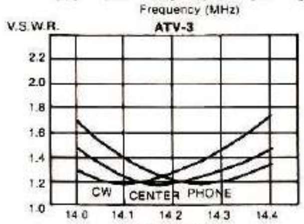


10-15-20-40-80 METERS

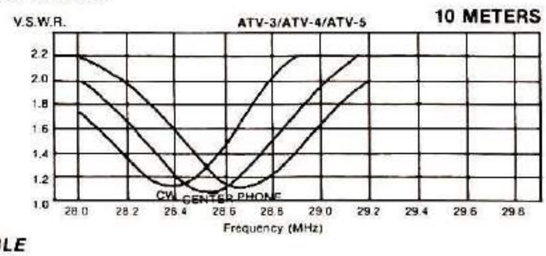


ATV-3 Cushcraft's ATV-3 multiband vertical provides low VSWR operation for both SSB and CW on 10, 15, and 20 meters. Matched to 50 ohms; built-in connector mates with standard PL-259. Stainless-steel hardware is used for all electrical connections. The ATV-3 is a compact 166 inches (4.2 meters) tall.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





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.



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.

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HAM RADIO HORIZONS

February 1979
Volume 3, Number 2

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CONTENTS

THE VIEW FROM HERE

Periodically, a story about the first ham station makes the rounds. It goes something like this: In Boston, just before 1910, there were three young wireless operators, Albert S. Hyman, Robert Almy and Reginald Murray. These young men put together a small wireless station, and since there were no licensing regulations at the time, they decided to call it the Hyman-Almy-Murray Wireless Station.

They soon discovered that was quite a fist-full on CW, so they took the first two letters of each operator's last name and station HYALMU went on the air. They used this callsign for several months, but were nearly involved in an international incident when a Mexican ship named the *Hyalmo* almost went aground off the New Jersey coast. They decided that their HYALMU callsign was too close to *Hyalmo* for comfort, so they took the first initials of their three names, and put Station HAM on the air. The first ham station? No. But probably the first, and possibly the only, Amateur Radio station with the HAM callsign.

Several sources have labeled this story as outright fiction, but it has been just persistent enough to arouse my curiosity. Several years ago I decided to track it down, and to determine once and for all if the story had any grain of truth.

Since at least one of the young men was supposedly a student at Harvard University and a member of the Harvard Wireless Club, I decided to start my search in the archives at Cambridge, Massachusetts. Sure enough, deep in the yellowed files there was an entry: Dr. Albert Salisbury Hyman, AB, 1915; MD, 1918. Could this be the same man who gave his last initial to Wireless Station HAM?

It looked promising. The Harvard Alumni Records Office revealed that Dr. Hyman was alive and well, and furnished me with his current address. I wrote to him, and his gracious reply confirmed that, yes, he was the same person who, with boyhood friends Robert Almy and Reginald Murray, had put Wireless Station HAM on the air. He also revealed that the "original ham" story first saw the light of day in a story written by wartime correspondent Percy Greenwood for a New York medical publication.

According to Dr. Hyman, Station HAM was not located at Harvard, as Greenwood's story indicates, but was actually at the Roxbury High School, which in the early 1900s was a prep school for the Ivy League.

A further search through the records disclosed that Dr. Hyman, before his graduation, was a shipboard wireless operator for the Eastern Steamship Line that ran ships from New York to Boston through the Cape Cod Canal. After graduating from medical school Dr. Hyman became a heart specialist and owned one of the first electrocardiograph machines in New York (in 1923). He was also the inventor of the artificial pacemaker used in resuscitating the dying heart.

So goes the saga of Wireless Station HAM. It was definitely not the first Amateur Radio station — that honor goes to some unknown wireless operator at least ten years earlier. Nor does it have anything to do with the fact that radio Amateurs are called "hams." That term goes back to the early days of wire telegraphy when slower, beginning operators were said to have a "ham for a fist;" Telegraphic shorthand reduced this phrase to *ham*. Since wire telegraphers were paid by the number of message words they exchanged during their shift, they didn't like to slow down for newcomers on the line, and they often let the poor beginners know about it in no uncertain terms!

When many of the wire telegraphers switched over to radio in the early 1900s, they brought with them much of their unique language. The commercial operators seldom communicated directly with Amateurs, but all the wireless stations in the early days were on the same frequencies, and the simple detectors then in use were unable to separate the signals; two Amateurs talking across town often jammed other local stations. When an important message was hopelessly garbled by a strong Amateur signal, the frustrated commercial operator often radioed:

"SORRY OLD MAN, PLEASE REPEAT, THOSE
DAMN HAMS ARE JAMMING YOU."

Amateurs, unfamiliar with the term, picked it up and wore it with honor. The original meaning of the word has completely disappeared over the years and is now used with pride by Amateurs all over the world.

Jim Fisk, W1HR
editor-in-chief

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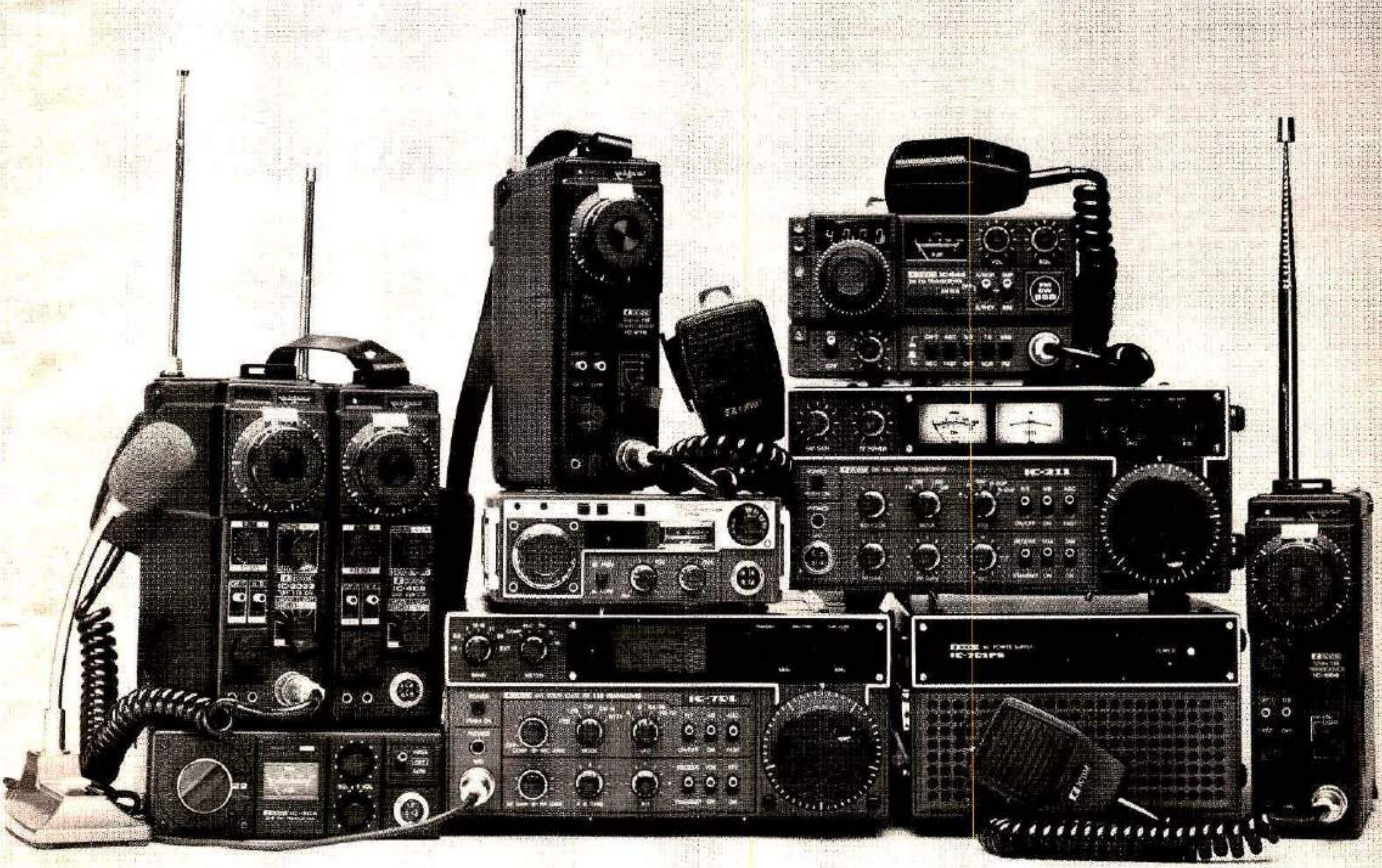

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FOCUS & COMMENT

This world of electronics is a fascinating place, and being in the publishing end of it makes it even more so — you just never know when you'll come across some interesting and unusual bit of information.

For instance, we have a story about Thomas Edison which should appear in our March issue. It's a great story, providing some insight into the drive of a great genius and experimenter. The authors really applied themselves to the subject, and the result is very readable, informative, and touches upon a discovery which Edison made but didn't develop.

In doing some research to find suitable artwork and illustrations to accompany the story, I visited a nearby large public library and gingerly leafed through the fragile pages of Scientific American from the period 1870-1880. That, in itself, is enough to keep you off the streets for hours at a time. It was a period of great and not-so-great inventions, and it became evident that a lot of people are still "inventing" the same gadgets (or trying to), 100 years later.

I'm not a poetry buff, having been force-fed plenty of it when I was too young to resist. However, something on one of the pages did catch my eye, and it was sufficiently unusual that I thought I'd pass it along. Of course, I had to find out what some of the names being tossed about have to do with the subject, so further research brought to light that Weber was a German physicist, and his name is now used to denote a unit of magnetic flux. Grove was a British physicist who invented several types of electro-chemical cells and used one type to provide electric light for a lecture. Daniell was a British chemist who invented a cell which was considerably better than the type then in use.

Several Encyclopedia did not enlighten me as to who or what Smee is, but then, poets are often hard pressed to find a rhyming word. I'll add that one to my list of things to look up the next time I'm in a large library. Here's a sample of what Maxwell did when he didn't feel like deriving equations:

ELECTRIC VALENTINE

Telegraph clerk A to Telegraph clerk B:
"The tendrils of my Soul are twined
With thine, though many a mile apart;
And thine in close-coiled circuits wind
Around the magnet of my heart.
"Constant as Daniell, strong as Grove;
Seething through all its depths, like Smee;
My heart pours through its tide of love,
And all its circuits close in thee.

"O tell me, when along the line
From my full heart the message flows,
What currents are induced in thine?
One click from thee will end my woes."
Though may an Ohm and Weber flew
And clicked this answer back to me:
"I am thy Farad staunch and true
Charged to a Volt with love for thee."

$\frac{dp}{dt}$

The cryptic signature was derived from the fundamental equation of thermodynamics:

$$\frac{dp}{dt} = J.C.M.$$ *(James Clerk Maxwell)*

Professor Maxwell used exercises like this in relaxation from more rigorous scientific thought.

From Scientific American, Jan. 10, 1880, reprinted with permission.

I couldn't have said it better myself! Happy Valentine's day, Happy Groundhog Day, and Happy Novice Roundup (that's a contest on February 3 to 11 — flex your keying muscles and go to it).

Thomas McMullen, W1SL
Managing Editor

ACCEPT NO SUBSTITUTES!

Before you make the choice of a new hand-held, ask about these important features:

1. Is the case fiberglass reinforced Lexan®?
2. Are the batteries convenient for carrying extras?
3. Is the capacity sufficient for a day's operation?
4. Is there a method for conserving battery life when high power is not required?
5. Does it fit your hand comfortably?
6. Do you have a choice of charging methods?
7. Do you have an ample choice of accessories to back up your radio?

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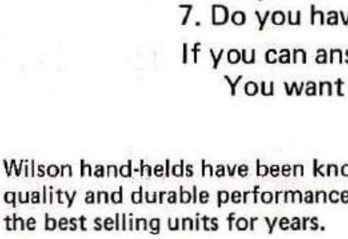
You want a Wilson Mark IV hand-held . . . and accept no substitute for it!

Wilson hand-helds have been known world-wide for exceptional quality and durable performance. That's why they have been the best selling units for years.

The Mark Series of miniature sized 2-meter hand-helds continues the tradition of dependability and operation, but in an easier to use, more comfortable to carry size.

The small compact size battery pack makes it possible to carry one or more extra packs in your pocket for super extended operation time. No more worry about loose cells shorting out in your pocket, and the economical price makes the extra packs a must.



Conveniently located on top of the radio are the controls for volume, squelch, accessory speaker mike connector, 6 channel switch, BNC antenna connector and LED battery condition indicator.

Optional Touch Tone™ Pad available.

MARK IV: ≃ 1 & 4.0 watts

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- Individual Trimmers on TX and RX Xtals
- Rugged Lexan® outer case
- Switchable Hi-Lo Power
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  TX - Mark IV: 900 mA Hi, 400 mA Low
- 12 KHz Ceramic Filter and 10.7 Monolithic Filter included.
- 10.7 MHz and 455 IKz IF
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- .3 Microvolt Sensitivity for 20 dB Quieting
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NEWSLINE

AMATEUR RADIO FARED QUITE WELL in the FCC's WARC 79 proposal, as further details were made available in mid-December. The biggest gain was the addition of three new HF Amateur bands — 10.1-10.2, 18.068-18.168, and 25.11-25.21 MHz — as exclusively Amateur bands worldwide. A 50-kHz addition to 15 meters, making it 20.95-21.45, is also in the proposed U.S. position, along with a shift 50 kHz downward for 40 meters to make it an exclusively Amateur band worldwide from 6.95-7.25 MHz.

80 Meters Would Become exclusively Amateur from 3.5-3.9 MHz in Region 2, where it's now shared with fixed and mobile services, while 3.9-4.0 MHz would remain shared as at present. The 10-meter band would remain as is, worldwide.

The Proposed Bottom-60-kHz loss on 160 to AM broadcast would be somewhat tempered by a proposed worldwide allocation of 1860-1900 kHz exclusively for Amateurs with 1900-2000 kHz remaining shared with other services in Regions 2 and 3.

With Two Notable Exceptions, the higher frequency Amateur bands also fared well. The big exception was 220-225 MHz, proposed for a worldwide Maritime Mobile band with Amateurs a secondary user in Region 2 only. Radiolocation use of the band would be continued as is through 1990 and beyond. The other significant loss is the lower part of the 1215-1300 MHz band, with Amateurs bumped from the lower 25 MHz in favor of navigational satellites. The 1240-1300 MHz portion would remain as is, shared with Radiolocation. No changes appear to have been proposed for 50, 144, 420, or the other higher frequency Amateur allocations.

REVELATIONS THAT AMATEUR RADIO was a principal communications tool of the People's Temple have heightened Amateur sensitivity to abuses of the Amateur bands. Legitimate Amateur operations by missionaries are sure to suffer from the tragic events, as government authorities as well as individual Amateurs pay more critical attention to what they hear in the Amateur bands. Amateurs in the Caribbean had been disturbed by the lower frequency Amateur operations of the People's Temple for some time, with a number of formal protests filed about those activities. It's no secret that Amateur frequencies and equipment have been used by dope traffickers, and unlicensed or improper use of the Amateur bands by boating enthusiasts has also been a cause of international concern.

A NEW ST. LOUIS AREA HAMFEST has just been announced for Saturday, March 31, at the St. Louis Convention Center. More than 30 exhibitors have already been signed, and a Midwest regional repeater council meeting will be held there along with the usual sessions on DX, antennas, computers, RTTY, ATV, and the like. For further details, contact K9EID.

UNUSUAL REPEATER INTERFERENCE in the Wyandotte, Michigan, 147.84-24 system was traced to a super-regenerative receiver in a nearby garage door opener. Quench frequency of the receiver detector was 600 kHz, and any strong nearby signal would cause the receiver to transmit signals of ±600 kHz from that signal. They could be heard for several blocks. The door-opener manufacturer has been very cooperative, working with area Amateurs to determine what's causing the problem.

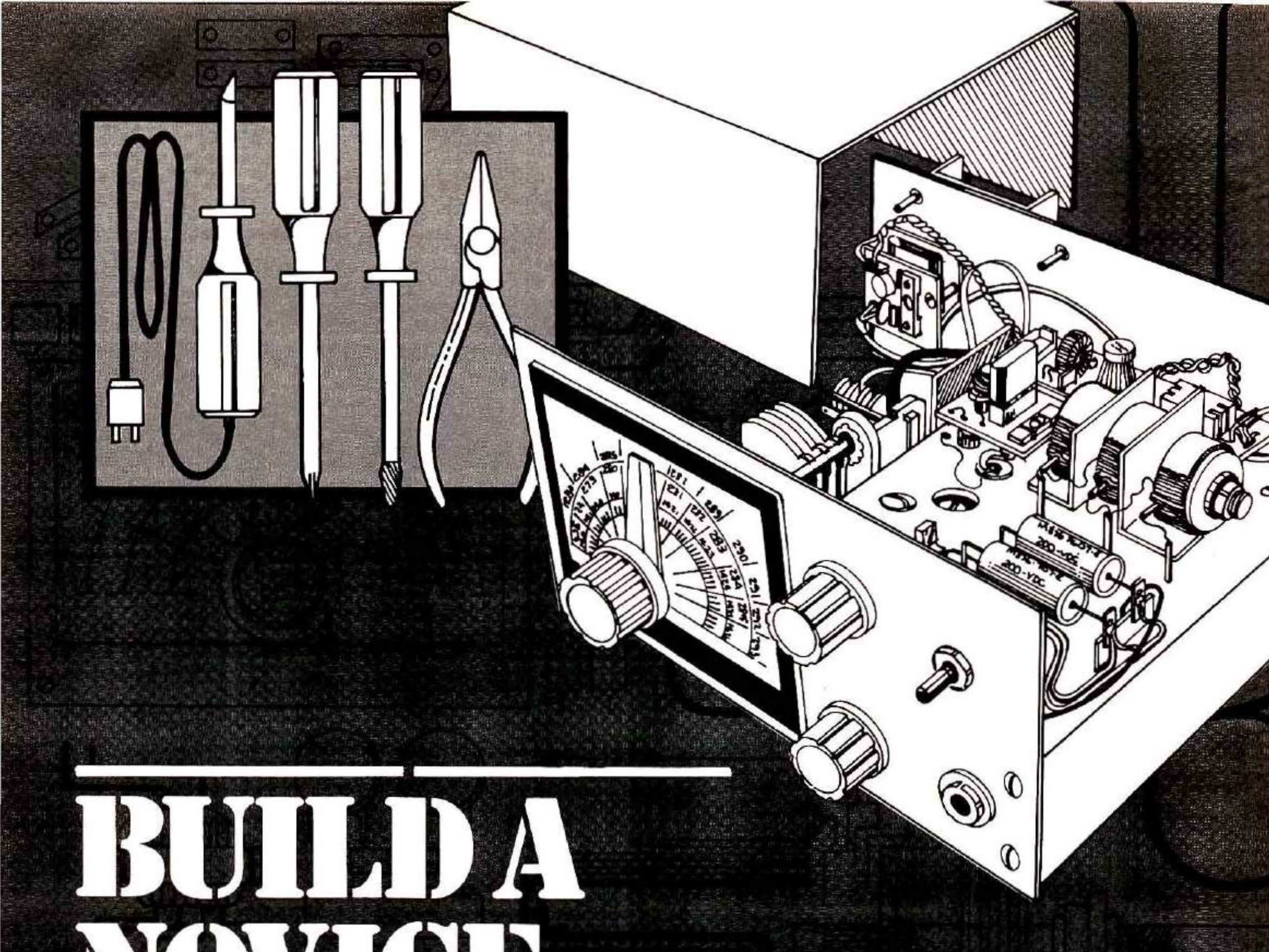
RADIO MOSCOW broadcasts RS satellite news in English on 7165 kHz at 0130Z Sunday (Saturday evening, U.S. time). Beacons from both RS satellites have been operating simultaneously much of the time, and indications are that RS-1 now leads RS-2 by several minutes.

Special Awards For RS Contacts have been announced by the Russians. The first 10 Amateurs on each continent who make a contact through RS are elegible to receive medals, while any Amateur making 10 contacts with other Amateurs using RS will receive a certificate. Details on additional RS awards are available from W9KDR at ARRL for an SASE. Applications for the awards go to Satellite Communications Committee, Box 88, Moscow, U.S.S.R.

AMSAT'S PHASE 3 SATELLITE PROJECT is progressing nicely at Goddard. Technician Marie Marr has completed a wooden mockup of the spacecraft for building a wiring harness, and K1JX is working on antennas for the new satellite.

DR. JOHN DEMERGADO, director general of Canada's Telecommunications Regulatory Commission, has just been licensed as VE3LBA.

A NEW SPANISH-LANGUAGE Amateur Magazine, Radioaficion, is being published in Spain by EA5ME/EA8LF. Price is 60 psetas an issue, from Ediciones, Andres Baquero 7, Mucia, Spain.



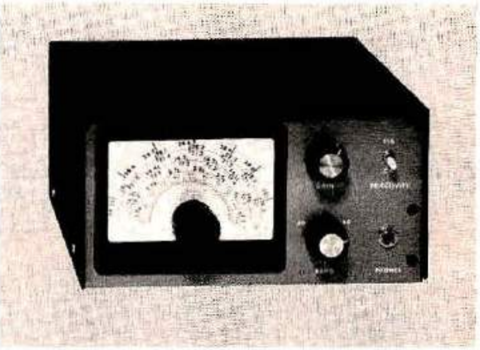
BUILD A NOVICE RECEIVER

BY BILL WILDENHEIN, W8YFB

Many beginners' receivers are designed solely for simplicity, and are a disappointment when you try to use them on a crowded band. All too often there is little that can be done to improve the simple receiver's performance. I have attempted to produce a set that would at least be equivalent in performance to the older, higher-quality, general-coverage receivers. As a result this receiver has sensitivity equivalent to a Hammarlund HQ-129X (which I used as a comparison receiver). Selectivity is quite similar — either 700 or 2500 Hz, with single-signal performance. What this means is that if you tune a synchrodyne (single-conversion) receiver, or any rather broad receiver, you receive the same signal on each side of zero beat; that is called "double-signal" reception. In my receiver, one signal is filtered out; this effectively doubles the selectivity. Stability is far superior to the Hammarlund. Image rejection on 80 and 40 meters is not as good, compared with the HQ-129X.

Essentially, you get the performance of an eleven-tube set, but my receiver requires only the equivalent power input necessary for lighting the two pilot lights on the Hammarlund! The only significant difference is in overall gain. This does not affect DX capability at all, since the effective signal-to-noise ratio is similar. This means that a 1-microvolt signal on 80 or 40 meters will result in a readable signal from the speaker in a normal hamshack environment. Although the Hammarlund can be cranked up to a higher volume level, the noise rises with the signal, which is therefore no more readable.

I would often go upstairs for a cup of coffee while running drift tests on the oscillator, and leave the receiver tuned to a QSO from distant parts of the world. There was enough volume from this receiver that I never missed a word as I sipped. The antenna most often used was a 40/20 meter sloping dipole.



Simplicity is the outstanding feature of the front panel of the receiver. A tuning dial to select the station, a volume (gain) control for the audio, and a band-peaking control to choose between 80 or 40 meters, cover the essential functions. Some degree of audio selectivity is provided by an internal filter, selectable by means of the CW/SSB switch. Calibration marks for the higher bands are used when an external converter is hooked to the receiver, as described later.

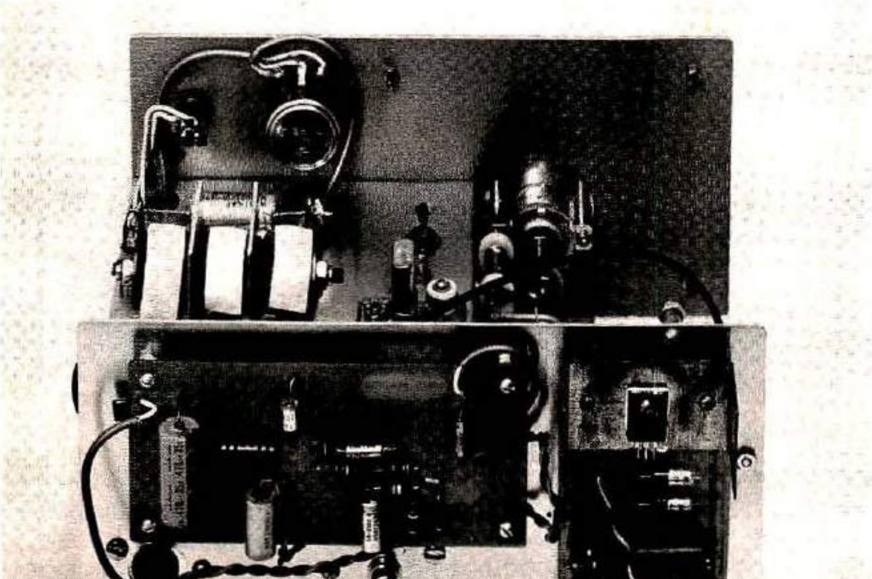
The modular approach

By making the receiver from a few simple modules it becomes very easy to later incorporate modifications or improvements without having to start over. You can build all the modules, interconnect them as a finished receiver on your workbench, and only then do you need to consider "packaging." You can build as few as three small modules and connect them as a receiver which will have surprising "punch," then add the other modules one at a time. The basic receiver covers 80 and 40 meters, but a simple two-transistor converter can be added for 20, 15, 10, and any other band of your choice. I'll describe just such a converter in a subsequent issue.

The complete schematic diagram for the 80/40 -meter receiver is shown in **Fig. 1**. It may seem complex, but it really is just a group of small, simple modules. The set can be duplicated and then tested with nothing more than a $15 imported 20,000-ohm-per-volt multimeter. Here's a quick rundown on the various stages, after which I have a few important precautions to discuss.

The antenna connects through L1 to the tuned circuit L2, C1, which tunes to either 80 or 40 meters without need for bandswitching. The diodes offer some protection against input overload from a transmitter. The input signal is mixed with the output of the local oscillator (LO) to produce the intermediate frequency (i-f) of

This view from the rear of the receiver shows the audio-amplifier circuit board on the left, and the power-supply board on the right. The large board for the audio amplifier is needed because the IC develops a considerable amount of heat, which is dissipated by the copper foil on the board. The power transformer for the supply is located in another enclosure, mainly to keep its ac field from causing hum in the high-gain IC. Voltage can be "borrowed" from the transformer in your transmitter supply, as described in the text.



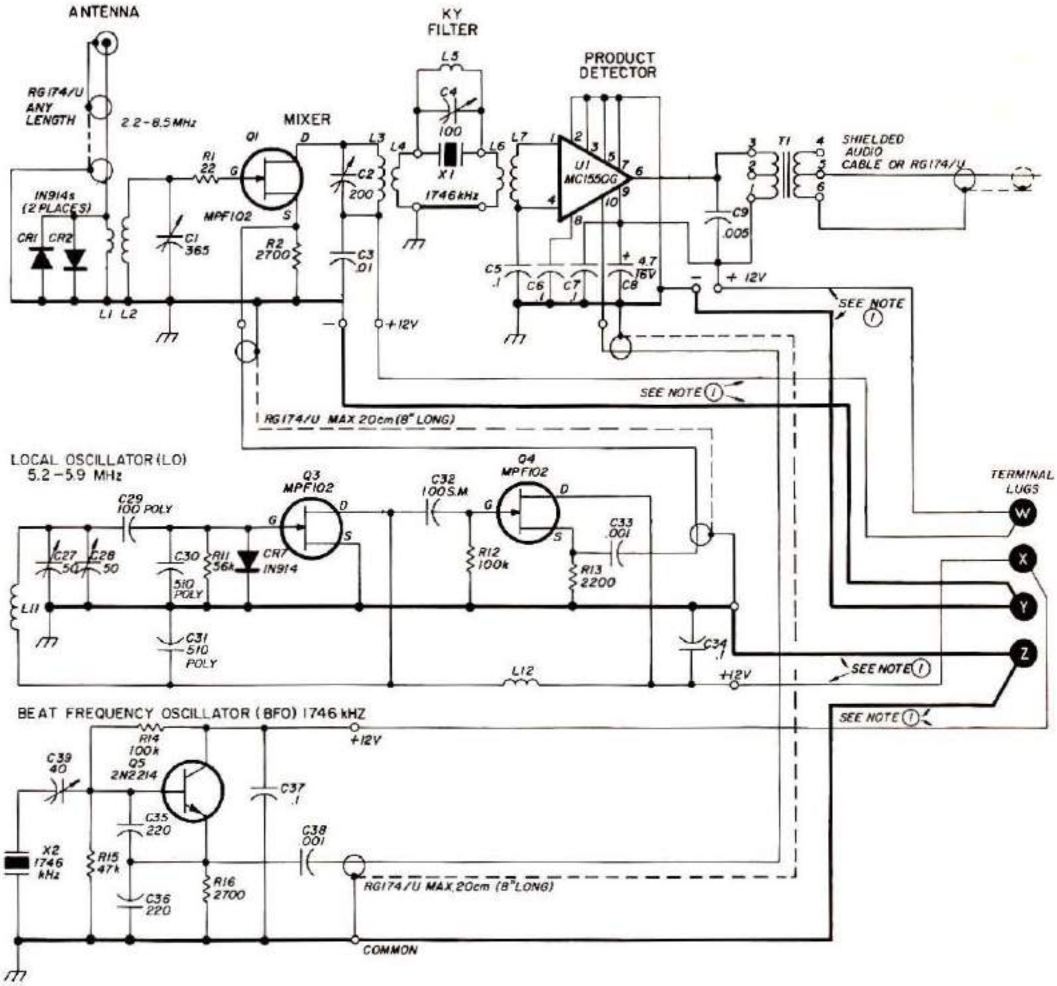


Fig. 1. The schematic diagram shows all the basic circuits for a receiver that is not overly complicated, yet is capable of excellent performance. The front end is a simple FET mixer, followed by an i-f crystal filter for selectivity. An integrated-circuit product detector will receive either CW or ssb (and a-m) signals. This stage is followed by an audio filter for more selectivity, and then an audio amplifier to drive a speaker or headphones. A very stable local oscillator (VFO) heterodynes incoming signals down to the intermediate frequency, and a crystal-controlled beat-frequency oscillator (BFO) generates the carrier needed for the product detector. Note the heavy lines showing the ground, or common, connections for the power supply and other modules. Some modules do not have a separate ground, but connect together for a common return to chassis ground. This prevents possible hum or noise pickup between stages.

1746 kHz. The local-oscillator frequency range is the same for both 80 and 40 meters, so again, no bandswitching is required. You can choose any intermediate frequency from about 1725 to 1748 kHz without any component changes other than the crystals in the filter and beat-frequency oscillator (BFO). This gives you some latitude when you look for surplus crystals.

Components C2 and L3 tune the mixer output to the intermediate frequency, and L4 (a part of L3) steps the impedance down to a value appropriate for the KY filter. This particular type of filter is popular in Europe but relatively unknown here. The filter is the circuit that provides the single-signal characteristic I mentioned earlier. The i-f signal from the KY filter is coupled to the product detector through the untuned transformer L6 and L7. The product detector is also a form of mixer. If the incoming signal is 1746 kHz, and in the product detector it is mixed with a 1747 kHz signal, the difference is 1 kHz (1000 Hz). This second signal comes from the beat frequency oscillator.

You probably have noticed that the KY filter and BFO both specify a 1746-kHz crystal. The KY filter uses the crystal in a series mode, while the BFO uses the crystal in a parallel mode. The average difference is about 250 Hz if both crystals are manufactured on exactly the same frequency. However, you needn't worry about this point; in the prototype receiver, the crystals were almost exactly on the same frequency, and the audio peak response was, as you might suspect, at 250 Hz. This is too low, but a more reasonable 700 to 1000 Hz audio signal can still be copied

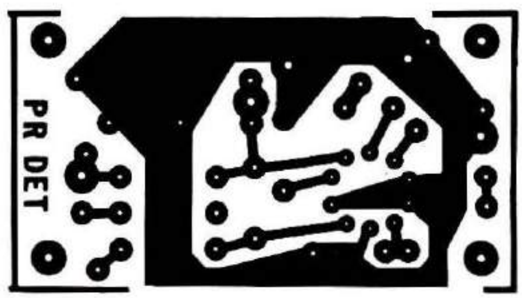
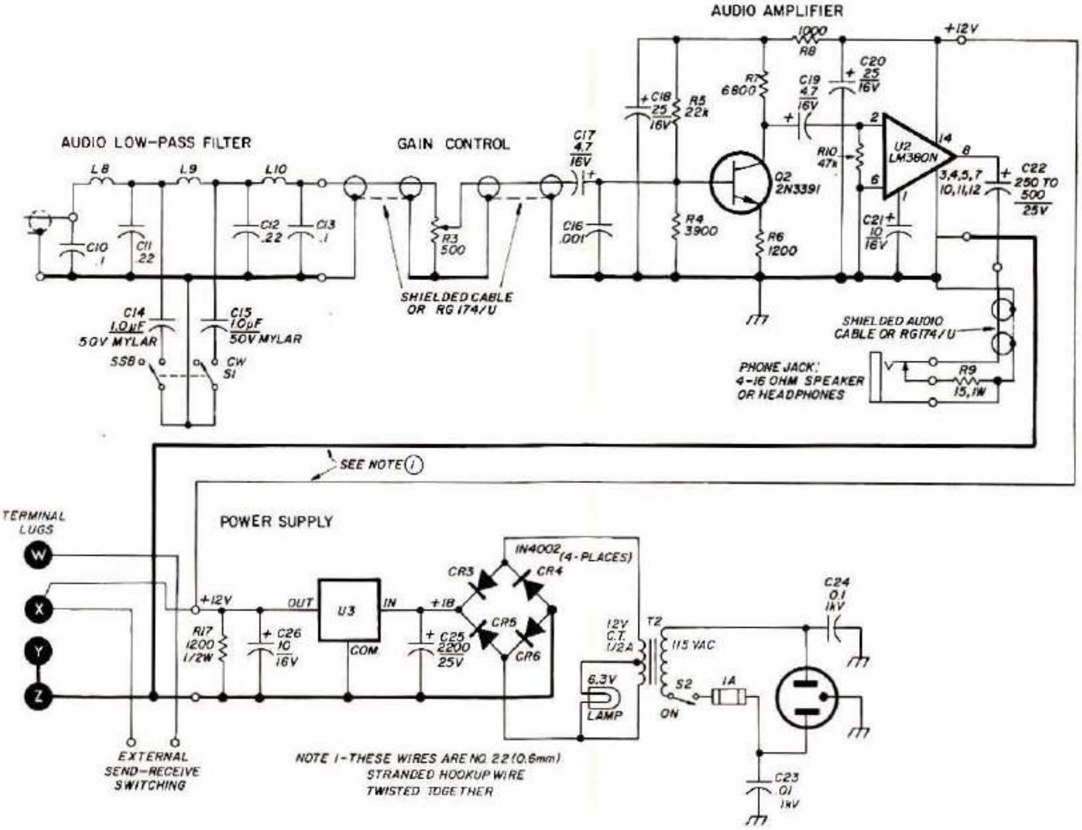


Fig. 2. This is the printed-circuit pattern for the product detector if you use a Motorola MC1550G or HEP590 integrated circuit. See **Fig. 3** for the parts placement. This view is from the foil side of the board.



nicely, even though this represents a loss in sensitivity of 10 to 12 dB. That was the situation under which I measured the sensitivity of the set and it still performed well. This represents a "worst case" condition, and yet it is a completely useful receiver! In other words, don't worry about the crystals! Just order a pair for the same frequency and you can't lose. Although improbable at the crystal frequencies used, you might get a pair 1 kHz apart. By merely swapping crystals between the KY filter and the BFO, you could obtain a separation of 1000 Hz, minus the usual 250 Hz due to their operating in different modes. This would result in a separation of 750 Hz, which would be excellent. The overall receiver selectivity will improve if your crystals have slightly more separation than mine did.

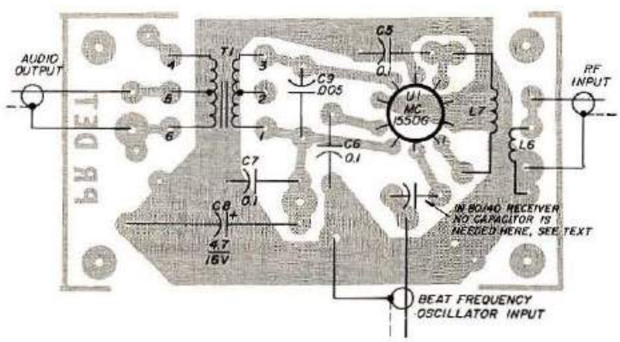


Fig. 3. A parts-placement guide for the product detector board of **Fig. 2**. The view is from the component side of the board.

The audio output from the product detector is fed to the audio lowpass filter. This filter provides the rest of the selectivity. It is switchable for 900 or 2500 Hz cutoff; it passes all audio below these frequencies. The value of capacitors in the filter is not critical. I have built this circuit many times, and never took any pains to match capacitors, yet it always works. The values shown were selected for my own personal preference as to audio quality on CW. You may wish to change them to suit your taste. The output of the lowpass filter couples to the GAIN or volume control. This control is also the terminating load for the audio lowpass filter, hence the low value of resistance chosen. The last stage is a 1-watt, high-gain audio amplifier. This stage is "almost hi-fi." Distortion is very low, and you will have nice audio quality if the receiver is connected to a better speaker than the one in the enclosure in the photos.

The beat frequency oscillator circuit was selected for two reasons: it operates the crystal in a parallel mode to achieve the frequency separation we discussed earlier, and its

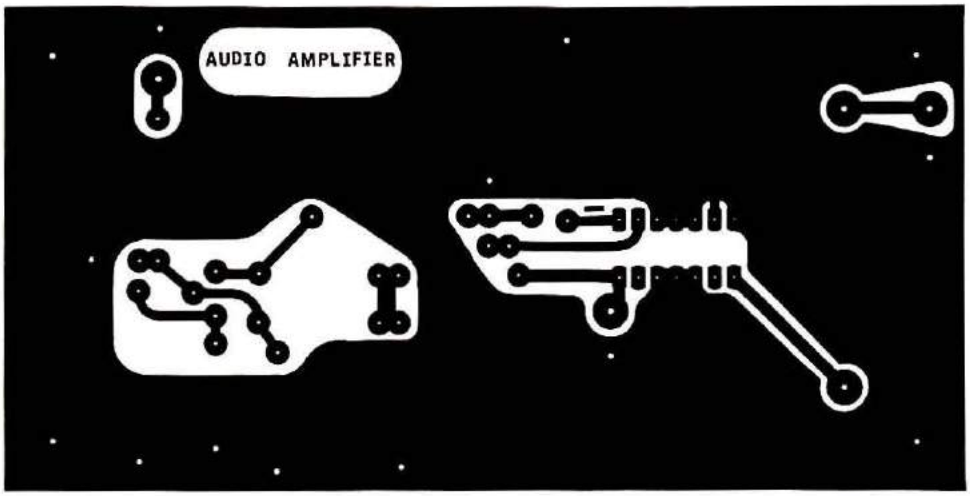


Fig. 4. This is the etching pattern for the audio amplifier, from the foil side of the board. The large copper area is required as a heatsink for the IC. See **Fig. 5** for component placement.

output level is compatible with the requirements of the product detector. Too much rf voltage can blow that integrated circuit. Capacitor C39 may not be necessary. I believe you would be as well off by replacing it with a fixed capacitor of a value between 22 and 39 pF. The purpose of this capacitor is to move the crystal frequency slightly.

The local oscillator is a Vackar circuit. It is not as widely used here as in Europe, but it is an inherently stable circuit. By proper proportioning of the fixed capacitors it is possible to reach a point where a husky change in power supply voltage has a very small effect on the frequency. In the prototype (and several others built at the same time to verify that they would behave the same), this shift was less than 100 Hz for a one-volt power supply change. The chosen values seem to pretty well compensate for the expected shifts in transistor gain. To verify operation, four different types of fets were used, all successfully. Two were vhf fets, one was a fet switch, and one was an audio fet. Capacitors C29, C30 , and C31 are sometimes specified as silver mica by some builders. Polystyrene capacitors are much cheaper and are far superior in performance. A number of each type was used during frequency-runs here. The silver micas commonly showed erratic jumps in frequency, while the polystyrene capacitors produced smooth curves, with variations of perhaps 5 Hz departure from the average drift curve in a half hour. After reaching temperature equilibrium, many of the oscillators would run for hours with 5 Hz (or less) drift per hour.

A part of this success is due to proper choice of L11. This coil is wound on a toroid having a small positive temperature coefficient. That is, the oscillator drifts lower in frequency as it warms up. The same is true for the variable capacitors. However, the polystyrene capacitors have a negative temperature coefficient, so they can do a pretty good job of balancing out the error. If you are an inquisitive nut like me, buy about five of the capacitors recommended for C29 and use the one with the best drift characteristic. Even without this extra effort, your receiver's ultimate stability will be within 100 Hz per hour. Actually, this is far better stability than you need; during a five-minute QSO this means a drift of about 8.3 Hz. By comparison, the Hammarlund HQ-129X has a half-hour warmup drift of about 8000 Hz on 40 meters, followed by a steady drift of about 900 Hz per hour for several more hours before it settles down to its "normal" drift of about 300 Hz per hour!

The reason I carried the work on this oscillator to such extremes was to be sure that you could successfully substitute capacitor C27 and still build a successful receiver. That capacitor, plus the dial shown in the photos, accounts for about half of the total cost of the receiver. Those particular components were chosen because they are currently available if you want to buy

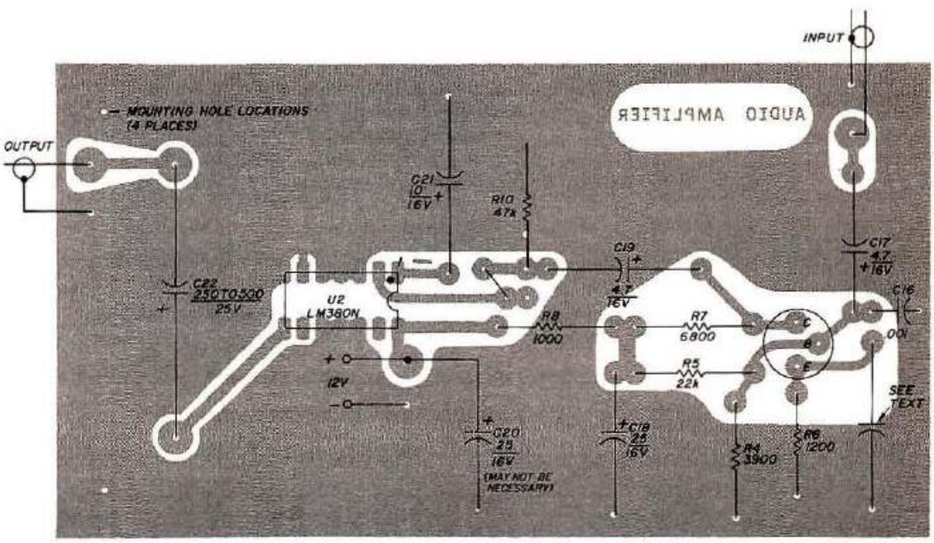


Fig. 5. A parts-placement guide for the audio amplifier, shown from the component side of the board.

new parts. If you wish, you can substitute a tuning capacitor from the ARC-5/SCR 274 Command transmitters; at our club flea market this summer I picked up four of those at $1.00 each! They are an exceptionally fine capacitor with about a 95:1 precision gear drive that makes tuning a pleasure. More about substitutions later.

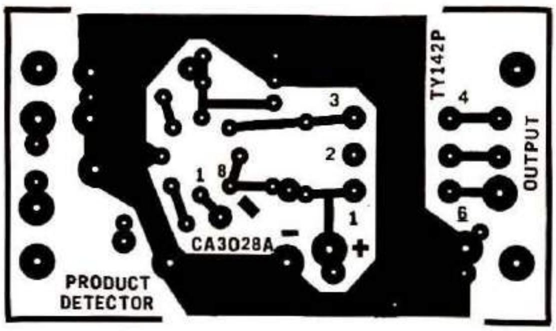


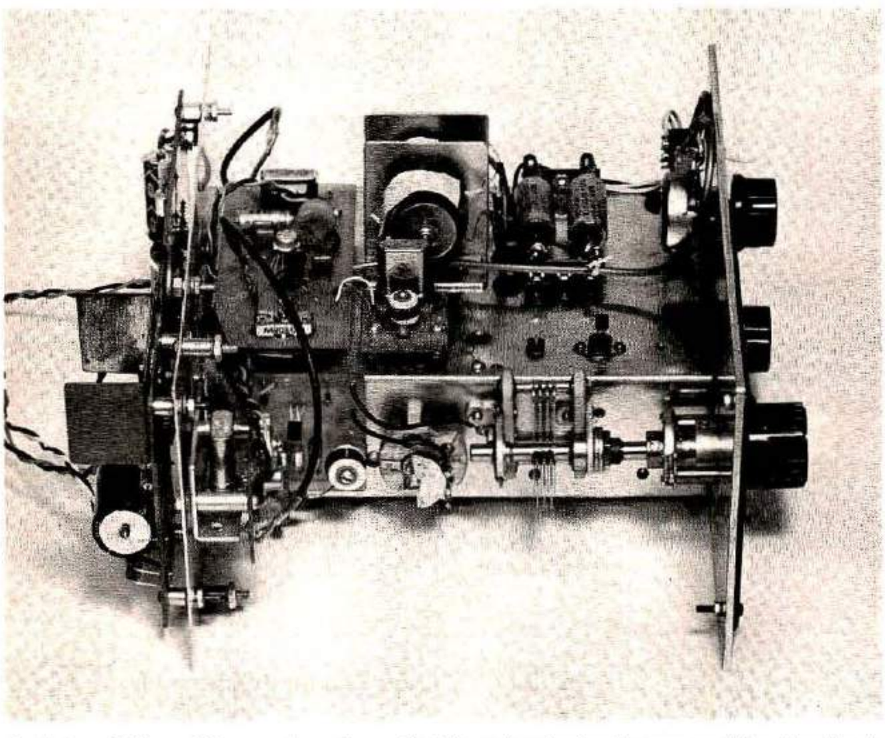
Fig. 6. This etching pattern is for an alternative product detector using the RCA CA3028A IC. Its performance is the same as the one shown in **Figs. 1** and **2**, and the input and output connections are the same.

Precautions

Now I have some very important precautions. Be sure you are familiar with them before you build! In **Fig. 1**, notice that the ground bus on each module is shown as a dark black line. At the audio amplifier, notice there is a chassis ground connected to this bus. Look at the GAIN control and note its common terminal has no chassis ground; neither does the lowpass filter common bus, nor does the output side of T1 connecting to the lowpass filter. The circuit board layouts to be presented later are arranged so the mounting screws do not touch this ground foil on the board. In other words, you have only one chassis ground in the entire audio system! By doing this, you can locate any module anyplace in the receiver without running into "ground loop" problems (such as feedback, instability, hum, and the like). The shielded wires interconnecting these audio modules must have a jacket over the shield braid to prevent the shield braid from touching the chassis.

The mixer, VFO, and probably the BFO, can have chassis grounds. In fact, the mixer and VFO *should* have such a ground since their tuning capacitors are both grounded to the chassis. The product detector and KY filter may or may not need a ground. It is easier to isolate these modules when you do your original circuit board layout than to try to isolate a completed circuit board if trouble appears later. You can always later put a solder lug under a mounting screw and run a piece of no. 22 solid wire to the nearest ground foil on the circuit board. (Actually, I got by with a second audio ground; the phone jack was not insulated from the panel, but no problem resulted. That was just luck.) Notice that the output of the BFO and local oscillator is fed through a piece of coax to their respective destinations. If you used ordinary hookup wire, these leads would become little antennas, broadcasting the oscillator signals to nearby wires and components. Keep these cables as short as possible. This allows you a little more freedom in locating modules and running interconnecting leads.

Finally, look at the power supply in **Fig. 1**. Notice that the output wires that feed power to the various modules are shown with the common, or minus 12 volt, wire in heavy black lines. This is just for ease in tracing out the circuit. However, notice that a separate, short, power cable feeds the audio amplifier, while another power cable goes to the lug strip where it branches out to all other modules. This is extremely important! The audio amplifier has a demand that swings wildly. When the amplifier is



An internal view of the receiver shows that there is plenty of room, and the circuitry is not overly complex. The variable capacitor connected to the tuning dial is C28 in the VFO circuit. No switching is necessary to cover either 80 or 40 meters.

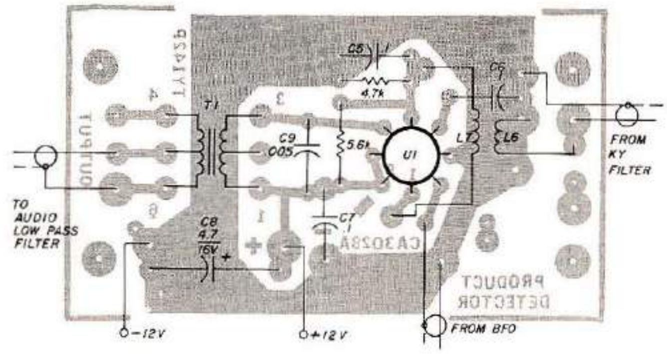


Fig. 7. Parts-placement guide for the alternative product detector board shown in **Fig. 6**, from the component side.

idling, current is about 7 mA. When you are copying a strong signal, the current in the audio amplifier can go to 120 mA or higher. Meanwhile, all the other modules together draw a steady, unvarying 18 mA from the power supply.

If you were to connect a sensitive scope across the amplifier end of the power wire, you would see an audio signal superimposed on the steady dc. If the other stages were connected to this point the signal would be fed back to earlier stages, to be amplified and fed to the audio amplifier again. As a result, your receiver can suddenly become a wild, uncontrollable audio oscillator.

One last thing about the power supply leads should be noted. You can see a pair of wires from the terminal strip marked "external send-receive switching." These wires go to a switch or relay that is open on transmit and closed on receive. This switch is already built into the transmitter that was described in the July, August, and September, 1978, issues of *Ham Radio Horizons*. This circuit cuts the power to the mixer and product detector when you switch to transmit. Notice that both oscillators are wired to run continuously; this will improve stability. Finally, in **Fig. 1**, notice that the power supply transformer, T2, and its primary wiring are enclosed in a pair of dashed lines. This portion of the circuit must be at least 12 inches away from the audio amplifier circuits — particularly the lowpass filter toroids — otherwise an annoying hum will develop and no amount of filtering can remove it. It's caused by the magnetic field of the transformer being coupled into the audio circuitry. In the photographs you can see that both enclosures are shielding their components quite well. However, if you place the receiver on the left side of the enclosure containing the transformer and converter, the hum is annoying. Put the receiver on the right side and the hum disappears. This also illustrates that aluminum is virtually useless as a shield at power-line frequencies. By careful location of the power transformer with respect to the speaker, magnetic coupling to the speaker voice coil can be reduced to a very low level.

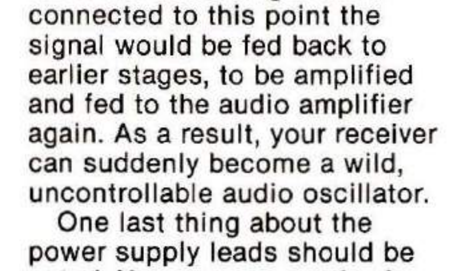


Fig. 8. Foil-side view of the etching pattern for the local oscillator, or VFO, board. See **Fig. 9** for the component layout.

Table 1. Sources of materials for the receiver.

Variable capacitors, APC capacitors, compression trimmers, toroid coil forms, rf chokes, enclosures	G. R. Whitehouse 15 Newbury Drive Amherst, New Hampshire 03031
Variable capacitors, compression trimmers, power transformers, rotary switches	Fair Radio Sales 1016 East Eureka Box 1105 Lima, Ohio 45802
Resistors, fixed capacitors, transistors, diodes, PC board material	Gull Electronics 12690 Route 3 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, transistors, fets, integrated circuits, components	Adva Electronics Box 4148A Woodside, California 94062
Fixed capacitors, switches, resistors, transistors, fets, integrated circuits	Digital Research Corporation Box 401247 Garland, Texas 75040
Transistors, diodes, integrated circuits	Integrated Circuits Unlimited 7889 Clairemont Mesa Blvd. San Diego, California 92111
Capacitors, diodes, transistors, integrated circuits	Bullet Electronics P.O. Box 19442 Dallas, Texas 75219
Transformer (T1)	Circuit Specialists 1344 North Scottsdale Rd. Tempe, Arizona 85281

Construction

Now that you have a feel for the circuits, I'll give you some construction details. Your first concern is circuit boards. There is no reason not to make them yourself if you have the equipment. The most difficult board is the product detector; its original artwork is shown in **Fig. 2**; the parts placement is shown in **Fig. 3**. Here is how it's done: **Fig. 2** is drawn to show the bottom, or copper-foil, side of the board. I find it easiest to first draw it accurately to exact size on a sheet of cross-ruled paper available at discount stores or other stores handling school supplies. You can place all the components right on the drawing to be sure they will fit. Next, cut the proper size of circuit-board material with a fine hacksaw. Protect the copper foil with a piece of smooth wood when you clamp the material in a vise. File the edges smooth. Now polish the copper surface thoroughly with fine steel wool. After polishing, do not touch the shiny surface with your fingers.

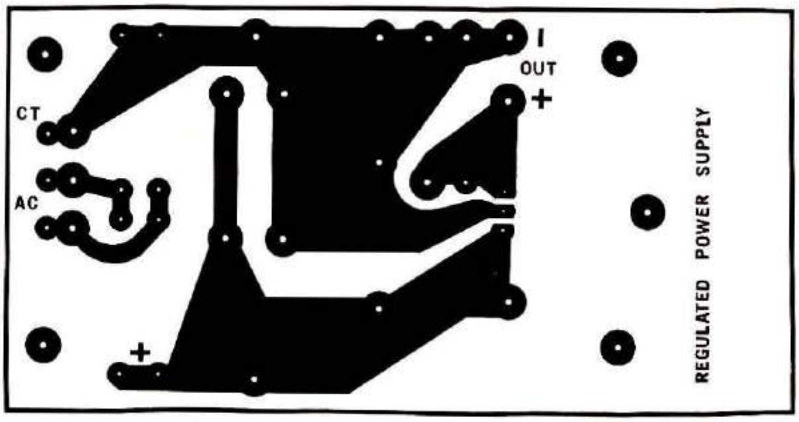


Fig. 10. Etching pattern for the regulated power-supply board. See **Fig. 11** for the parts placement.

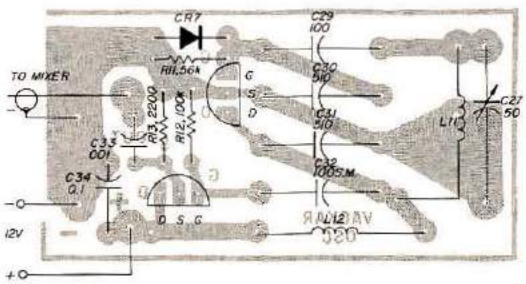


Fig. 9. Local-oscillator parts-placement guide, shown from the component side. The FETs are MPF102 — other types may work, but some have different pin connections and would require another board layout.

Next, use masking tape as wide as the board to cover the shiny copper. Do not use smaller masking tape, as the etchant will often eat under a masking-tape joint. Firmly press the masking tape in place all over the board. Now you can draw or trace your layout on the masking tape. With a very sharp jack knife, modelmaker's knife, or razor blade, cut away the unwanted material and peel it off the board. In all the layout views, the dark portion is the copper you *do not* want etched away; it is the area that is left covered with masking tape. After the unwanted masking tape is peeled away (keep your greasy fingers off that exposed copper!) it is ready for etching. At this point I usually mark all the holes to be drilled on the remaining masking tape.

Radio parts supply houses have ferric chloride etchant available; Radio Shack is a good source. You'll need a heater to keep the stuff warm; the cheapest solution is a 40-watt light bulb in a two-pound coffee can. Place a plastic dish on top of the coffee can and pour in enough etchant to cover the board well. Put the board in with the masking tape up. With a small plastic or wood stick filed to a chisel point to get under one end of the board, rock it up so it is lifted from the etchant at one end. As the etching takes place, you will notice that each time you lift the end of the board out of the etchant a dark slurry can be seen running down the board. This is etchant loaded with copper. That is the reason for moving the board — you bring fresh etchant in contact with the copper.

In about 20 minutes your board should be completely

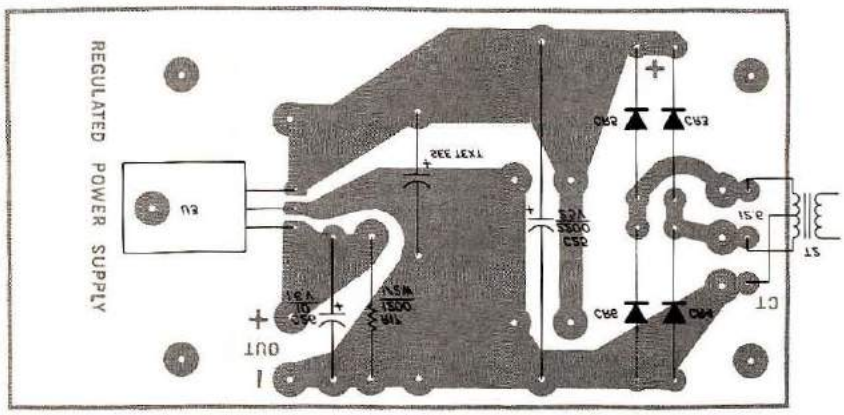


Fig. 11. Wiring guide for the power supply board, from the component side. The ac-input connections are to be wired to a 12-volt, center-tapped transformer mounted in the speaker cabinet, or to voltages "borrowed" from a transmitter power-supply transformer.

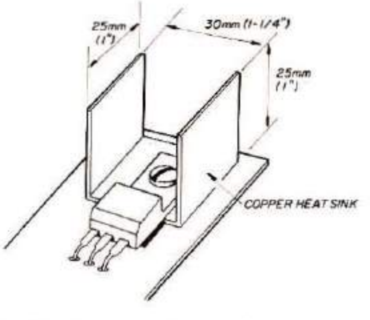


Fig. 12. A copper heatsink is necessary for the regulator IC in the power supply. You can easily make one from a piece of copper, bent as shown here. This mounts on the component side of the board.

etched. Remove it from the solution and thoroughly rinse the board to stop the etching action. Pat it dry with a cloth, then drill the holes. I usually use a no. 66 drill for most holes, a no. 60 for heavier component leads, and usually a 1/8-inch drill for mounting holes. When the holes have been drilled, peel off the remaining masking tape. Again, rinse thoroughly after scrubbing the board with strong cleanser to eliminate any traces of etchant. Clean it very well — even the tiniest bit of etchant can slowly eat through small component leads.

After your board is clean and dry, paint the foil side with a thin mixture of rosin dissolved in alcohol. After this dries you'll have a hard coating of rosin that allows you to handle the board without getting your

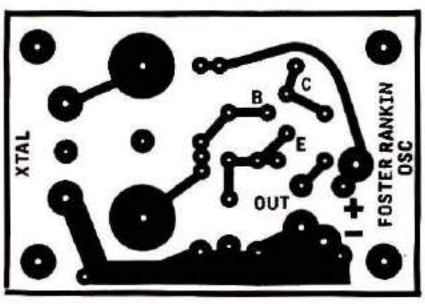


Fig. 13. A foil-side view of the etching pattern for the crystal-controlled beat-frequency oscillator (BFO). See **Fig. 14** for the parts location.

fingers on the copper. Now you can mount components on the board. Be sure the leads are clean. Don't use a dinky 25-watt soldering iron! Use a 47- to 56-watt heating element with a 1/8-inch tip. If you are a beginner, use heatsinks on component leads until you develop a sure hand and speed. Don't try to use a Weller gun! That is a good way to wreck transistors.

After all components and interconnecting cables are soldered in, scrub the rosin off the board with a toothbrush dipped in alcohol. The rosin will readily absorb moisture and can form "flux bridges" that will be partial short-circuits later. Examine the board very carefully for solder bridges between foils.

Fig. 3 is a component layout for the product detector. Notice that one capacitor is not needed. I usually allow for "coupling capacitors" on all boards. For instance, if I made an oscillator with too much output, I could reduce the output by using a very small capacitor for coupling. It is often difficult to foresee which board will be most accessible for this adjustment, so I include provisions on all boards that might need it. If unneeded, the coax can, as in this case, be connected directly to the pad in pin 8 of the IC. **Fig. 4** is the PC layout for the audio amplifier, and **Fig. 5** is the component layout for it. Notice one capacitor connected to the emitter of Q2 is marked "see text." This can be about 10 to 20 μF, 6 to 25 volts, and will increase the gain of the amplifier considerably. If you substitute a low-beta transistor at Q2, you might need more gain. If the recommended transistor is used, there will be ample gain, and adding this extra capacitor may make the amplifier a bit wild. Capacitor C20 also may be unnecessary. I usually park

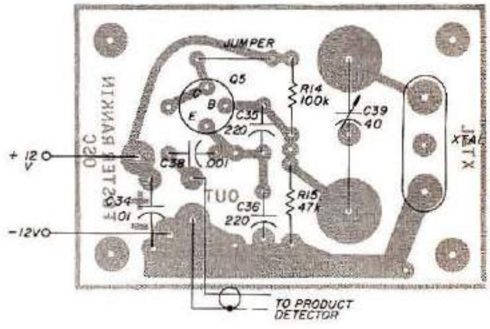


Fig. 14. Parts-placement guide for the BFO board shown in **Fig. 13**, from the component side.

an appropriate capacitor right where the power cable enters a circuit board, just as a precaution. This capacitor can be used to cure instability, if it occurs. Notice that both the product detector and audio amplifier have electrolytic or tantalum capacitors. These *must* be installed with the correct polarity.

Fig. 6 is the product detector modified for use with an RCA CA3028A integrated circuit. All components are of the same values and have the same purpose as in the previous product detector except for two added resistors. **Fig. 7** is the component layout, and indicates the values of the added resistors. Sometimes the RCA device is more readily available. The HEP 590 IC can be used in the first layout (**Fig. 2**), but is much more expensive. **Fig. 8** is the local oscillator board layout, and **Fig. 9** is its component layout. The fet shown, Q3, is an MPF102; other fets may require a different layout. **Fig. 10** is the PC-board

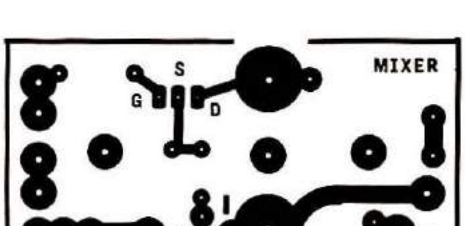


Fig. 15. Etching pattern for the mixer board, foil-side view.

Table 2. Parts list for the beginner's receiver.

Fixed Capacitors

Designation	Description
C3	0.01 μF, 25 V, disk ceramic
C5,C6,C7 C34,C37	0.1 μF, 16 V, disk ceramic
C8,C18,C20	4.7 μF, 16 V, electrolytic
C9	0.005 μF, 25 V, disk ceramic
C10,C13	0.1 μF, 50 V, Mylar
C11,C12	0.22 μF, 50 V, Mylar
C14,C15	1 μF, 50 V, Mylar
C16,C33,C38	0.001 μF, 25 V, disk ceramic
C17,C19	1 μF, 16 V, electrolytic or Tantalum
C21,C26	10 μF, 16 V, Tantalum
C22	250 μF, 25 V, electrolytic
C23,C24	0.01 μF, 1000 V, disk ceramic
C25	2200 μF, 25 V, electrolytic
C29	100 pF, 630 V, polystyrene (Mallory SC 310 — do not substitute)
C30,C31	510 pF, 630 V, polystyrene (Mallory SX 310 — do not substitute)
C32	100 pF polystyrene or silver mica
C35,C36,C40	220 pF dipped mica or silver mica

Variable Capacitors

Designation	Description
C1	365 pF maximum, broadcast receiver type
C2	24 to 240 pF compression trimmer (ARCO 425); add C40 (220 pF) in parallel
C4	7 to 100 pF compression trimmer (ARCO 423)
C27	50 pF air trimmer (Hammarlund MC 50S or equivalent)
C28	30 pF APC air trimmer
C39	4 to 40 pF compression trimmer (ARCO 422); for lower cost, substitute a 33 pF disk ceramic

Resistors

Designation	Description
R1	22 ohms, ¼ to ½ watt
R2,R16	2700 ohms, ¼ to ½ watt
R3	500 ohm potentiometer
R4	3900 ohms, ¼ to ½ watt
R5	22 k ohms, ¼ to ½ watt
R6	1200 ohms, ¼ to ½ watt
R7	6800 ohms, ¼ to ½ watt
R8	1000 ohms, ¼ to ½ watt
R9	15 ohms, 1 watt
R10,R15	47 k ohms, ¼ to ½ watt
R11	56 k ohms, ¼ to ½ watt
R12,R14	100 k ohms, ¼ to ½ watt
R13	2200 ohms, ¼ to ½ watt
R17	1200 ohms, ½ watt

Miscellaneous

Designation	Description
CR1,CR2,CR7	1N914 or 1N4148 silicon diodes
CR3,CR4 CR5,CR6	1N4002 or any 1 A, 100 PIV or higher diodes
L1,L2,L5 L6,L7	Toroid core, type T-37-61 (3 required)
L3,L4	Toroid core, type T-50-2 (1 required)
L8,L9,L10	88 mH toroids (surplus okay)
L11	Toroid core, type T-50-6 (1 required)
L12	500 μH rf choke (J.W. Miller 4629 or equivalent)
Q1,Q3,Q4	MPF 102 JFET (2N3819 usable with different lead connections)
Q2	2N3391, MPS 6515, or 2N4401, NPN audio amplifier transistor
Q5	2N2219, 2N3904, 2N2222, NPN transistor
T1	1000 ohms primary, 2000 ohm C.T. secondary (Calectro D1 719)
T2	115 V primary, 12.6 V, ½ A secondary (secondary voltage may be as high as 16)
U1	Motorola MC1550G, HEP 590 (RCA CA3028A usable with alternative layout in **Fig. 8**)
U2	LM380N or ECG 740A 2-watt audio amplifier IC
U3	LM340T-12 12-volt regulator IC

Wire and Hardware

Plastic-covered hookup wire; No. 24 enamel covered; No. 28 enamel covered; RG-174/U coaxial cable; insulated, shielded audio cable; transistor socket; RCA phono plug; closed-circuit phone jack; 2 two-terminal tie-lug strips; 4 six-terminal tie-lug strips; dial-drive of your choice; small plastic cable clamps; assorted lengths No. 4-40 and 6-32 screws with nuts and lockwashers; several 1/4-inch diameter metal spacers, 1/4 and 3/8-inch long.

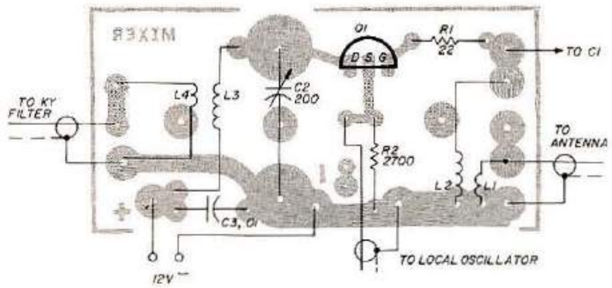


Fig. 16. Parts-placement guide for the mixer board shown in **Fig. 15**, view from the component side.

layout for the power supply. Notice the very heavy interconnections which are necessary for stability. As it turned out, the capacitor marked "see text" was not needed; occasionally an extra filter capacitor helps here, so I always include space for one in a regulator layout. **Fig. 11** is the component-placement guide. **Fig. 12** shows the heatsink for the power supply IC. Occasionally, you can buy scraps of flashing copper from roofing contractors or sheet-metal shops; another source is hobby shops. The copper can be very thin and still be effective. Aluminum could be used if you increased the heatsink area 30 to 50 per cent. In any case, be sure to smear the inside of the sink and the bottom of the IC with thermal

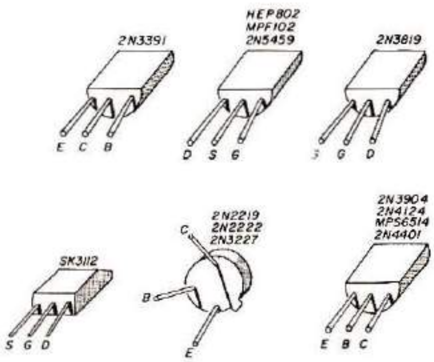


Fig. 17. Lead identification drawings for the transistors used in the beginner's receiver.

grease. **Fig. 13** is the BFO, and **Fig. 14** is the component layout for it. **Fig. 15** is the PC layout for the mixer, and **Fig. 16** is its component layout. Here again I've made provision for a coupling capacitor from the local oscillator output.

The KY filter does not need a circuit board; a little scrap of aluminum or unclad circuit board can be used to mount the components. Similarly, the audio lowpass filter is built on the chassis with rather conventional techniques. In the beat frequency oscillator component layout you may

Table 3. Coil winding data.

Designation	Description
L1	1 turn plastic hook-up wire
L2	17 turns No. 24 e.c. Core: T-37-61
L3	80 turns No. 28 e.c.
L4	16 turns No. 28 e.c. wound over L3 Core: T-50-2
L5	49 turns No. 28 e.c. Core: T-37-61
L6, L7	19 turns quadrafilar No. 28 e.c. (see text) Core: T-37-61
L11	43 turns No. 24 e.c. Core: T-50-6 core.

Note: The abbreviation e.c. means enamel covered

wonder why the collector of Q5 was not directly tied to the +12 volt line. If the jumper is replaced with a 1500-ohm resistor, and C38 is moved around to connect to the collector, much higher voltage output is possible. This is an example of how you can make "convertible" layouts to accommodate various modifications.

This completes the board layouts for the receiver. You have probably noticed that each one is not difficult. I recommend that you use G10 fiberglass-epoxy in making the boards. You can buy this high-quality board for reasonable prices from surplus dealers, and it is well worth looking for. The phenolic type of board will work in this receiver, but is not as permanent, and beginners usually have more trouble with overheated pads loosening up with this type board.

Shopping List

I've included a shopping list with this part of the receiver description, so you can start accumulating the things you'll need. Most are common parts available through many suppliers and mail-order houses (I've listed some of the places that have been good sources). If you find a good variable capacitor that is not exactly the same, physically, as mine, but the capacitance range is the same, then use it. Similarly, the dial-drive mechanism can be substituted if you have one that works smoothly and feels right to you. Allow plenty of room for calibration marks, however.

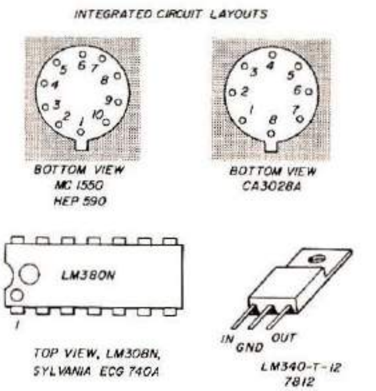


Fig. 18. Pin connections and lead identification for the integrated circuits used in the receiver. You will not need both the MC1550 and the CA3028 devices; just be sure that the board you have and the IC you buy will work together. The MC1550 or HEP590 detector is shown in the schematic diagram, **Fig. 1**.

By the time you have all the parts and have made (or bought) your PC boards, the next issue of *Horizons* should arrive, and I'll tell you how to wind the toroids and about hooking up the modules.

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an active amateur radio club

BY BILL WELSH, W6DDB

Suggestions on how to improve your ham club

This article describes some of the past and present activities of an active Amateur Radio club. We hope that newer amateurs will benefit from it and will gain a better understanding of how a successful club works, and the possibility of making the Amateur Radio service better through club activities.

Most of the larger industrial companies offer employees recreational opportunities and provide the facilities for them. Company recreation programs often include sports (softball, basketball, tennis, golf, bowling), special events (picnics, dances, Christmas parties, trips), and the sponsorship of special-interest groups, such as Amateur Radio clubs.

The Lockheed Employees' Recreation Club (LERC) sponsors Amateur Radio club W6LS, one of 33 recreational groups sponsored by LERC in Burbank, California. The parent organization, LERC, is a nonprofit corporation. It's located on its own property, separate from company areas, thus providing complete freedom of access at all times.

The Lockheed Amateur Radio club (W6LS)

W6LS has its own facilities in the main LERC building. The radio shack occupies about 4.6 by 9 meters (15 by 30 feet). It's stuffed with materials associated with its many activities. We have access to a kitchen, class room, auditorium, parking, and other facilities.

Most club-oriented amateurs will realize the difficulty of obtaining adequate permanent space and the importance of good facilities for the successful operation of a club. The few Amateur Radio clubs that have obtained their own buildings and facilities are to be congratulated. They have really accomplished a major feat!

Continuing, regular W6LS activities involve most of the time, effort, and money expended at this club. Most of the everyday W6LS activities are common to other Amateur Radio clubs. They're arranged alphabetically and are briefly described for readers who may not be familiar with club activities.

W6LS club activities

Answering service. W6LS has its own telephone (213-842-1863) and uses an automatic telephone-answering device to accept messages when the shack is not manned. About 25 messages are received on this unit each week, and all requests are handled within two days. The recorded, introductory remarks clearly ask that the caller provide his or her name and address to receive the data being requested.

Awards. To encourage new amateurs, W6LS recently initiated an award for confirmed contacts with all ten American call sign areas. Most operating awards are beyond the immediate grasp of beginning amateurs, but the Ten American Districts (TAD) award is well within the reach of even the newest novice. American amateurs simply send in *post-*

marked QSL cards, proving a two-way contact with an amateur in each of our ten call sign areas (1 through Ø). (Postmarks are required since it's easy to obtain blank QSL cards as samples from QSL printers, and W6LS wants its awards to be *earned* and to have value.) One dollar covers printing and mailing costs. The cards are returned in an envelope and the award is mailed in a cardboard tube.

TAD awards have been issued to more than nearly 2000 amateurs, including novices in all 50 states and more than 200 foreign amateurs. Handprinted endorsements are added to certify special operating achievements, such as code, one band, OSCAR, QRP, SSB, and YL.

Bulletins. The W6LS bulletin is currently sent to about 375 amateurs and 75 Amateur Radio groups in 33 states and eight countries. It keeps members fully informed of all club activities, and provides an excellent way to bring hot new scoops to members long before publication in national magazines.

A good bulletin can do wonders in perking up club activities. Bulletin editors are a special group and have their own organizations, such as the Amateur Radio News Service (ARNS). The W6LS bulletin normally includes a list of all elected and appointed club officers, date and subject of the next meeting, introduction to new members, minutes of the previous meeting, the treasurer's report, ARRL official bulletins, items for sale, items wanted, reports on club projects, late-breaking news, tidbits from HR Report, items from other club bulletins, and articles by members.

Some bulletins are quite professional in appearance, whereas others are quite rough; nevertheless, even a crude-looking bulletin can do an effective job for a club.

Club members turning out bulletins and memos on a duplicating machine. It's all part of typical club activity, and all the work is done in the spirit of enhancing the image of Amateur Radio.

DX QSL bureau. W6LS was the mailing point for the ARRL California incoming DX QSL bureau from 1974 to mid 1978. About 50,000 cards and envelopes were received each month. Club members and their amateur friends sorted incoming cards and envelopes according to the first letter in suffix of the call sign. As an example, a DX card to W6JEP is sorted into the **J** bin. Cards and envelopes go to each suffix sorter at least once per month, and many suffix sorters picked up their material every week at W6LS. If you are new to Amateur Radio and don't know how the DX QSL bureau operates, you're welcome to request a DX QSL bureau data sheet from W6LS. It will be sent to you at no charge; just be sure to enclose a note stating what you want, and send the usual SASE.

Cards sent through the bureau don't have to be addressed; they are simply arranged in alpha-numeric sequence and shipped in a package to the outgoing DX QSL bureau. One of the best known and most effective bureaus in the world is the one operated by the American Radio Relay League, 225 Main Street, Newington, Connecticut 06111. W6LS was part of the ARRL QSL bureau through its association with the Los Angeles Area Council of Amateur Radio Clubs, which handles incoming (only) DX QSL cards to California amateurs. You don't have to be an ARRL member to receive incoming DX cards through the bureau. However, every active amateur who ocassionally works a foreign amateur should have at least one SASE on file with his

View of the operating position at W6LS. The station is used in the club's licensing program. Hundreds of newly licensed hams have made their first contact from W6LS.

The ARRL QSL bureau for California amateurs. The W6 Bureau was operated and maintained on a volunteer basis by LERC Amateur Radio Club members until mid 1978. About 3500 man-hours a year were required to handle this vast task.

bureau at all times.

You may find it interesting that W6LS received about 1000 cards per month that should not be received. Many foreign amateurs assume that all American stations including a 6 in their call sign are handled by the California bureau. Consequently, cards for all Pacific areas (such as KB6, KC6, KG6, KH6) are commonly sent there. Such cards are gathered together by call sign prefixes and mailed to their correct destinations at least once per month.

It's important to understand that the QSL bureau is extremely efficient but not fast; most incoming DX cards are for contacts at least a year back, and some confirm contacts made a few years ago. So don't be impatient — the bureau does a good job. Also, please appreciate the fact that many volunteers donate a lot of time to distribute DX cards as quickly as possible. It takes about 3500 man-hours per year just to do the work associated with the California incoming DX QSL bureau. This amounts almost to two people putting in a year-round 40-hour work week. Fortunately, a lot of dedicated amateurs are willing to work to help the Amateur Radio service.

Library. W6LS maintains a good library for use by members, students, and other amateurs. Nearly complete sets of *CQ, ham radio, Ham Radio Horizons, QST*, and *73* are bound and available in the library. Textbooks, flyers, and catalogs are separated under functional headings.

The W6LS library is used by many people in addition to club members and students in W6LS licensing courses. Teachers and students in local schools, colleges, and universities have become aware that this excellent library is available evenings. Books are not loaned, since experience has taught that they're quickly lost under any lending arrangement.

Magazine service. W6LS has conducted a used-magazine service since 1962. This service provides back issues of *CQ, ham radio, QST*, and *73* to individuals, clubs, and libraries. Magazines are donated to W6LS from all over the country, but most are brought to W6LS by amateurs who live in the Los Angeles area. This service has been used by amateurs in every state as well as amateurs in more than 50 countries. As many as 3000 issues have been shipped in one month. It's seldom that fewer than 300 magazines leave W6LS in a month.

Despite the preceding figures, W6LS cannot fill more than half the magazine requests received. The newest and oldest issues of *CQ, QST*, and *73* are always in short supply. The stock of *ham radio* magazines is usually zero, because issues go out within a few days after donated issues have been received. If you want a data sheet on the W6LS used-magazine service, include a SASE with your written request.

Operating. Very little is done at W6LS, although the club shack always has a good station ready for use by members and students. Club members are active on the air, and they keep the Los Angeles area easy to work at all times. However, when members are at W6LS, they usually perform a particular job that's part of a club project; consequently, they seldom operate W6LS.

Equipment is changed quite frequently, and W6LS usually has two positions operable. Equipment changes are not always intended to improve the station; it's often just a case of trying out a new piece of gear to obtain first-hand knowledge. Beam, ground plane, end-fed long wire, and dipole antennas provide students and members with a chance to compare performance.

The club station is a useful tool in the W6LS licensing program; hundreds of newly licensed amateurs have made their first contacts from there. Now that it's legal to allow an unlicensed person to operate code on the amateur bands under the direct supervision of a licensed amateur, students are urged to make an on-the-air novice-band code contact at the time they take their FCC Novice code test (5 wpm receiving and sending) with the volunteer examiner at W6LS. Any student who can make a two-way contact on the air is truly qualified to meet the Novice code requirements. The program helps students work a few contacts under the supervision of an experienced amateur, who can provide constructive criticism to eliminate incorrect operating procedures from the start. Despite limited use, about 3000 contacts are made from W6LS each year.

Silent key. Some clubs have a formal silent key committee that disassembles and sells stations for relatives of deceased amateurs. W6LS has no formal silent key committee, but it does honor about a dozen of these requests for help each year. Surviving relatives usually don't know the actual value of amateur equipment and accessories. It's important to help these people disassemble the station to minimize equipment damage and loss of accessories (cables, manuals, connectors).

Test equipment and tools. W6LS has limited test equipment because the equipment doesn't get much use. At one time the club set up work benches and started acquiring expensive test equipment, but lack of use made it apparent that space and money could be better used in other areas. Nevertheless, the club has the usual assortment of test gear, including a vom, vtvm, grid-dip oscillator, tube/transistor checker, capacitor checker, dc supply, ac supply, af generator, rf generator, dummy rf load, swr meter, and oscilloscope. The tool cabinet is quite complete and is used almost every day.

Training. W6LS conducts Novice and General/Advanced amateur licensing courses on a regular basis at its location. A good classroom which comfortably seats 65 students is used. Each course is filled (but limited) to that total. Excellent projectors with special lenses are used, and a large viewing screen has been mounted at the front of the room. We have a large chalkboard across the classroom front wall and have added many refinements to help students attain their goals. Individual code sending instruction is given to each student.

We have 20 file drawers filled with class examinations and printed aids. Club training material has been sent to more than 100 other clubs in the last 15 years, and about 90 such requests are still answered every year, with requesters paying only the few dollars required to print and mail a set of class aids.

W6LS also conducts occasional Novice, General, Advanced, and Extra class licensing courses at other locations. W6LS instructors have taught these courses in high schools, museums, Civil Defense centers, major corporations, colleges, churches, and a hospital. Several former students of W6LS courses are now active licensed amateurs, who conduct Amateur Radio licensing classes that are completely separate from W6LS activities. The W6LS licensing program includes its own series of 15 code-training cassette tapes, a few films, and help in selecting initial station equipment and accessories.

A corner of the library at W6LS. A comprehensive selection of periodicals is maintained for members and others. Also included are textbooks, flyers, and catalogs. The library is available to anyone interested in electronics.

Tubes and parts. The club keeps a few hundred tubes on hand. These tubes are donated; they're boxed to minimize damage and to make them easier to find. The tubes aren't tested, but experience has shown that very few are bad. There's no reason to donate bad tubes to the club, and few people do it. Unfortunately, tubes are seldom arranged in alpha-numeric sequence, which makes it necessary to hunt for what's needed.

Members, students, and others used this tube service to obtain a set of equipment spares. Resistors, capacitors, fuses, nuts, bolts, washers, knobs, transistors, diodes and other small items are separated in parts bins. All tubes and parts are made available at extremely low prices. Buyers total their own purchases and deposit payments into a tin can. Since all charges are "peanuts," an old peanut can is used to collect this income.

TVI and BCI. Some clubs have a formal committee to handle broadcast interference (BCI) and television interference (TVI) complaints in their areas. W6LS doesn't have a separate TVI/BCI committee, but members do help resolve several of these problems each month. Most requests for information and help don't come from club members or other amateurs; they come from local people experiencing interference.

The club library contains a fine assortment of useful publications on interference and filters. TVI is not as much of a problem as it was when TV initially became popular in the late 40s and early 50s. Many amateur stations had unshielded equipment in the early days of TV, and the possibility of causing TVI was very high. Shifts to shielded equipment and single sideband voice communication (from amplitude modulation) greatly reduced the probability of amateur equipment operation causing TVI. It's far more common for nearby TV sets to cause interference to amateur operation.

Annual club events

In addition to the continuing activities previously summarized, W6LS is involved in a few major annual events:

Auction. The annual auction is held each September at W6LS. It attracts amateurs from all around Los Angeles. The sale or purchase of relatively expensive equipment is handled better through bulletin ads, so a limit is enforced on the value of items accepted for auction. This keeps the auctions alive, because the lower-cost items have more potential bidders. It's possible to purchase needed items at these auctions and to get them at low cost. Basically, W6LS auctions are held in a spirit of fun, which most attending enjoy. Each transaction is completed immediately, with the club treasurer serving as intermediary between buyer and seller. The club retains a small

Tool-storage area of the W6LS Amateur Radio Club. Basic hand tools and accessories are available for personal and club projects. Tools and test equipment are restricted to use at the club facility; they are not loaned.

percentage of the sale price of auctioned items, and this amount is deducted from the payment being made to the seller. The W6LS September auction is a fun affair.

Contests. W6LS and its members participate in several contests each year. Members conduct almost all contest activities at their home stations. However, the club station is active in a few of the major events. The annual ARRL field day contest is used as part of the overall training program at W6LS. Newer amateurs are encouraged to build and erect antennas for use in this test of emergency preparedness. The club has a tent and a gasoline-driven electric power generator, plus a good assortment of the material needed to set up stations.

W6LS field day exercises have helped many people get a start in Amateur Radio. The club score is never high during field day, but the overall results are always excellent as far as participating new amateurs are concerned. Field Day is just one of several contests that can be used to give new amateurs operating training and experience under less-than-ideal conditions.

Contests are in progress every weekend, and most of them are well advertised in the Amateur Radio magazines.

Convention. W6LS hosts the only major Amateur Radio show held annually in the Los Angeles area. The lucky 13th Annual Los Angeles Amateur Radio Convention was held at W6LS on the weekend of May 20-21, 1978. These shows just seem to improve with time. Better displays, programs, and prizes are enjoyed each year by more amateurs who travel greater distances to attend. The lowest attendance was about 650, and the highest so far was over 3000. The entire show is operated on a non-profit basis, with all left-over money donated to worthwhile amateur activities.

These conventions have been the source of more than $6000 donated to Amateur Radio projects. As examples, W6LS donated more than $1000 worth of Amateur Radio books to local libraries. Show income has also been used to donate money to worthwhile causes, including AMSAT-OSCAR, ARRL building fund, purchase of equipment and accessories to support other local Amateur Radio groups, medical fund-raising drives, and activities related to WARC (World Administrative Radio Conference). These shows have proved to be a real asset to our Amateur Radio service, but our working members are so busy with their convention duties they get very little chance to enjoy any of the show features.

Prizefest. The December W6LS regular business meeting is called the Prizefest. This is a completely nontechnical meeting. Members are urged to bring their families to enjoy an excellent general-interest program. Drawings are held as part of the program, and Christmas comes a little early to the lucky few who win nonamateur prizes such as TV sets. W6LS has had a minimum of one prize and a maximum in excess of 100 prizes at this event.

Special projects

In addition to its continuing weekly and annual activities, W6LS becomes involved in special projects. A few of these unusual projects are described below.

Blood program support. Since W6LS uses the Lockheed blood-donor building to house part of its annual Amateur Radio convention, it's natural that cooperation should develop between these two groups. Lockheed employees have contributed more than half a million blood donations since the bloodbank idea was conceived by a colonel from Hickam Field following the December 7, 1941 attack on Pearl Harbor. When Lockheed replaced its old donor center in 1965, the first donor into the new building was a W6LS member who has now made blood donations totaling more than 16 gallons!

W6LS members conducted an aluminum collection drive throughout 1977 and used the income to purchase refreshments served to blood donors. This W6LS project aided the 12 bloodmobile visits in producing about 4000 units of blood used by the more than 250 hospitals in Los Angeles and Orange counties.

French Atlantic Affair. One of the unusual calls received at W6LS was from Ernest Lehman (K6DXK), who was writing a novel that included Amateur Radio as a major ingredient. As a direct result of this personal contact, W6LS is one of the call signs used in *The French Atlantic Affair.*

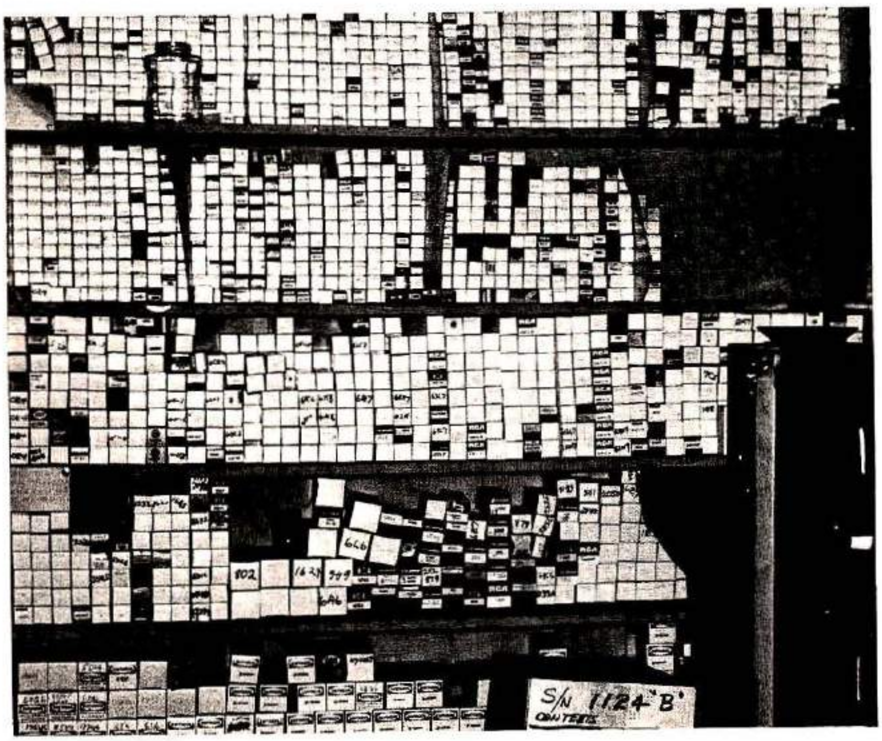
Guide dog. W6LS helped pay the costs associated with obtaining a guide dog for a blind amateur. This contact with International Guide Eyes, Inc., led to the chief surgeon (Joe Giardina, now WB6INB) and the head trainer (Erich Renner, now WA6MAM) completing a W6LS General-class licensing course and becoming amateurs. The organization's headquarters has its own club station with the call sign WB6ZUN.

Guidelines. The scope of W6LS activities has made experts of members in some interesting areas. One member wrote a booklet about Amateur Radio licensing courses. This booklet was used by the ARRL for a decade as an aid to club instructors. Individual sets of guidelines have been prepared by W6LS to help untrained people prepare suitable material for use by their local newspapers and radio/TV broadcast stations.

Hosting. W6LS hosts several meetings each year for other radio groups, including radioteletype, repeater, radio control, and the Southern California Antique Radio Society. W6LS members have recently hosted a couple of young foreign amateurs in connection with the Youth for Understanding program. OH6KN (Veija) was a frequent visitor to W6LS before he returned to his home in Finland.

Liver transplant. W6LS members have been generous is supporting several fund drives. One of the most satisfying of these involved a little girl whose family was having trouble paying the bills for her liver-transplant operation. The young girl was unusually impressed by the financial support she received, and she still drops in to visit.

Section of W6LS's tube stock, which is available at low cost. Also available are small parts such as resistors, capacitors, and hardware. All are donated. A well-equipped tool cabinet is also available, as well as a limited variety of basic test equipment.



Open house. W6LS is just one of 33 groups in the Lockheed Employees' Recreation Club, as mentioned previously. The parent organization conducts an open house every few years to display the scope of activities to the general public, and W6LS has had more than 3000 visitors during just one of these open houses. These visitors don't see the normal W6LS radio shack with materials piled from floor to ceiling and jammed into every space. The last time an open house was held, a huge stake truck was filled with material taken out of W6LS, and the truck was parked at a member's warehouse. The shack was cleaned to the point that members didn't recognize it. Literature and displays about Amateur Radio were set out for the benefit of visitors, and members were on hand at all times to answer questions. These open-house events have enabled W6LS to make many people more aware of our Amateur Radio service. The single most popular handout item each time has been the club QSL card.

USS New Jersey. During the Vietnam war, the battleship New Jersey (BB-62) was taken out of mothballs and put into service. While the battleship was being made ready at the Long Beach Naval Shipyard, a couple of crew members visited W6LS and mentioned a need for music and an Amateur Radio station aboard ship. A W6LS member, who was active in a local a-m radio broadcast station, obtained an excellent selection of taped music for use by the ship's entertainment center at no cost. W6LS members helped obtain and install an Amateur Radio station aboard the ship before it left Long Beach. The club received a wall plaque as a token of appreciation from the ship and also received regular copies of the ship's newspaper until she was again removed from service and mothballed.

The preceding information may convince you that W6LS has hundreds of active members, but the club membership has fluctuated from 70 to 140 for the past 20 years. All clubs need as many active members as they can get, and W6LS is no exception. The only difference between the "in-clique" and the "outsiders" in any group is that the "in-clique" pitch in and do the work. If you're presently in a club, choose some project or position that's particularly interesting to you, and improve your club by doing it to the best of your ability.

The success of an Amateur Radio club can't be determined by its membership total, treasury balance, club house, publicity, or aggregate contest score. A dedicated group of just 10 to 30 amateurs can operate a club that is an asset to themselves, their community, and the Amateur Radio service.

It's natural for amateurs with common interests to band together in clubs, and there are many things that are accomplished more effectively by clubs than by individual amateurs. However, it helps the Amateur Radio service to maintain a good balance, and specialized groups should promote their interests by maintaining maximum contact with other amateurs, clubs, and councils of clubs.

The prospective amateur can get a distorted impression of Amateur Radio by attending meetings of any special-interest club. The value of any club should increase if it expands its activities to include more than one aspect of Amateur Radio. If you're looking for information about starting (or rejuvenating) an Amateur Radio club, the ARRL has a packet of data on this subject that's very useful.

Prior issues of Amateur magazines also contain many helpful ideas, and a glance through December/January indexes should lead you directly to this type of data. If all else fails, just send the usual, large 254 by 305 mm (10 by 12 inch) SASE to W6LS with your request for a copy of our club operations guidelines. Don't be afraid to tackle large projects, because clubs (like people) rise to meet challenges. Too little activity is much more likely to kill a club than too much activity.

It's possible to spur club membership with specialty items such as automobile litter containers, ballpoint pens, calendars, caps, cups, decals, embroidered patches, felt-tip pens, fine-line markers, pencils, playing cards, QSL cards, tee shirts, and three-ring notebooks.

The club has designed and printed a few types of QSL cards, which are made available to members at a moderate cost. It's necessary to have 100,000 or more cards printed at a time to get the price down to where it's not prohibitively high when the charge is added to cover personal data (name, address, and call sign) overprinted on the basic card. The club picks up the entire cost of these cards, and W6LS usually has more than $1000 tied up in QSL inventory. This investment is a good one, since members appreciate being able to get excellent cards at reduced cost.

Closing remarks

This article should have given you some idea of what W6LS stands for and does. Each club has its own story. We hope this article will help promote increased interest in clubs, since they can be a major factor in determining whether the Amateur Radio service deteriorates or improves.

Further reading

Knadle, Charlene, WB2HJD, "Radio Clubs," *Ham Radio Horizons*, March, 1978, pages 26-29.

hr report, Amateur Radio's Weekly Newsletter, published by Communications Technology, Inc., Greenville, New Hampshire 03048. **HRH**

Memo from Drake

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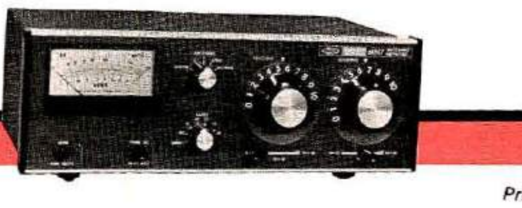

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A Guide to VHF Propagation

Part 1

BY JAY BUSCEMI, K2OVS

The amateur bands of 50 through 450 MHz offer some of the most exciting propagation effects in the radio spectrum. Most casual vhf operators are unaware of these effects and fail to take full advantage of them. In this article I will categorize the major modes of propagation in the vhf spectrum and provide some guidance to the uninitiated in how to best make use of these higher bands.

Most extended-range vhf communications take advantage of natural meteorological phenomena which affect radio propagation in the earth's atmosphere up as high as about 400 km (250 miles). **Fig. 1** depicts the various "layers" which you can use to extend vhf communication range. The actual height of these layers and their ability to reflect or refract vhf signals varies with the time of day, time of year, sunspot activity level, and local weather conditions. They are presented here only to familiarize you with their existence; more detailed descriptions of their behavior are available in *The Radio Amateur's Handbook* and other literature.[1,2]

A brief word about equipment and operating techniques is appropriate at this point. In general, most DX communication is carried out on CW or ssb in the lower portions of the vhf band segments. These modes can be successfully used by a station with 70 to 100 watts output, a medium-size beam antenna (10-16 elements, horizontally polarized), and a receiver with a 2-3 dB noise figure. The popular multi-mode transceivers used in conjunction with a small amplifier will work quite successfully, particularly on 2 meters. Certain DX modes, such as E-skip and TE scatter, have been used by 10-20 watt stations — so more elaborate equipment is not always a necessity. The most popular calling and listening frequencies used in the continental U.S. are these:

6 meters:	50.100 CW, 50.110 usb
2 meters:	144.100 CW, 144.210 usb, and 146.52 fm (vertical polarization)
1¼ meters:	220.010 CW, 220.050 usb
70 cm:	432.090 CW, 432.100 usb

When conditions are good for band openings, you will almost always make the earliest contacts by monitoring these frequencies. As the conditions improve, stations tend to spread out above and below these frequencies by 20 kHz or so. Tuning around will pay off as the band gets crowded.

The major modes of terrestrial vhf propagation are shown in **Fig. 2**. The frequency of occurrence of these modes is based on my observations over a 20-year period from the New York City/Long Island area. Obviously, those modes affected primarily by local geography (such as tropo ducting and temperature inversions) will vary greatly, depending upon location.

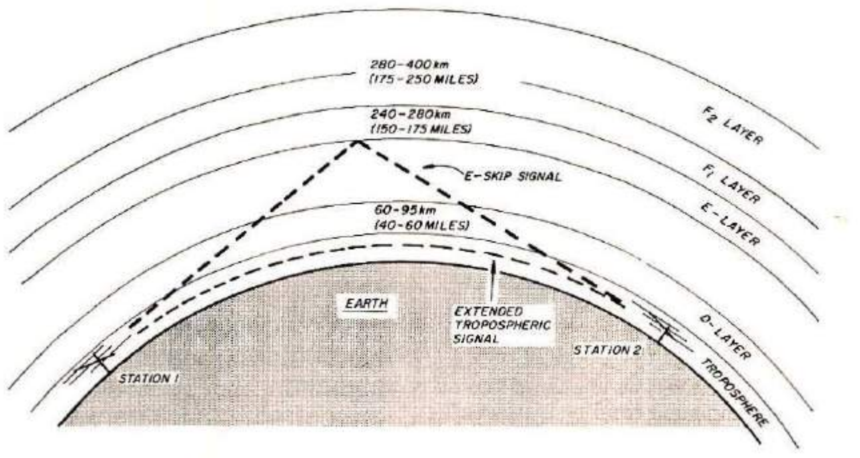

Fig. 1. The space through which radio signals propagate is made up of several layers. The lower one, called troposphere, bends the signal path by temperature differences or disturbances in the air mass. Higher layers, in the ionosphere, are subject to varying degrees of ionization — which either helps or hinders the signals as they pass through. The layers are not in fixed positions, but rather shift up and down depending upon weather conditions, solar activity, and the time of day.

Specific propagation modes

Normal coverage: vhf propagation is generally believed to be line-of-sight, that is, the radio path is the same as an optical path. In practice, the so-called normal vhf range is actually 7-15 per cent farther than the optical path, a result of the presence of moisture in the atmosphere and the bending of radio waves back toward the earth.[3] Over flat terrain, a rough calculation of a station's line-of-sight distance can be made by the following equation:

$$D\ (\text{kilometers}) = 4.1\sqrt{\text{height of antenna in meters}}$$

$$D\ (\text{in miles}) = 1.4\sqrt{\text{height of antenna in feet}}$$

Fig. 2. The type of propagation of vhf signals varies from month to month, and some modes appear only at certain seasons. This chart shows what you can expect in the way of normal or exotic conditions on the different bands.

	Approximate useful days per year				
Mode	**50 MHz**	**144 MHz**	**220 MHz**	**432 MHz**	**Notes**
Normal coverage	300-320	300-350	300-350	300-350	Slightly beyond line-of-sight, affected by local terrain.
Temperature inversion	20- 60	20- 60	25- 60	25- 60	Affected by local weather patterns, best in spring and fall.
E-layer skip	50- 70	2- 10	*	*	Best in June, July, and January.
Tropospheric ducting	0- 10	5- 20	10- 20	10- 30	Due to large stationary weather systems.
Back/forward scatter	70-120	10- 20	*	*	Combination of E, F layer and meteors.
Aurora	10- 40	10- 30	10- 15	0- 5	Generally higher latitude effect.
Intense meteor scatter	20- 40	10- 30	5- 20	0- 5	Best during major showers in August and December.
Trans-equatorial scatter	10- 50	5- 20	*	*	Generally middle latitude effect.
F-layer skip	0- 10	*	*	*	Usually during sunspot peak years.

* Insufficient data

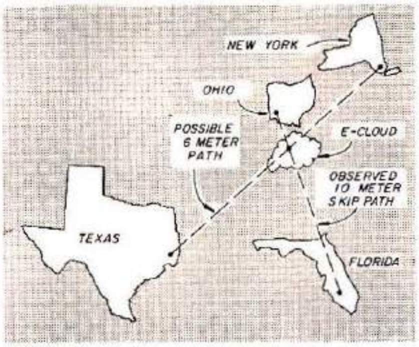

Fig. 3. Sometimes an observed skip opening on a lower band can tip you off to good conditions for 6 or 2 meters. E-layer clouds move fast, so a path may not exist for very long.

For example, if a vhf antenna is 15 meters (50 feet) high, the approximate line-of-sight distance for the horizon is

$$D = 4.1\sqrt{15.24} = 16 \text{ km}$$

$$D = 1.4\sqrt{50} = 10 \text{ miles}$$

If the station on the other end of the path has an antenna that is at the same elevation, the maximum two-way line-of-sight distance is twice this value, or approximately 32 km (20 miles). The antenna height should include the ground elevation if it is significantly different from the surrounding terrain.

Some 10-15 per cent of the time, local conditions will tend to be subnormal due to very low humidity (no refraction) or heavy rain or snow (high absorption). During times of the year when foliage thickens and absorbs moisture, higher-than-normal signal attenuation should be expected.[4] The traditional adage "get your antenna as high as possible" helps overcome this effect.

Obviously, many other factors affect a station's coverage. A large hill or mountain will block vhf signals, particularly one close to the station. Tipping the antenna up from the horizontal, when it is aimed at a large obstruction, can sometimes be used to scatter vhf signals. Man-made structures such as buildings or bridges can be used to some advantage in extending local coverage. Several stations on Long Island, New York, have used the Throg's Neck Bridge in New York City to reflect two-meter signals into northern New Jersey, as an example.

Temperature inversion

By far the most common form of extended-range propagation is observed on the vhf bands during a temperature inversion, that is, when bending (refracting) of the wave in the troposphere is caused by a reversal of the normal height-to-temperature relationship. Normally, the temperature decreases rapidly with height above the ground up to 15 km (50000 feet) or so. When this condition gets reversed at some point in the troposphere, vhf signals tend to be bent back toward the earth over extended distances — out to twice or three times the normal range.[3] Inversions are particularly common along coastal areas in the spring and fall months due to the increased temperature difference between the land and the water. Intermixing of warm and cool air at altitudes of up to 16 km (10 miles) creates the inversion. Propagation is generally enhanced along these mixing lines, which tend to follow the coastline. As an example, stations on the coast of Maine regularly can work as far south as Virginia at least 60 to 70 days a year with good signal levels. Storm centers, well-defined weather fronts, and other atmospheric disturbances also produce local temperature inversions along their front lines.

Propagation by this mode is primarily a nighttime effect; the sun's heat during the day tends to smooth the temperature *versus* curve height. After dark, the air-mass mixing begins and improves conditions throughout the night. Conditions often reach a peak in early morning, perhaps 7:00-9:00 local time.

One of the best indicators of a temperature inversion is the increase in signal strength on fm repeaters. Check the common frequencies in your area to learn the direction and intensity of the improved signal conditions. Weak vhf and uhf TV signals on locally unoccupied channels also provide an indication of good conditions. A temperature inversion can be quite selective in terms of station locations. Amateurs not very far apart may experience vastly different signal strengths from a distant station as the temperature-inverted air layers drift around. Listen to what is being worked by nearby stations to determine the best direction as the evening progresses.

Temperature inversions tend to favor the higher-frequency bands for a given set of conditions. Many Amateurs will move up to 220 or 432 MHz when conditions are good on six or two meters, often finding stronger signals over the same path. However, the maximum length of the path than can be worked is generally the same for similarly equipped stations. Inversions that affect vhf signals seem to have well-defined geographical start and stop points, regardless of the band used.

E-Layer skip

The ionospheric E-layer, responsible for short skip on the high-frequency bands, can become sufficiently ionized in patches to reflect six and two meter signals with very high received-signal levels. E-skip is

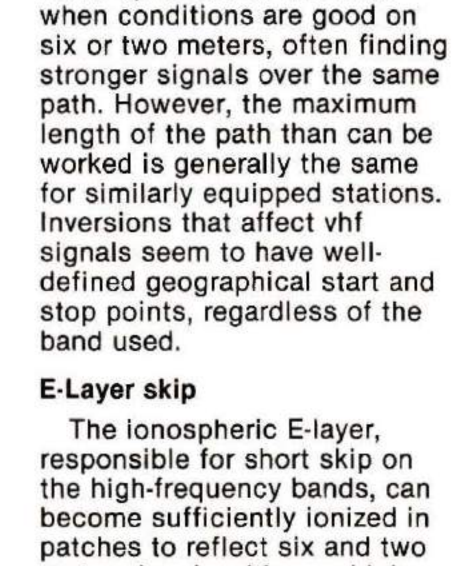

Fig. 4. A rare occurrence that pays off in very good DX on 6 or 2 meters is the positioning of two E clouds so that you can extend your range far beyond normal.

generally observable in January, June, and July, but it can occur at any time of the year. These patches of high ionization, called "sporadic-E clouds," are generated around the equator and travel in a northwesterly direction across the country. The clouds are generated in bunches, and have an apparent size of up to several hundred feet across.

Several good indicators are available to help you identify the presence of sporadic-E clouds. The 10-meter band is one of the best; when strong stations are being heard at distances below 500-600 km (300-400 miles), the maximum usable frequency (MUF) of the E-clouds is going up. A check of the six-meter band should find strong stations out to 1600 km (1000 miles) or so. As the skip shortens on six-meters, the two-meter band may begin to open and E-skip will be observed there. The vhf TV channels provide a constant monitor on E-skip conditions. When channels 2 or 3 in your area show signs of co-channel (same-frequency) interference, six meters is open in the same direction as the interfering TV station. As co-channel interference is observed on TV channels 4, 5, 6, and the fm broadcast band, it is likely that E-skip will start on two meters.

Because the clouds are physically small, some knowledge of their location at any given time is important so you can aim your antenna at the cloud. To approximate the cloud's location, listen on a lower frequency (10 meters) and note the location of stations talking to each other. For example, if Florida stations are working Ohio, the cloud is located somewhere near the midpoint of that path, maybe over Tennessee. Aiming your antenna towards Tennessee on the next higher band may allow you to work Texas, if you are located in the New York-New Jersey area. Constant observation of the next lower frequency band will allow you to readjust your antenna heading as the E-cloud moves (**Fig. 3**).

Signal levels tend to be very strong when reflected by the E-clouds. Many stations running 10 watts or so have worked over 1200-1600 km (800-1000 mile) paths with S9 signals. Another characteristic of the E-skip signals is their "there-or-not" nature. Signals can disappear in mid-sentence and reappear just as quickly. Short CQs and listening periods (15 seconds or so) are necessary to take full advantage of the shorter openings, especially on two meters. E-skip on six meters can last hours; two meter openings rarely exceed 15 minutes or so. The best listening times are mid morning and early evening, up to 9:00 p.m. local time, although E-skip has been observed around the clock on occasion.

Double-hop E-skip has been observed on six meters, extending the skip range out to 4800 km (3000 miles) or more. This requires two or more E-clouds to be in just the right position (**Fig. 4**).

Tropospheric ducting

Large, stable, high-pressure systems can form elevated ducts with fairly well-defined boundaries at altitudes of up to a few miles. These ducts act as waveguides for vhf signals and can propagate the signals over distances of 6500 km (4000 miles) with almost no loss of strength. Ducts of this type have been responsible for Hawaii-to-California and New York-to-Bermuda contacts on two meters in recent years.[5,6]

Weather maps provide the best source of information for predicting the possibility of ducting. A large, stable, slow-moving, high-pressure center moving across the country may produce ducts along its front lines. Ducts tend to have well-defined boundaries, so stations a few miles apart may experience vastly different signal levels. A duct must terminate

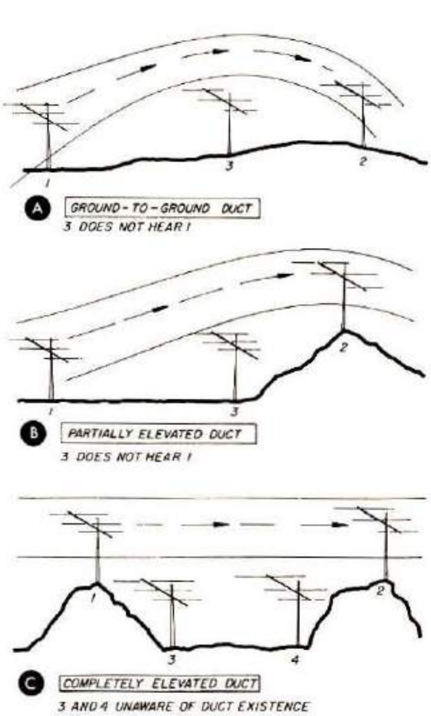

Fig. 5. Tropospheric ducting can propagate signals with very little loss, but you have to be in the right place to use this mode. Some ducts form so high that only aircraft or mountain tops are in the right spot, but enough do end at ground level to keep vhf work interesting.

at some ground location to be useful; totally elevated ducts are useful only for aircraft or stations at high elevations. Some of the Hawaii-to-California openings were available only to stations on mountain tops; the duct never dropped below approximately 1500 km (5,000 feet), (see **Fig. 5**).

Once a duct is formed, it may last several hours or days, drifting both in starting point and height. Furthermore, certain frequency bands may be favored at different times. It is not unusual for signals to be much stronger on 432 than on 144 MHz, so changing bands can be a good idea. Keep a watch on unused TV channels, particularly 7 to 13 and 14 to 50 for indications of duct formations. Keep in mind that most TV transmitter sites are located at relatively high elevations, so a distant station's signal may be entering a partially elevated duct at one end of the path at an elevation unaccessible to amateur stations. This same

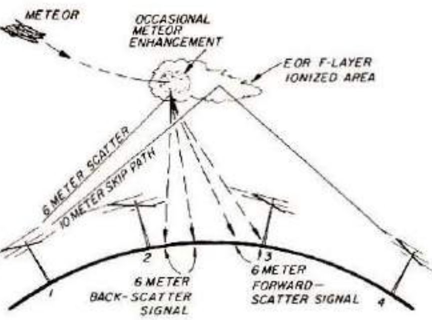

Fig. 6. Scatter signals occur when there is not enough ionization to cause loud-signal propagation, but there is some improvement over normal conditions. Random meteors sometimes add to the effect.

effect can occur with repeater signals, as repeaters are generally at higher elevations. However, these indicators will tip you off to the existence of a duct which may descend and become usable.

Apparently, ducting occurs much more often than was once suspected. Commercial and military air-communications links and radar are frequently distrupted or confused by tropo ducting.

Ducts are sometimes optically visible, particularly in areas with high dust or smog levels. The dust particles in the air seem to concentrate near the duct boundary, producing a dark band across the sky. An observer can estimate the elevation of the duct and possibly its end point. In southern California, some operators take mobile or portable vhf stations to the higher areas when an elevated duct is observed near the coast line. This technique has resulted in many low-power, long-distance contacts on two meters.

Back and forward scatter

Since ionized patches and layers in the ionosphere are far from uniform in shape or surface consistency, signals striking them do not always reflect back down to earth in a straight line, as optical theory would predict. Some portion of the energy scatters off the ionized area in arbitrary directions (**Fig. 6**). Signals bent back toward the transmitter are commonly called "back-scatter" signals; those reflected ahead or to the side of the reflecting layer are called "forward-scatter" signals.

Ionospheric scatter signals are generally usable above the normal maximum usable frequency (MUF) of the reflecting layer. For example, an ionized area of the F_2 layer may be producing strong skip signals on ten meters from New York to California but may not be sufficiently ionized to propagate six meter signals. By aiming an antenna toward the reflecting area, your weak six meter scatter signals may be available to a station at the end of the 10-meter circuit. Ionospheric scatter signals may be momentarily enhanced by meteors entering the atmosphere, temporarily raising the effective MUF of the ionized area in use.

Operating via the scatter mode is not limited to the D, E, and F layer ionized areas; any physical irregularity in the earth's troposphere can produce usable scatter signals. A storm center, weather front, or other disturbance along the radio path can be used to produce contacts over extended distances (**Fig. 7**). Thunderstorm scattering, although potentially dangerous (most stations prefer to ground their antennas during a thunderstorm), has been successfully used for extended-range two-meter contacts in the Midwest, as lightning produces highly ionized columns in the troposphere.

Scatter signals tend to be much weaker than most VHF propagation modes, so high power, large antenna arrays, and low-noise-figure receivers will improve your ability to successfully use this mode. Except for momentary meteor enhancement, fading tends to be slow and the scatter path may be open for extended periods of time with relatively consistent, but weak, signals. Because of the weak-signal nature of this mode, TV and fm broadcast channels are not generally affected enough to be usable indicators. However, strong short-skip on 10 meters may indicate potential ionospheric scatter signals on six meters, and local disturbed-weather patterns may produce tropospheric scatter on two meters and up.

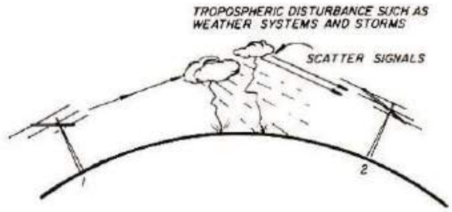

Fig. 7. Almost any discontinuity in the atmosphere can cause scatter-signal propagation. Storms and storm systems should be watched closely. The highly ionized path of a lightning bolt can provide a momentary increase in signal strength — sometimes many dB above normal.

There's a lot more to vhf propagation than I've covered so far, but I'll have to finish it up next month. The modes just explained have been, for the most part, supported by phenomena in the lower and middle atmosphere. Next month I'll get to the higher limits of the ionosphere, and tell you about some types of propagation which are understood but infrequent in occurence, and about a relatively new mode that offers Amateurs a chance to explore, learn, and add to the body of scientific knowledge.

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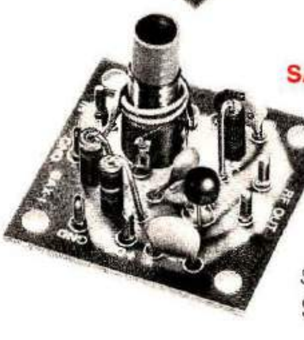

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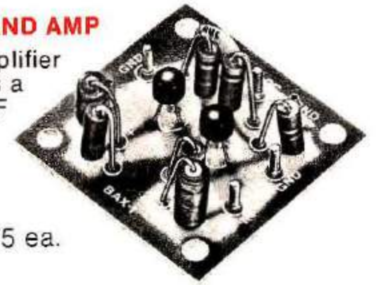

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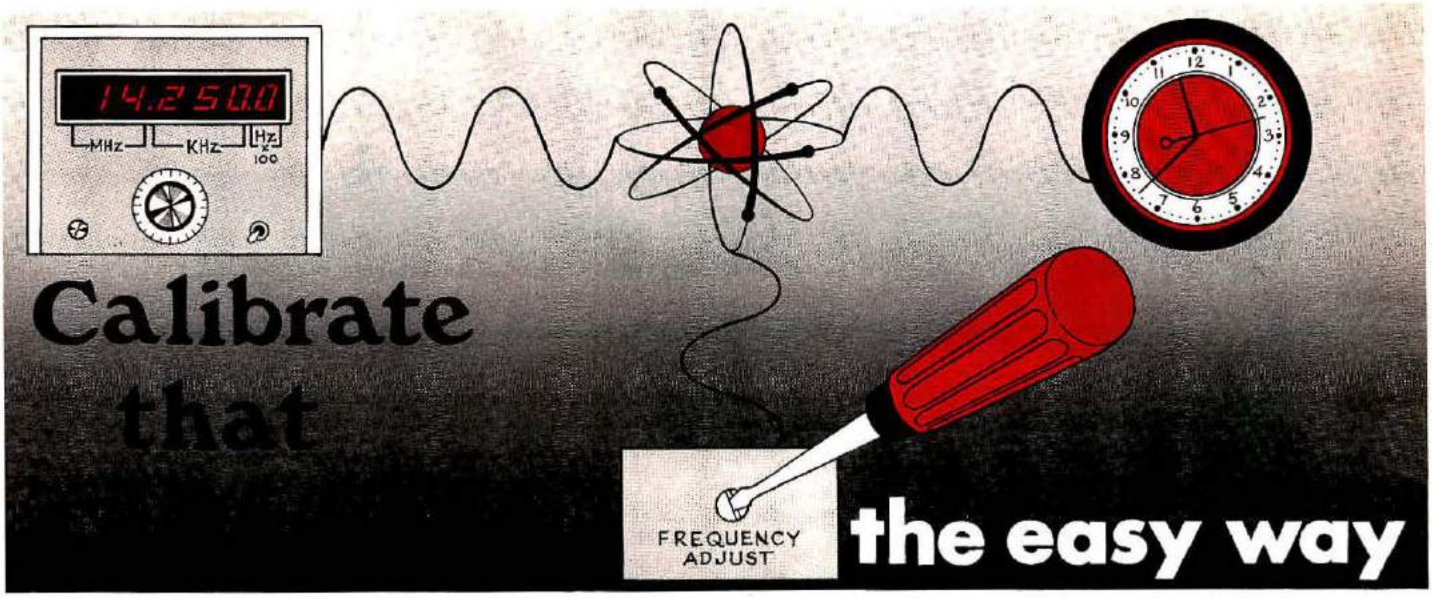


An explanation of the zero-beat method of putting your time base right on frequency

BY KARL T. THURBER, JR., W8FX

Once you've installed that crystal calibrator (or oscilloscope time base, frequency-counter, master oscillator, or whatever) the problem remains of accurately calibrating it against WWV, WWVH, or another source of *known* frequency. And it *is* important to calibrate the unit accurately. For example, a 2-Hz error at the fundamental 100-kHz frequency of the typical calibrator crystal results in a 100-Hz error at 5 MHz — and many times that at vhf or uhf.

There are a number of precise methods of exact frequency-setting, such as the oscilloscope Lissajous pattern method, the oscilloscope "drift pattern" method, or indirectly by the so-called "time comparison of clocks" method. All these sophisticated techniques require equipment not usually possessed by the amateur, so most experimenters either don't calibrate at all (hoping that the circuit, as built, is close enough to frequency), or half-heartedly zero beat against a local broadcast station or WWV. This article explains and refines the heterodyne method, which is capable of providing surprisingly good results even when the objective is to come up with a known calibrated reference well into the vhf region.

It is well worthwhile to calibrate carefully against WWV or WWVH, since extreme accuracy is possible. These stations derive their signals from a cesium-beam standard, and each uses atomic-clock references to provide time of day, audio tones, and radio frequencies. The frequencies of the cesium standards at the stations are controlled within plus or minus 1×10^{-12} of the NBS (National Bureau of Standards) master frequency standard, which is located in Boulder, Colorado. Also, time at the stations is controlled to within plus or minus 5 microseconds of the UTC/NBS time scale. Not bad for government work!

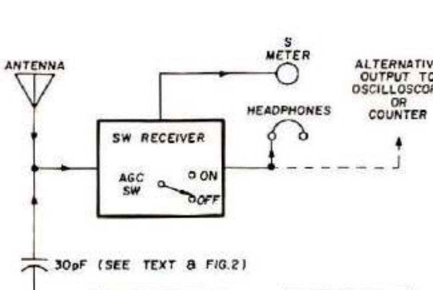


Fig. 1. Equipment interconnections for beat-frequency method of calibration.

Beat frequency, or heterodyne, methods of frequency comparison with standard frequencies, such as WWV or WWVH, are a simple technique often used to calibrate transmitters and to tune receivers. Frequency offsets of less than 1 part in a million can be accurately determined. Thus, a 1-MHz signal that is calibrated in this way can have an anticipated error of but 1 Hz! (Good results can also be obtained by calibrating against United States or Canadian broadcast stations on 1000 kHz or any 100-kHz increment in the broadcast band, though accuracy will suffer if they are slightly off-frequency — and this *can* happen.)

The heterodyne method consists of beating or mixing a known, accurate frequency (such as the WWV/WWVH signal) with the output of an rf oscillator. The mixing is accomplished by the converter circuit of a superhet hf receiver. The frequency difference between the two signals can be amplified and detected, the result being an audio output signal called the beat frequency or beat note. The basic setup is shown in **Fig. 1**.

The frequency of this beat note is, of course, the difference between the two rf-input frequencies. When the two frequencies are equal, their difference decreases to zero and is known as zero beat. Obviously an oscillator can be set very nearly equal to WWV or WWVH in frequency and can thereby provide a good secondary frequency reference for most purposes. To calibrate a frequency standard or oscillator with an output frequency lower than that broadcast by WWV, an appropriate harmonic equal to the WWV signal is required. As an example, if a 100-kHz signal is to be calibrated against the WWV 5-MHz frequency, then it must also contain a harmonic fifty times itself and be at a submultiple of the WWV frequency.

In theory, a pure sine wave does not contain any harmonics. In practice, though, the sine-wave signals used in radio-frequency work contain *some* harmonics, and enough harmonic content is usually available to produce a discernible beat note. A square wave, on the other hand, is very rich in harmonic content and is considered ideal for generating harmonics to calibrate receivers, transmitters, oscillators and VFOs in the hf and vhf bands.

If the calibrator doesn't have sufficient output at the higher WWV frequencies, a simple method of developing a square wave from a sine wave is by clipping the signal with a dual-diode clipping circuit as shown in **Fig. 2**. This will enhance the high-order harmonic output. If the receiver input impedance is low (50 to 75 ohms) a 20-40 pF capacitor can be used to couple the calibrator harmonic output to the receiver input and to attentuate the oscillator's fundamental frequency. If the receiver has a high input impedance with twin lead or single-wire lead-in from the antenna, the harmonic signal can be loosely coupled to the receiver input by wrapping several turns of an insulated wire around the antenna lead-in and connecting it directly to the calibrator output.

If the beat note is above 50-60 Hz or so, headphones, a speaker, or a frequency counter can be used. Below these frequencies, an oscilloscope can be connected to the receiver output. An S-meter can also be used and the beats counted visually. The agc (automatic gain control) or avc (automatic volume control) should be disabled, if possible, for the meter fluctuations to be more pronounced. The receiver's manual rf gain control can be adjusted to compensate for the loss of agc or avc action.

To correct the oscillator or crystal calibrator frequency, the frequency adjustment trimmer is turned in a direction that decreases the beat-note frequency. Between 50-60 Hz and about 1 Hz, the beat note cannot be heard and the S-meter will begin to respond to, or track, the beat as it approaches 1 Hz. As it nears zero beat, a very slow rise and fall of the background noise or the WWV audio tone can also be heard in the speaker or headphones. The visual meter effect is much easier to follow, though, as it approaches zero-beat frequency; the slow rise and fall of the signal strength may sometimes become difficult to distinguish from signal fading due to propagation effects. However, I've found that observing the S-meter as the adjustment goes through zero beat to be a very excellent means of calibrating the oscillator, allowing a resolution of but a few hertz if done carefully under conditions of slow signal fade. To get a strong, well-defined beat note may take some experimentation with relative WWV/WWVH and calibrator signal levels — they should be equal, if possible.

In an alternative method suggested by NBS, when fading is a problem, the oscillator adjustment can be *interpolated*. First, the oscillator is adjusted to the minimum beat frequency that can be detected without interference. For best accuracy, the number of deflections of the meter in 10 seconds are counted. The setting of the frequency adjustment trimmer is then marked. Next, the adjustment is made to pass zero beat until the beat is again visible on the meter. By coming up with the same number of

Glossary of Terms

Beat note is the regular pulsation arising from the interference of simultaneous sound waves or radio waves that have slightly different frequencies.

Clipping circuit is used to develop harmonic-rich signals from a sine wave by limiting the peaks of the wave. This simulates a square-wave, which is rich in harmonic energy.

Heterodyne relates to the combination of two signals so that their sum and difference frequencies are produced. One signal is usually the received signal and the other is a signal introduced into the apparatus.

Interpolation is a method of estimating the values of a function (oscillator frequency) between two known values (number of meter deflections per unit time, in this case).

UTC is derived from the French *Universel Temps Cordonné*: the English version is *Coordinated Universal Time*, or, simply, *Universal Time*. UTC, CUT, and UT are often used interchangably.

Zero beat refers to the adjustment of two signals so that no discernible frequency difference exists in their beat note.

meter deflections as with the previous beat note, the frequency of the oscillator can be set midway between the two settings of the oscillator trimmer adjustment. (I definitely prefer the visual S-meter technique as being more practical and accurate and have used it to put both crystal calibrators and counters on frequency.)

Remember that heat will affect calibrator stability. Also, crystals drift in frequency with age, which is commonly referred to as aging or drift. Therefore, all crystal oscillators should be checked and recalibrated periodically to ensure accuracy. Whenever high long-term accuracy is required, such as in a frequency counter, a high-accuracy crystal and an oven should be used for maximum stability.

As a point of interest for those who are trying to calibrate a frequency counter with a 10-MHz crystal time base, often merely opening the cabinet and placing the unit next to the station receiver or transceiver will provide enough signal to beat with WWV for accurate setting. If not, a link of a few turns of insulated wire can be loosely coupled to the time base and fed to the receiver through a short length of coaxial cable for adjustment. If the calibrator uses an oddball time base, such as a 4-MHz crystal, the regular station crystal calibrator can first be accurately set against WWV or WWVH, then the counter 4-MHz oscillator can be immediately zero beat against the calibrator with little loss in overall accuracy.

In any case, be sure to calibrate when WWV or WWVH are not broadcasting their audio tones. It's all too easy to zero beat against one of the two sideband difference subcarriers. A glance at the broadcast formats shown in **Fig. 3** will indicate the best times to calibrate.

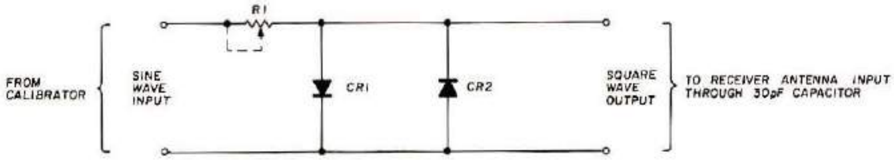


Fig. 2. Diode clipping circuit. Resistor R1 may have to be adjusted depending on calibrator output. Practically any junkbox potentiometer up to about 2500 ohms may be used to allow adjustment of calibrator output.

Although WWV and WWVH transmit on several different frequencies, in most cases at least one of the frequencies will be received strongest at a particular location and time of day. Different frequencies may have to be tried to suit varying propagation conditions. Good reception of signals, that is, a good signal-to-noise ratio from the stations, is absolutely essential for high frequency resolution and calibration accuracy. Field strength and geographical location will determine the receiver and antenna requirements. In poor reception areas, a directional antenna may be necessary so that it can be oriented to produce a strong signal. Usually, however, the regular station antenna will suffice for reception.

Let's take a quick look at the characteristics of the available WWV and WWVH frequencies:

2.5 MHz. Signals at this lowest WWV/WWVH frequency have a short range during the day due to ground-wave propagation limitations. Use would be restricted to locations within a couple of hundred miles (150-300km) from the transmitter site. This frequency becomes more useful at night, however, particularly during the winter in the higher latitudes where longer nights occur. However, reception is possible over distances of several thousand miles or km, the sky wave signal is predominant and a horizontal half-wavelength dipole is suggested (a 160- or 80-meter dipole will do). Static can often be annoying when trying to calibrate using this frequency, particularly during the summer months in the lower latitudes.

5.0 MHz. This frequency can be received usually at much greater distances than the 2.5-MHz frequency at any time during the day or night. Reception is possible up to 1000 miles (1600km) under good conditions; but under normal circumstances daytime propagation conditions limit its useful range, and reception is often limited to less than 1000 miles (1600km) during the day. At night, 5 MHz is a very good frequency for long-range reception. It is also excellent during the early dawn and evening hours in the winter months when the signal path is in darkness.

10.0 MHz. Reception over long distances is possible during both day and night. It can be classed as an intermediate frequency, which is somewhat dependent on the sunspot cycle. This frequency also provides daytime reception at fairly close range (200-300 miles or 300-500 km) and can often be used when 5-MHz reception is marginal or unusable.

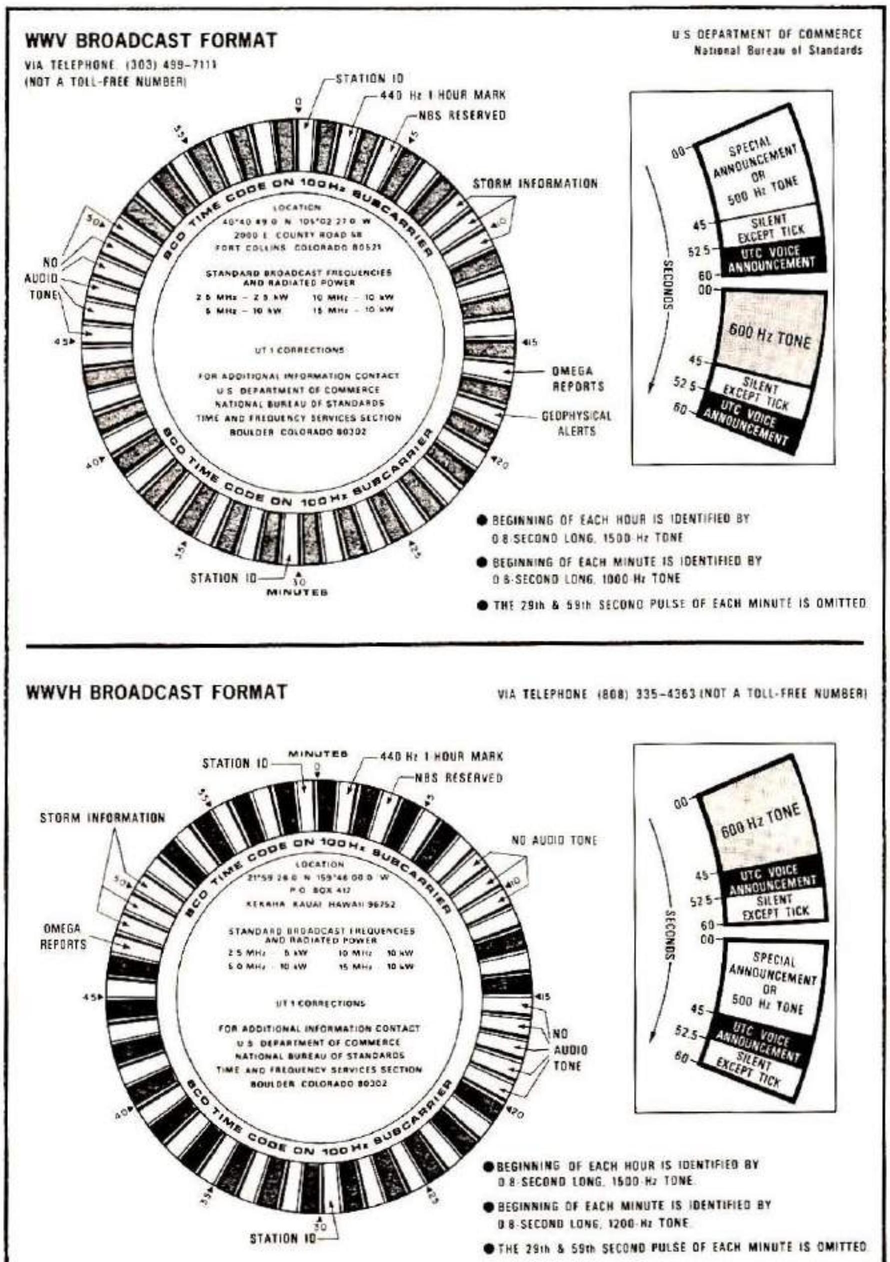
15.0 MHz. This tends to be the best frequency for long-range daytime reception. It's not generally usable for short-range reception except during periods of sunspot maxima. However, for long-distance reception, it's the best frequency during both maximum and minimum sunspot cycle conditions. During maximum sunspot conditions, reception is possible during the night in some locations. During the minimum of the sunspot cycle, however, 15 MHz is useful only during the daytime and at dawn and dusk. (Many newer transceivers feature receive-only capability of 15-MHz WWV for internal calibrator adjustment. This is a particularly handy feature, indeed.)

The highest frequency receivable normally should be used for routine calibration, since errors in zero beating at the lower frequencies will be multiplied as frequency increases.*

Buying a calibrator

If your receiver or transceiver is not equipped with a built-in calibrator, a number of excellent accessory crystal calibrators are now available. I have found the Rainbow Industries† Model FS-200C to be about the most versatile unit available in its price class ($35). It provides calibration markers not only every 100 and 1000 kHz, but switch-selected, strong square-wave markers also every 500, 250, 50, 25, 10, 5, 2.5, and 1 kHz *and* every 500, 250, 100, 50, and 25 Hz, well into the vhf range. As such, it can perform triple-duty as an oscilloscope, time-base calibrator and audio signal generator.

Fig. 3. WWV and WWVH broadcast format.



Another unique crystal calibrator is Ten-Tec's model 206, which is designed as a companion to their Argonaut transceiver but can also be used with any other receiver or transceiver that can furnish the required 12 volts for operation. The output of this unit, which also extends well into the vhf spectrum, is gated at several pulses per second for easy signal identification. This feature is especially useful in discriminating between signals close together, which may be confused with the calibrator's output signal.

The MFJ Model 200BX frequency standard is another unit that features a distinctively gated output and which provides strong markers every 100, 50, or 25 kHz well into the vhf region. All these calibrators have adjustable trimmer capacitors for exact zero beating to WWV, as described in the article.

For complete information on NBS, WWV, and WWVH and their many technical services, refer to the references listed below. These can be obtained either from NBS or the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

References

1. *NBS Time and Frequency Dissemination Services*, NBS Special Publication 432, January 1976.

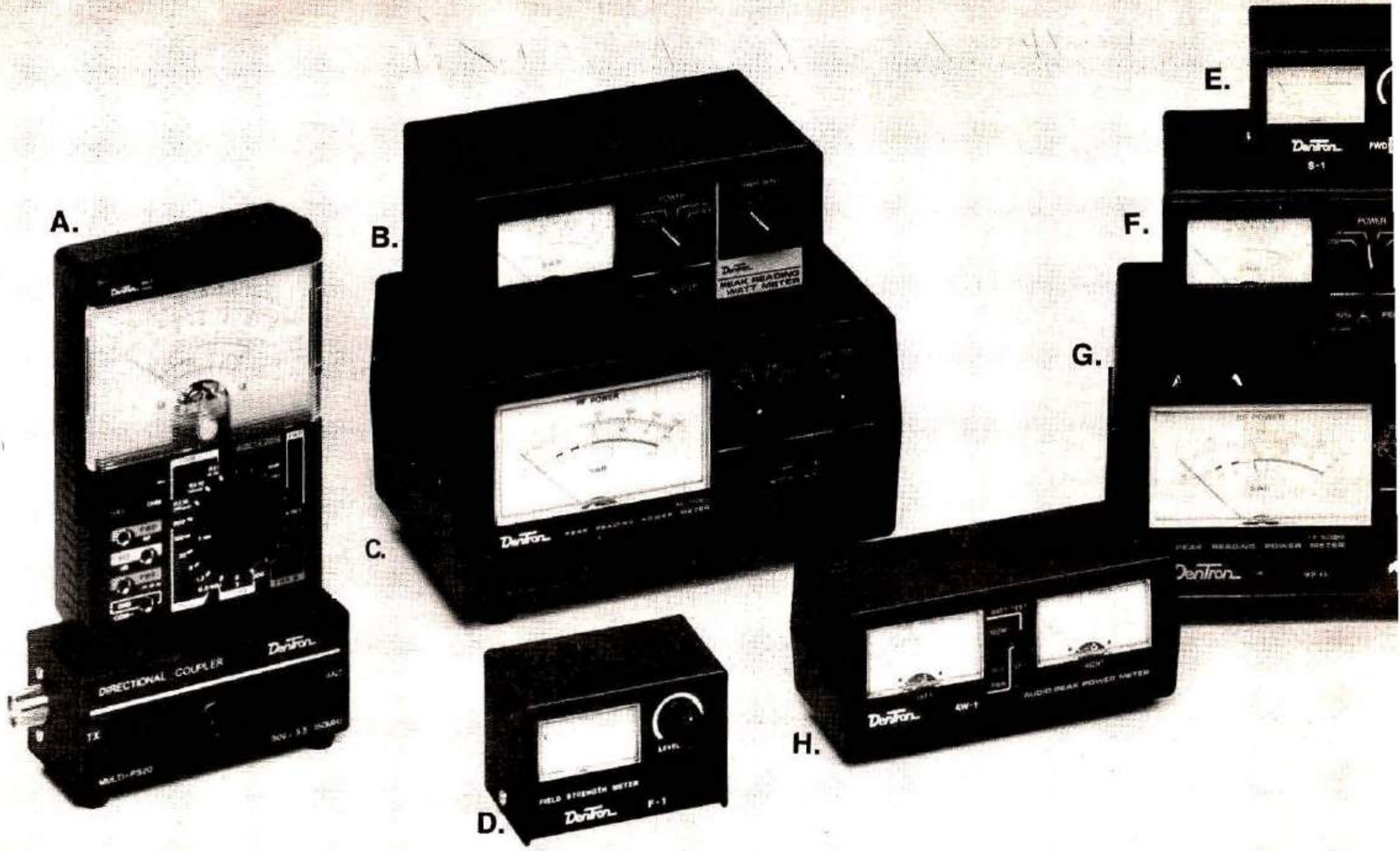
2. *The Use of National Bureau of Standards High Frequency Broadcasts for Time and Frequency Calibrations*, NBS Technical Note 668, May 1975.

3. *NBS Time and Frequency Broadcast Services: WWV, WWVH, WWVB, WWVL*, NBS Publication TFS-601, January 1976.

HRH

*For more information about Standard Time and Frequency broadcasts, and a listing of stations in other parts of the world that can be used for calibration purposes, see "Time and Time Again," in the September, 1977, issue of *Ham Radio Horizons*, page 42.

†Rainbow Industries, Post Office Box 2366, Indianapolis, Indiana 46206.



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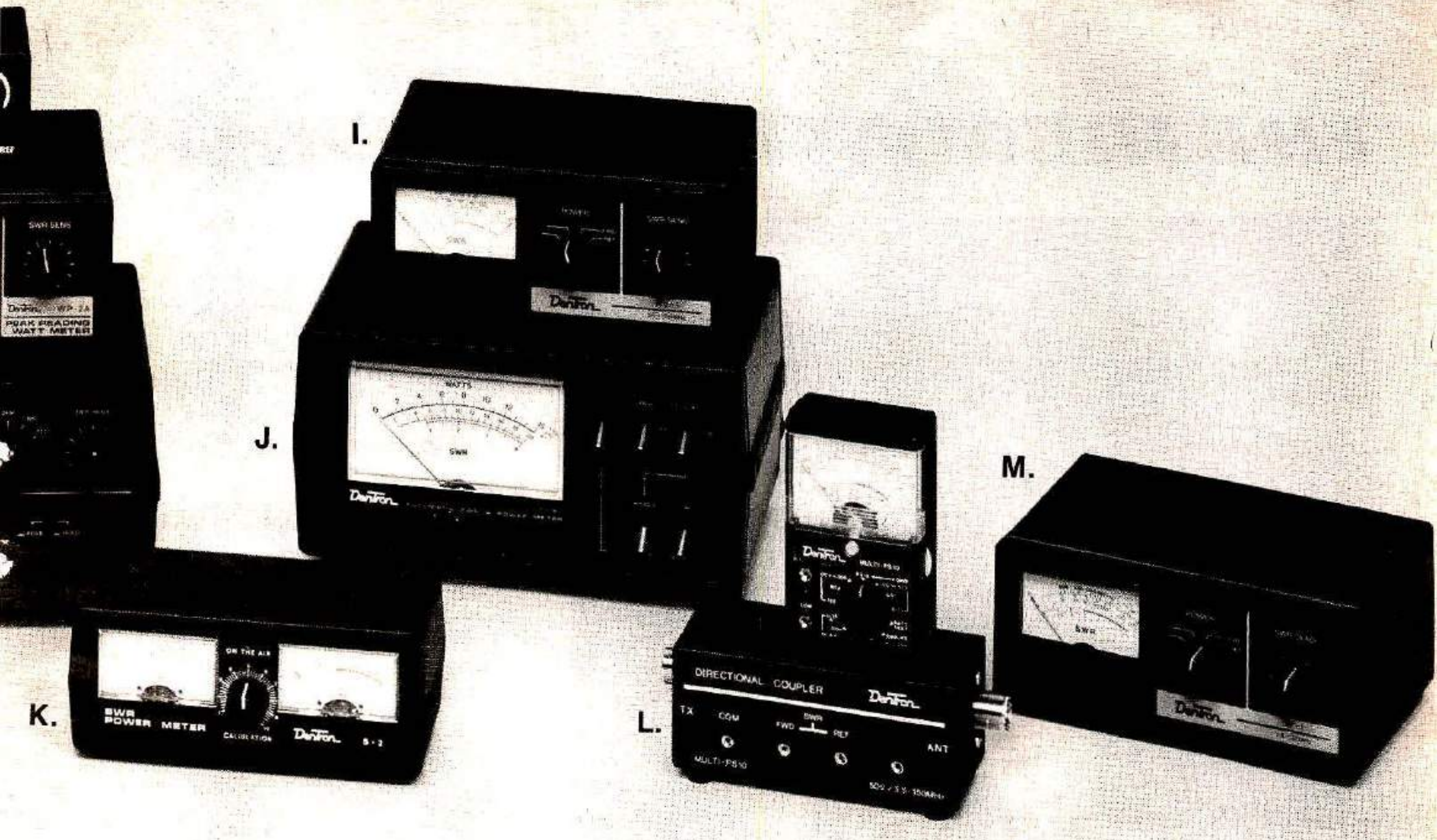

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THE HIERONYMOUS MACHINE

Can you help solve this riddle?

BY JAMES H. GRAY, W1XU

If there's anything a ham can do, it's put two and two together and make 4, 22, 100 (binary) or whatever combination is not immediately apparent, right? Right!

Traditionally the radio amateur has been viewed by his friends as a "tinkerer," by his neighbors as "that fool kid with all the radio junk" and by his family as a time waster. History, however, records a more favorable, if longer, view. The ham has usually been the experimenter who, not knowing "it can't be done that way," has gone ahead and done it anyway, like the bumblebee. Some people call it genius. The ham prefers to think of it as just a little different way of looking at things. Today, more than ever, the world needs people who see things in more than one perspective and from more than one point of view.

A challenge

You ask, "What has this got to do with me?" Well, there's a real riddle afoot and it's been around for at least thirty years. It's just the sort of thing that perhaps a ham might solve. The solution will probably require some different, original, and creative thinking. Here's what it's all about.

In 1946, inventor T. G. Hieronymus filed a patent application dealing with a method and apparatus for the "Detection of Emanations from Materials and Measurements of the Volumes Thereof." In 1949, U.S. Patent 2,482,773 was issued to T. G. Hieronymus for his method and apparatus. Copies of this patent may be obtained for a nominal sum from the Commissioner of Patents, United States Patent Office, Washington, D.C. So far so good. There's only one problem, or riddle, with Hieronymus's machine: it just can't work by any known method or means, yet it does. It can be demonstrated, it can be described, and it can be built inexpensively. This is the *how* of the invention. No one knows or can describe *why* it works, what its principle of operation is, or what kind of emanations are detected. Furthermore, it works for only about 60 per cent of the people who try it.

The apparatus

What does it do? Well, one thing it does is analyze materials by — presumably — detecting some form of radiation or emanation from the material being analyzed. Hieronymus found that these emanations can somehow be "focused" by a lens, refracted, and dispersed by a prism. He speculated that the emanations

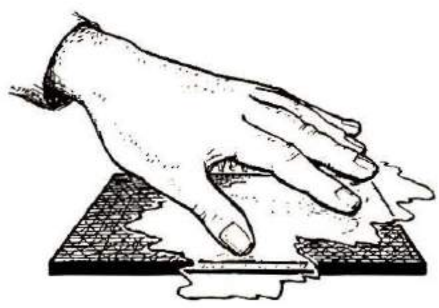
were electro-optical, he built an electro-optical detector coupled to a tuned rf amplifier, a variable resistance element, an analyzer, and, finally, a pickup coil or loop. The detector is merely a piece of plastic with a flat — or spiral — wound coil attached to it. The coupling transformers are untuned rf types. The rf amplifier is a simple, 3-stage, broadcast-frequency type; and the analyzer, which at first appears complicated, is really quite simple. The pickup or sampling coil may be a single-layer cylindrical inductor or it may be a flat, spiral type.

The analyzer includes a pair of broadcast tuning capacitors, a prism (or lens), a pickup antenna, and a calibrated dial scale, plus a platform or box to mount these on. The antenna is movable in an arc along the dial scale, changing its position with respect to one face of the prism (or changing its distance with respect to the lens) over a predetermined range of positions and distances.

How it works

To operate the machine, a sample of unknown material is placed near the pickup coil; the operator turns on the amplifier and gently strokes or touches the plastic detector plate while tuning the capacitors in the analyzer and changing the angle between antenna and prism. At some point, or points, of adjustment a peculiar sensation may be felt on the detector plate.

To some persons the sensation is sticky or tacky; to others, it feels cool or warm; to still others, it feels slippery! However, the angle for maximum sensations from a particular sample *remains the same*, even for different operators. If the material contains a considerable amount of one element, the sensation is strong. Conversely, if only a small quantity of an element is present, the sensation is weak. Thus a *gain* control, or variable resistance, can be of use in calibrating the machine. Each material tested or analyzed will

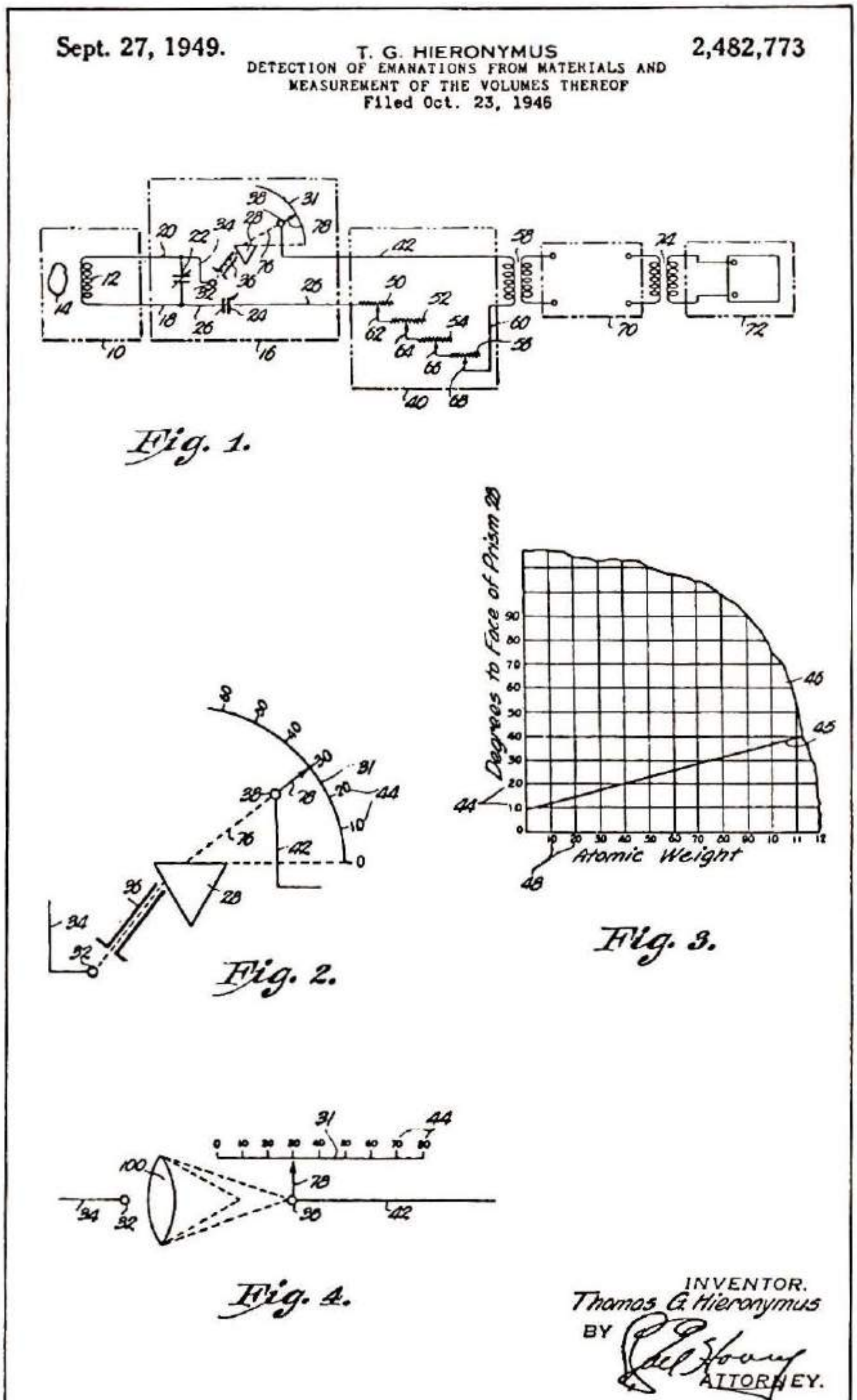


have its own particular angle, or angles, of antenna adjustment for the production of sensations at the detector. If these angles are plotted as a series of points on a graph having on one axis the atomic weights of the elements from the periodic table, and on the other axis the prism angle, a straight line can be drawn connecting the points on the graph and showing atomic weight as a function of prism angle. In this manner, after a graph has been constructed, one may analyze unknown material to determine its composition and obtain a relative idea of the quantity of each element present in the sample. This brief description is by no means complete or sufficiently detailed to offer more than an idea of the invention. The complete details of construction and operation must be obtained from the patent declaration.

Ideas for the experimenter

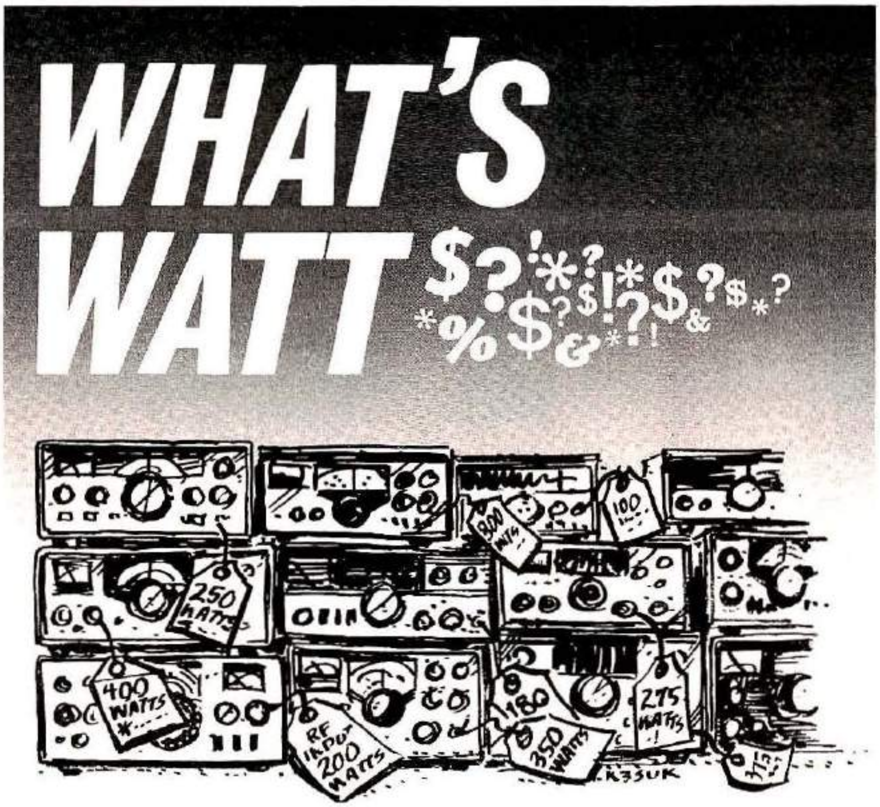
It is not a hoax, and every word is true to the best of my knowledge. Of course, this article only poses the questions and does not provide many answers. I have some questions of my own! Could two machines be built and used as transmitter and receiver by loosely coupling the sample coils of each? Would filters improve sensitivity? Is the device frequency sensitive? Can materials other than metals be easily analyzed? Will other forms of detector work (*i.e.* audio, rf, ultrasonic, infrared or ultraviolet)? Why can't everyone use it? What, if anything, is being detected or emanated? Can the circuit be transistorized? Some constructors suggest that only a circuit schematic is necessary; it need not be a physical reality!

C'mon you hams, inventors, and creative thinkers, give it a try. It's a good bet that if the riddle is to be resolved it won't, in all probability, be deciphered by an established scientist. The solution could well be provided by a ham — perhaps you!



Reproduction of part of T. G. Hieronymus's patent declaration for his apparatus for "Detection of Emanations from Materials and Measurement of the Volumes Thereof," issued in 1949. Some questions about this scheme remain unanswered. Perhaps readers who have inquiring minds can provide the answers. A provocative challenge for experimenters!

Scientists, in the narrowest sense of the word, won't touch pseudoscience! Those of broader views will at least look. Does anyone know any more about the Hieronymus machine than was known in 1946? If someone does, let him come forth and explain. Here's a golden opportunity to make a fundamental discovery and have some fun at the same time. For experimental use, serious investigation, or just plain fun, try a Hieronymus machine! **HRH**



BY HARRY LEEMING, G3LLL

Suppose you're in the market for a new hf-band transceiver. You read the ads and see something like (A): "two rugged 6146B final amplifier tubes." Or (B): "250 watts." Or (C): "350 watts rating, typically 400-450 watts." Or (D): "rf input power on ssb 200 watts PEP." Or (E): "power consumption 350 watts."

Perhaps you wish to move up and add a linear amplifier. Do you want (A): "3-kW PEP," (B): "1-kW average, 2-kW PEP, rf output 1200-plus watts," (C): "2000 watts PEP," or (D): "1200 watts input"?

Maybe you're confused by all these numbers. What do they mean? Do they mean anything at all? Let's take a look at advertised ratings of high-frequency-band amateur equipment and try to sort out some of the claims.

Electrical power measurement

First we'll make clear what we mean by electrical power and how it's measured. Electrical power is measured in watts, which is the product of current multiplied by voltage. (The exception to this law is when current and voltage are out of phase in an inductive or capacitive circuit.) The calculations work out the same for dc or ac power frequencies (including radio frequencies) provided that, in the case of radio frequencies, the rms (root-mean-square) values of voltage and current are used.*

Power ratings in amateur radio applications

Power limitations for amateur licenses vary from country to country, but in most cases a maximum *dc input power* to the final stage of the transmitter is stipulated. If Amateur Radio were a new idea, and licenses were being drawn up for the first time, it's quite possible that the authorities would quote a maximum radio-frequency *output* power. But when the first amateur licenses were issued, low-cost rf power meters weren't available, and very few stations or official government inspectors had any reliable means of measuring radio-frequency power output. With a CW, a-m or fm transmitter, dc power input was easy to measure, and so a simple and unsophisticated method of rating power kept everyone happy.

All went along nice and smoothly until the advent of single-sideband suppressed-carrier transmissions, when some questions arose. With a CW or a-m transmitter a steady reading could be measured. But what sense could one make of a constantly moving power-amplifier current meter attempting to do the impossible task of following voice frequencies?

In the United Kingdom, the Radio Society of Great Britain and the authorities discussed the matter and came up with the following reasoning: British hams had always been licensed to 150 watts dc input power. This meant that with a typical class-C efficiency of around 60-70 per cent, the output carrier would be in the region of 100 watts rms. During high-level plate and screen modulation, the peaks of the modulation envelope would have a peak power of 400 watts. Hence it was decided that ssb transmitters should be allowed to give the same peak output power as a fully modulated typical 150-watt a-m transmitter.

In the UK, therefore, our

*The rms value is that value of alternating current that will cause the same heating effect as the same amount of steady direct current (see the *Radio Amateur's Handbook*).

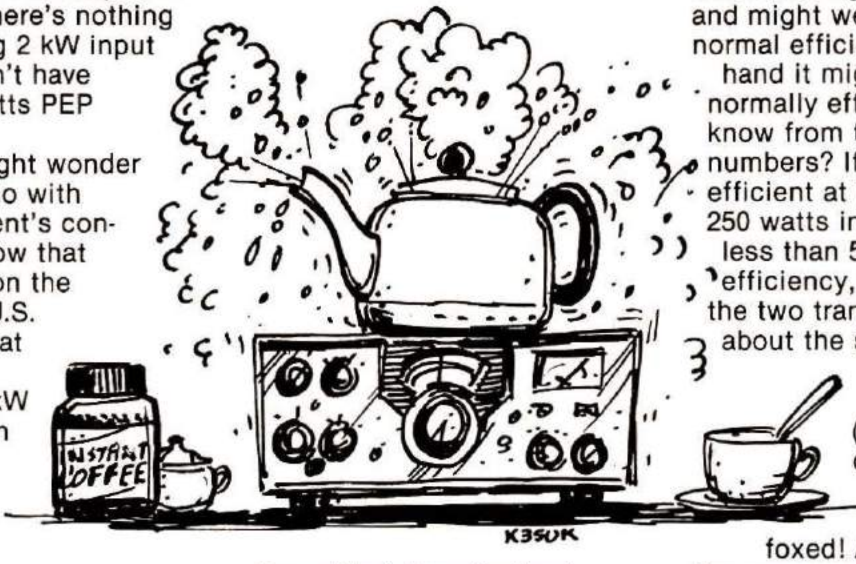
†PEP is a standard term for designating single-sideband power and represents the instantaneous peak power of the peaks of the voice cycle.

license allows 400 watts peak envelope output power† fed from the transmitter or linear amplifier to the antenna. With typical class AB1 efficiencies, this gives us something in the region of 700 watts PEP maximum input power, but we're not limited to this. If we wish to run an inefficient power amplifier stage, there's nothing to stop us running 2 kW input so long as we don't have more than 400 watts PEP *output*.

U.S. readers might wonder what this has to do with them, but a moment's consideration will show that this throws light on the question of why U.S. stations licensed at 1-kW dc input are allowed to use 2-kW linear amplifiers in the ssb mode. When operating on cw or a-m, U.S. hams licensed at 1-kW dc input can run 6.66 times the power of the British ham licensed at 150 watts dc input. To maintain this power advantage on ssb, the FCC would have to allow U.S. stations to run 2660 watts PEP output power when operating on ssb, which would require the use of a linear amplifier rated at somewhere around 4-kW PEP input power.

Advertised ratings

Let's be fair. You wish to sell your house: the front looks over the Atlantic Ocean, but the view from the rear is of the local sewage disposal plant. Which feature would you mention in your ad? We shouldn't be too surprised, therefore, when manufacturers having the choice of two numbers quote that which sounds the most impressive. As in the high-fidelity field, one could be forgiven for thinking that the specifications of some ham equipment were drawn up by the advertising department, rather than the technical department. It's therefore essential that, when comparing specifications of different makers, one compare "like with like." With this in mind, let's review the quoted advertisements and see if we can make some sense of them.



Demand the full specifications!

(A): "Two rugged 6146B amplifier tubes." and (B): "250 watts." Several manufacturers using the 6146B tubes seem shy of actually admitting in their ad copy that the dc input power to these tubes is usually around 180 watts PEP. Perhaps they reason that this may sound a little QRP; for similar reasons most of them also omit to mention that the rf power output is not likely to be much over 100 watts. In practice, I would defy anyone to tell over the air the difference between (A), a transmitter running at 180 watts PEP input, and (B), which in the complete absence of any qualification we can only assume represents 250 watts input power.

(C): "350 watts rating, typically 400-450 watts" would appear to be rather more powerful. Once again, as the maker has not qualified the numbers, we can only assume that it refers to input power. Remember, though, input power does not work DX, and so, in the absence of quoted radio-frequency output power, we can only assume normal efficiency of around 60 per cent. This rig is transistorized and might well have less than normal efficiency; on the other hand it might be more than normally efficient. Who's to know from the advertised numbers? If (B) was super efficient at 75 per cent with 250 watts input, and (C) had less than 50 per cent efficiency, the rf output of the two transmitters would be about the same — think about that.

(D): "Rf input power on ssb 200 watts PEP." Now this one has me foxed! All the transmitters I've come across take in dc input power and give out rf output power. Presumably they really mean the dc PEP input power, in which case we can expect about 100-120 watts rf output. I could be wrong, though, and in this case they have just talked themselves out of a customer!

(E): "Power consumption 350 watts." The picture includes knobs and a dial, and I've heard one of them on the air, so it must be a transmitter, otherwise I'd have thought it was a dummy load. Perhaps they mean you have to plug it into an ac power-outlet socket giving at least 350 watts; that's the input power to the whole transmitter. After you've knocked off the consumption of the blower, tube heaters, pilot lamps, and the dc power to the rest of the set, what remains will be the input power. Whether that's 300 or 30 watts, however, is anyone's guess.

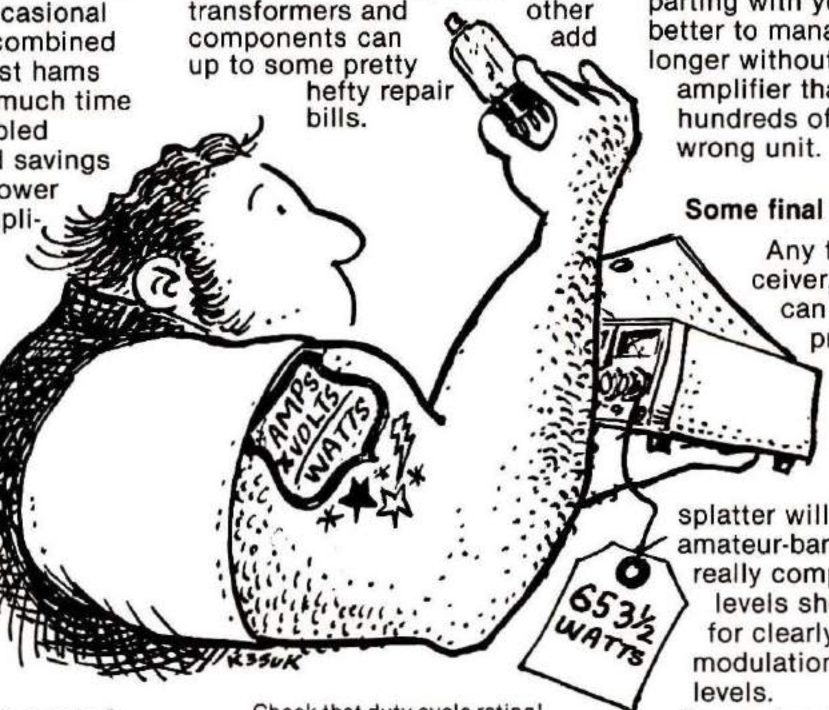
CW, a-m and slow-scan power ratings

Ordinary speech without speech processing has a pretty low duty cycle, so that the power amplifier stage of an ssb transmitter is required to run at full power only on occasional peaks. This feature, combined with the fact that most hams listen for at least as much time as they talk, has enabled corners to be cut and savings to be gained in the power supply and power-amplifier components of typical ham rigs.

These savings are quite legitimate because they enable us to purchase more transmitter for less money. But such savings must be accounted for when the equipment is operated in any mode other than low-duty-cycle ssb, otherwise reliability can suffer. Unprocessed ssb has a duty cycle of around 20 per cent. CW operation brings this up to about 50 per cent. Manufacturers usually quote CW ratings for their equipment, which are as much as 20 per cent less than the PEP ssb ratings.

A-m or slow-scan television operation demands a continuous carrier with 100 per cent duty cycle, and this mode of operation is not really compatible with the average ssb power amplifier stage or linear amplifier. In these modes it's wise to limit power to around one-fourth of the PEP ssb rating. Throttling back a class AB1 stage in this way results in inefficiency, and typical transceivers running around 300 watts PEP input on ssb can be expected to give only around 30 watts of rf output when used in the a-m or slow-scan modes.

Not all rigs must be derated by these amounts — it depends on how near the makers have pushed their components to the limit. If in doubt it's better to under-run equipment, because burned-out tubes and cooked power transformers and other components can add up to some pretty hefty repair bills.



Check that duty cycle rating!

If you're thinking of future slow-scan television activity it's essential to ensure that the rf output power your rig will produce continuously and safely is sufficient to drive any linear amplifier you contemplate purchasing. It's no use buying a linear that needs 100 watts of drive if your 300-watt rig will give only 30 watts continuous output.

Having now clarified one or two points, I'd like to take another look at the linear-amplifier specifications. Here, we can only presume that most of the numbers given refer to PEP input power, and specification (B) is the only one that even starts to tell the full story. (A), (C), and (D) leave to guesswork how much output power is available; neither do they stipulate whether high power, continuous, slow-scan, or a-m operation is permissible. If you're considering buying such a unit, demand the full specifications; if this leaves you in doubt about any point, ask questions and, preferably, get answers in writing before parting with your money! It's better to manage a few weeks longer without your linear amplifier than to spend hundreds of dollars on the wrong unit.

Some final thoughts

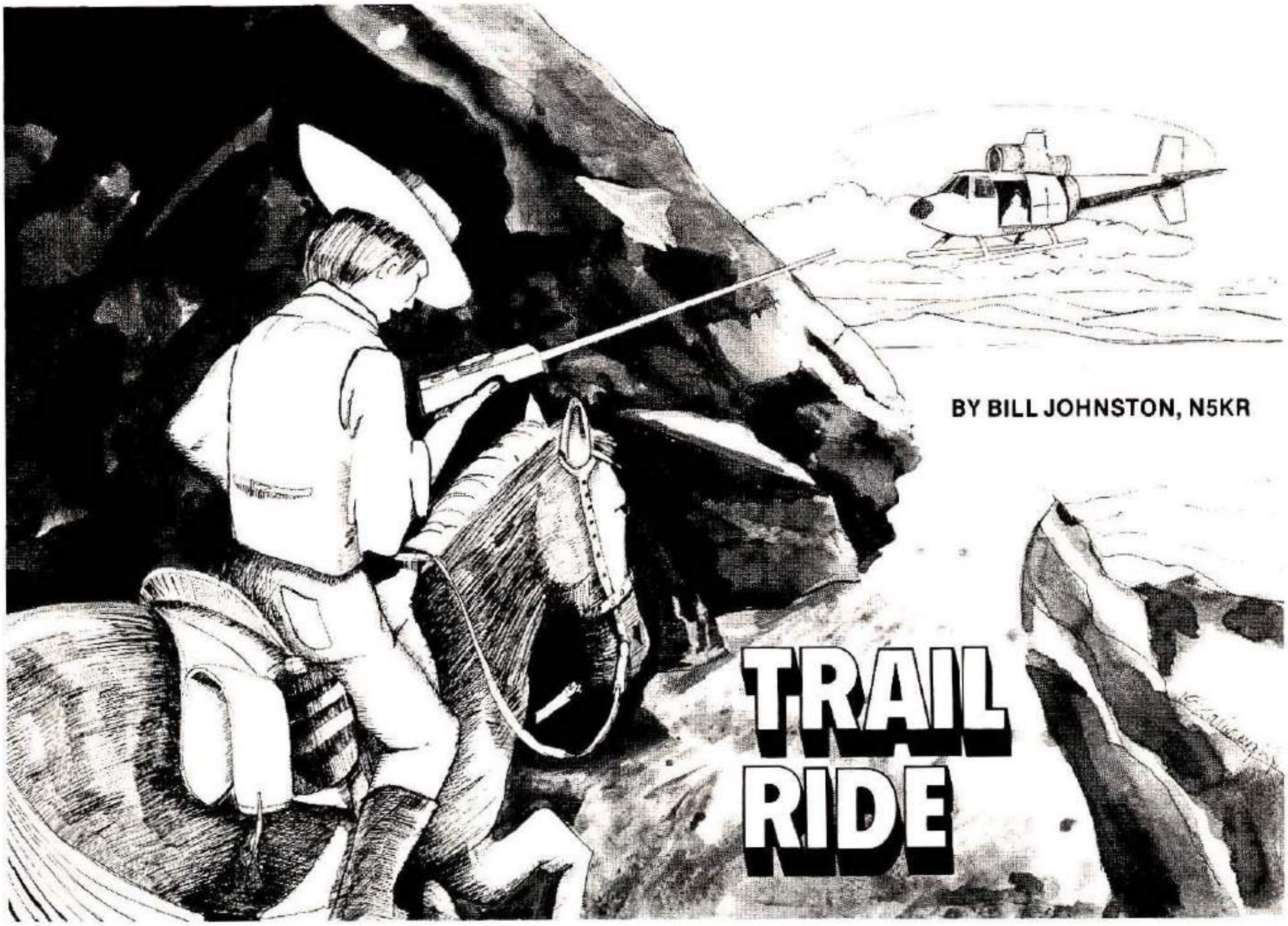
Any transmitter, transceiver, or linear amplifier can be squeezed to produce a little extra power if overdriven; but the intermodulation products will increase, and splatter will annoy other amateur-band users. To be really complete, power levels should be quoted for clearly defined intermodulation distortion (IMD) levels.

Remember that stations using high power have a special responsibility to see that their signals are splatter-free and of high quality. Don't get too hooked on power, as you must at least *double* your output power before anyone will notice the slightest difference in your signal strength. You may gain talk power by driving your power amplifier into clipping, but this causes adjacent-channel interference.

If you do want extra ssb talk power, install rf clipping in the low-level stages of your transceiver. If this is too difficult, try a good-quality audio-rf-audio clipper, such as the Datong unit, in the microphone lead. These units will ensure that your speech is loud and will enable you to get full talk power without running your power amplifier stages to their absolute maximum level.

HRH

More details? Ad Check page 86.



TRAIL RIDE

BY BILL JOHNSTON, N5KR

Sunday dawned cool and overcast with calm winds. For the fourteen horseback riders it would be a perfect day to traverse the expansive gypsum dunes of White Sands National Monument. Seven hundred square kilometers — a wonder to behold — but where even brief exposure to the bleached surface without protective clothing can bake a person senseless. The winds that scour the Tularosa Basin mold the sands into an infinity of shapes, and just as quickly erase the tracks of the unwary.

Our destination was Lost River, a usually dry bed of sand and salt cedar, some 12 kilometers to the northeast. Tony Genta, the trail leader, was the only one who had made this trip before, but we were all experienced riders — except Debbie, who had never been on a horse in her life.

Some of the riders brought their own horses, while others were supplied by Tony. The group included a couple of wranglers, Quincy and Charlie (ten-year-old Charlie chewed tobacco with the best of them), as well as folks from more mundane backgrounds. Dave, the oldest of the group, was a retired Army man who had served with the horse-drawn artillery in the early 1930s and was one of the more experienced horsemen. My wife, Jackie, had been riding since she was three years old.

By nine o'clock our gear had been checked and rechecked, and Tony gave the signal to move out. The sky had cleared and the steadily rising temperature went almost unnoticed as we took in the beauty and solitude of this remarkable piece of New Mexico desert, disturbed only by the rhythmic clomp of the horses' hooves. The first portent of things to come arrived more than an hour later when the horse that Dave's wife was riding began to show that it had a mind of its own — by kicking another horse in the leg. Shortly thereafter it decided to roll in the sand, happy as a pig in a mud wallow.

Dave and his wife moved to the end of the line to solve the kicking problem, and we thought the remainder of the ride to Lost River would be uneventful. While the other riders absorbed the beauty of the desert and were amused by the antics of Blue, our wiry trail dog, Dave's wife was, without anyone's realizing it, becoming seriously ill. She continued, uncomplaining, to the destination, where broad stands of salt cedar mark the

Lost River. Here the party fanned out, each of us finding his own place to tie up his horse, eat lunch, and enjoy the scenery. Though we all were within sight of each other, the wide separation prevented anyone from realizing that something was amiss. Dave's wife was resting, but the sun, the heat, the motion, and the strain of an uncooperative horse had already taken their toll; instead of getting better, she was getting worse.

The trail riders cross the dunes amid sparse vegetation, on the way to Lost River.

The emergency

Two hours later the signal was passed to mount up, and it was only at this time that a rider brought word that Dave's wife was not in condition to ride, nor for that matter was she able to walk, nor even stand for more than a few seconds at a time.

The options were quickly discussed. It was now the middle of the afternoon — the hottest part of the day. At best it was a hard two-hour ride to the ranger station. If outside assistance were to be of value, it would have to come soon. Even a four-wheel-drive vehicle could not negotiate this terrain in darkness.

I explained to Tony that I had with me my ham-radio transceiver, and that I would attempt to establish communications before we sent out riders. Pulling the rig from my saddlebags, I set the frequency for the WR5AHD 146.34/.94 repeater and punched the button. "Is there anyone on frequency who can make an emergency phone call to the ranger station at White Sands National Monument? This is N5KR."

N5KR/horseback mobile makes a call through the WR5AHD repeater.

Silence. Eleven horses shifted quietly as we all watched the little black box. After what seemed like an eternity, but in reality was little more than three or four seconds, the loud speaker blared back the answer. "This is WA6DUI portable five. What is the message?"

Pete, located at Holloman AFB, began relaying the information over the telephone, and the rangers began assessing the situation. A problem surfaced almost immediately. The rangers needed to know our position accurately to avoid wasting a lot of time searching. Although we knew where we were, we didn't have a map with us to give them the coordinates.

Fergy, W5KDB, advised that he was on the highway, very close to the ranger headquarters, and he would make his mobile rig available for direct communications with our group. Fergy arrived at the headquarters within minutes, and Dave was able to send background medical information and other data about his wife directly to the park rangers.

Meanwhile, the rangers were

The park ranger and the crew of the Medivac helicopter check the patient before evacuation.

working on two possible approaches to a rescue. One method would be overland; water supplies were redistributed and two riders were sent to a prominent landmark to lead a party back if that method were chosen. Jackie and I stayed with Dave and his wife, while the rest of the riders started back as a group so they would be out of the dunes by dark.

The other possibility would be an evacuation by air. I scouted around and reported that there appeared to be some areas where a helicopter might be able to land, but that I couldn't be sure, not knowing thd landing requirements of the aircraft. Consequently, some extra time was needed to prepare a hoist; the pilot then would have a choice whether to attempt a landing. While all this was being done, Pete had traveled from Holloman AFB to the ranger headquarters, bringing with him a hand-held unit. This would enable the rangers to stay in touch with us whether they came by land or air.

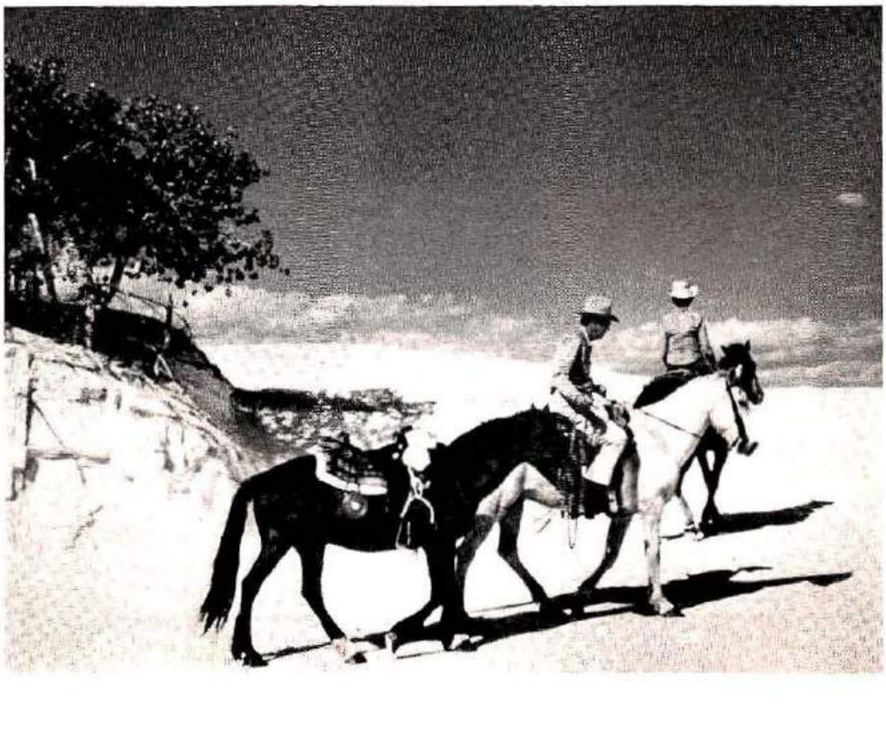
To firmly establish our position, I took sightings from a number of prominent landmarks using a toy compass that was mounted on a plastic canteen. The bearings were radioed via the repeater and the rangers plotted them on a map while John, W5DVA, plotted them on an aeronautical chart. They were in agreement, establishing the position within a mile or so, and confirming that we were in fact where we thought we were.

The rescue

The rangers had decided to make the evacuation by air, and a Medivac helicopter from the U.S. Army Air Operations contingent at Holloman AFB departed for White Sands National Monument headquarters to pick up the ranger who would be their guide. W5DVA monitored the progress of the helicopter over his aircraft radio.

All of the preliminary preparations had been meticulously carried out by those in charge, and the payoff came now. Within minutes of picking up the ranger, the helicopter came into our view. The pilot circled once, then settled down in a tiny clearing between the surrounding dunes. Dave's wife was placed

Dave and Jackie on the way home.



on a stretcher and the medics quickly took blood pressure and other readings before loading her on the chopper. The doors slid shut and the helicopter rose noisily out of the dunes. A short time later the patient was safely in the hospital.

Dave had elected to ride back with us to pick up his car before going to the hospital, so the three of us mounted up and headed back across the dunes, leading the extra horse. I reported over the repeater that everything was under control, enabling Peter, Fergy, and John to end their operations. For the next few hours, Dave, Jackie, and I enjoyed a pleasant ride through the sands, admiring the sculptured beauty of the ever-changing terrain. By the time we got back to the road, most of the other riders had left for home. Novice rider Debbie, they said, had been mighty happy to get out of the saddle.

Thanks to the experience and professionalism of the White Sands Monument park rangers and the Medivac aircrew for the U.S. Army Air Operations outfit at Holloman Air Force Base, Dave's wife had been quickly evacuated from a difficult location, and within a few days she was fully recovered. Thanks to Amateur Radio and WA6DUI, W5KDB, W5DVA, and WR5AHD, the rescue operation was under way several hours sooner than would have otherwise been possible. The preparations went much faster and smoother because of the good communications.

We were just about to call it a day when one old cowpoke pointed to the little unit hanging from my saddlehorn and said, "That thing's sure not a CB radio, is it?"

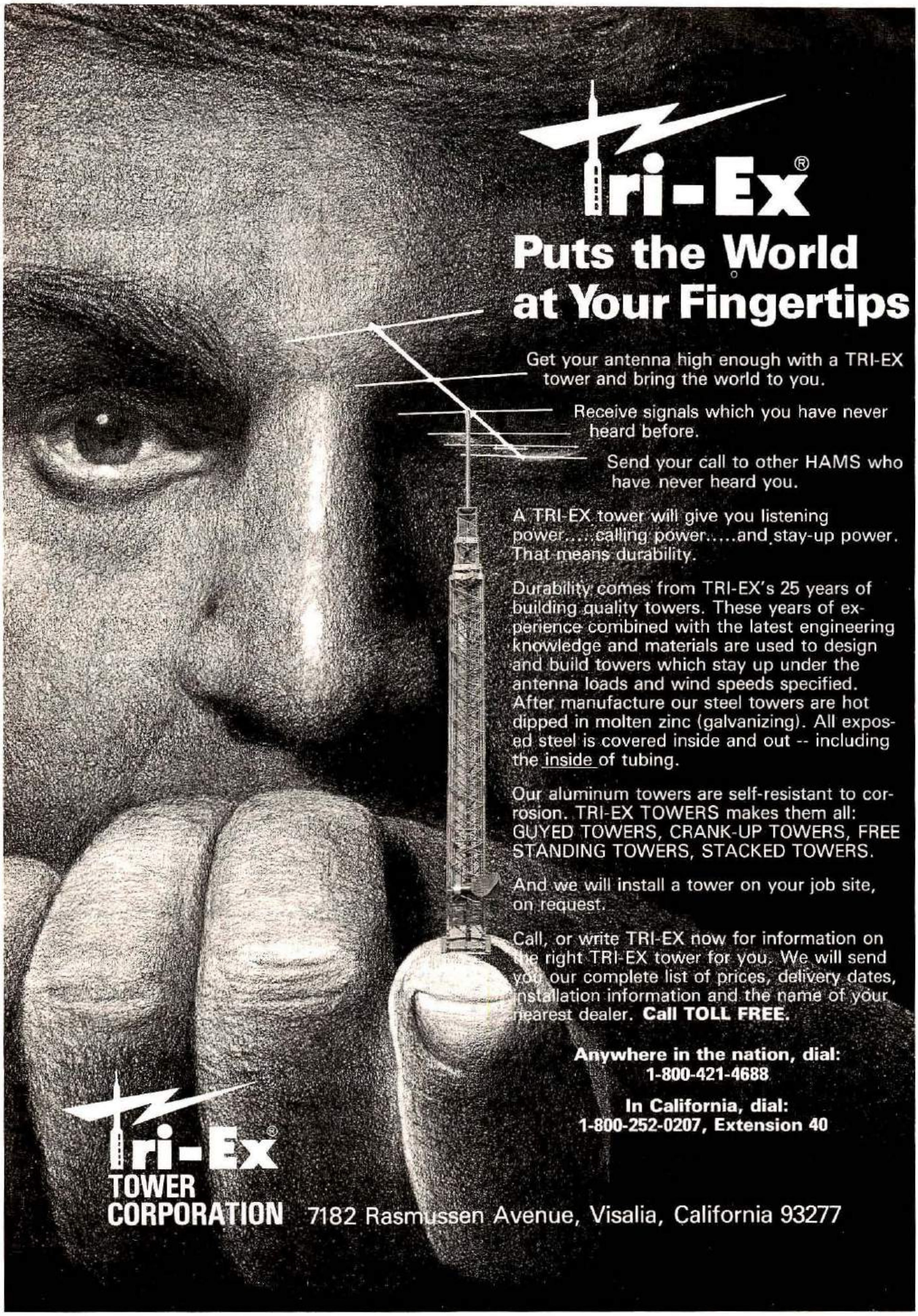
"No," I replied, "it's a ham radio."

"Well," he remarked, "it was sure handy to have along. We had a good ride."

Yes sir, we had a good ride.

HRH

More details? Ad Check page 86.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POST BOX

Dear Horizons:

In your April, 1978, issue you had an article entitled "One-Transistor Rig For 40 Meters." I built this radio and am having difficulties with the tank circuits. The inductor core called for is a torodial T-94-2 ferrite core. When I ordered the core from a mail-order place I noticed they had two lists of torodial cores, powdered iron and ferrite. All the ferrite ones had numbers with an "FT" prefix. I just assumed the number was correct in the article, and I ordered the T-94-2 core. I now find that the circuit resonates on my grid-dip meter at about 44 MHz. I wonder if there was some error in the core type called for in the article. The company I got my core from didn't have an FT-94-2, so I assumed there probably wasn't one . . . Thank you very much for your help. I really like *HRH*.

Mike Lawrence, WB7UMA
Tucson, Arizona

Mike, several readers have reported excellent results with the transmitter, and they used the T-94-2 core just as in the instructions. I wonder if perhaps your grid-dipper is reading something other than the tank circuit resonance — toroids are notoriously hard to couple to for such a reading. Most builders make a one-turn link; just one turn of wire through the core, and brought out to another turn near the dipper coil. In this way the dipper is away from stray resonances which could upset the reading. It just doesn't seem logical that the right number of turns, with the correct capacitance across them, will be resonant at 44 MHz. Recheck everything, and try the one-turn loop trick — and remember that the transistor may be loading the circuit so much that the dipper's indication of resonance may be a very tiny flicker. You might be better off to look for rf energy with the meter used as a wavemeter and the oscillator turned on. Thanks for writing, and good luck. **Editor.**

Dear Horizons:

Just a few lines from a Novice who has just received his license. There are very very few Amateurs who will listen to a slow CQ call. Perhaps they have forgotten they were here too.

If they would come back to us Novices at a slow speed so that we could advance. I'm sure we would both learn a whole lot about this world. I'm 65, just retired, and trying to keep my mind active.

Frederick W. Steinbauer, Sr.
KA4BAF
Riviera Beach, Florida

Dear Horizons:

I've been a subscriber to Ham Radio Horizons since it was first published . . . I must say I enjoy every issue, as each article is written in an easy-going language. Keep up the good work. I am an old-timer, in ham radio for forty years.

William Tietz, W2LYC
Schenectady, New York

Dear Horizons:

I have only received nine of my twelve trial issues of your fine magazine, but enjoy it so much that I am enclosing my renewal for three years. To a young man like me (14 years old), your magazine is a great help in putting together and operating my station of 1½ years. I use your ads, enjoy your fiction and technical articles, and use the DX guide most of all. Thank you for a super magazine, and keep up the good work!

Gregg Kamila, WB6YDS
Cerritos, California

Dear Horizons:

The Newsline item in the November, 1978 issue is in error; the Double Eagle II was not the first free-aircraft to cross the Atlantic — it was the first *manned* free-aircraft to do so. The first free-aircraft to make the crossing was a high-altitude research balloon flown from Trapani, Sicily, in July, 1975, and brought down near Lexington, Kentucky after about 84 hours. Another balloon was flown from Sicily to Massachusetts in July, 1976. These balloons flew at an altitude of approximately 125,000 feet and had about 20-million cubic feet of capacity; they were launched and flown by National Scientific Balloon Facility personnel from Palestine, Texas for scientists from Italy, England, and Germany.

Spencer Petri, WA5JCI
Palestine, Texas

Dear Horizons:

The other day, while making one of my periodic parts runs to the local parts store, I stumbled upon the last copy of September *HRH*. After glancing through it (and, of course, buying it!) I just had to drop you a quick note to tell you what a great magazine you have here!

I've been an avid SWL ever since I could reach the knobs, and "almost a ham" for just about as long (I'm 24 now). Somehow, I just never got my code speed up to par. After reading *Horizons*, my interest has been revived — and *this* time I'm going to get it.

I particularly enjoyed the article, "So You Want To Be A Lid." I also enjoyed the articles on traffic handling and the OSCAR 8 Satellite. As a matter of fact, I enjoyed everything! I hated to see the back cover come! Keep up the good work, and I'll catch you on the air when I get my ticket.

Dan Case
Corry, Pennsylvania

Dear Horizons:

I obtained a copy of the first issue of *Ham Radio Horizons* when it first came out, and entered my subscription. That first issue rekindled a desire to be a ham that I had about ten years ago . . . . I'm waiting for my Novice license in the mail and will start taking a class soon for my General.

I want to express my thanks to the people who put together a magazine like *Ham Radio Horizons* for people like me.

John L. Harley, Jr.
La Crescenta, California

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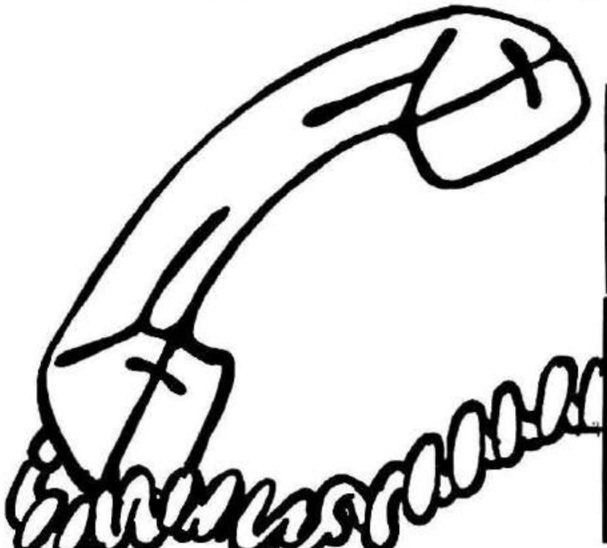

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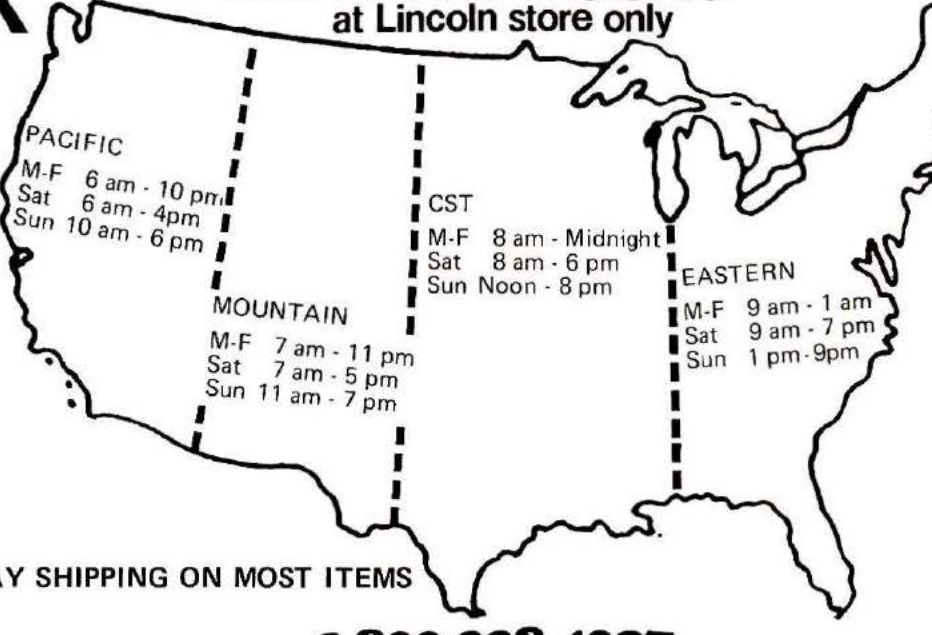

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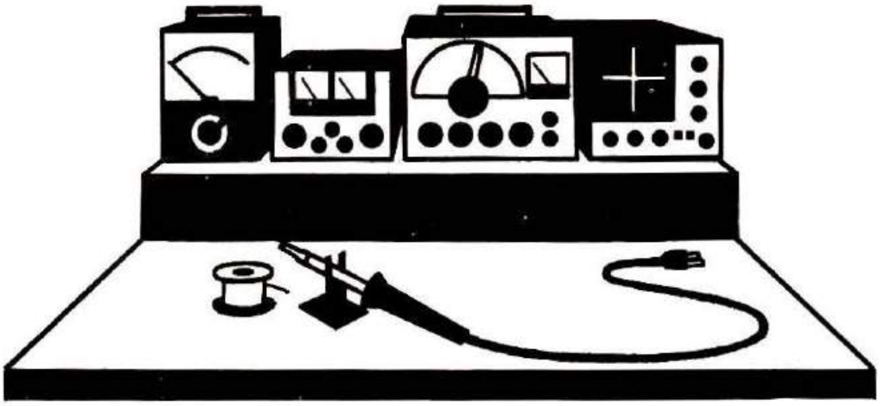
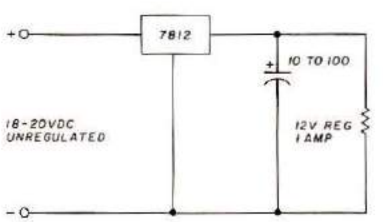


BENCHMARKS

Regulated Power Supply Trick

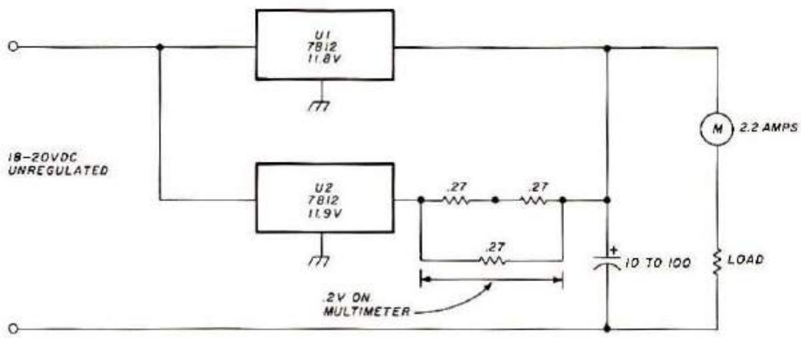
With the availability of the inexpensive three-terminal voltage-regulator chip rated at 1.5 amperes maximum, construction of low-voltage, low-current regulated power supplies became mighty simple. See **Fig. 1**.



But, if you want 2 or 2.5 amperes you are back to the big transistor, zener diode, voltage divider, and a bunch of components. Of course you can buy a big chip for about $15. These days of low-powered transceivers for the high-frequency bands and 10-watt two-meter rigs calls for something a little larger than 1 ampere, but a lot less than 10 amperes. In my case I needed 2.2 amperes.

To solve this problem, the idea of paralleling voltage regulators occurred to me. In general this is frowned on because one regulator will grab all of the load and the other will take none. The regulators are never *exactly* identical. The time-honored system of equalizing currents is to put a series resistor on each device. I decided to give this a try with a couple of 85-cent 7812s. When placed in the circuit of **Fig. 1**, one of the two delivered 11.9 volts and the other delivered 11.8 volts.

A handful of fractional-ohm, 1-watt resistors was necessary; I had a bunch of 0.27 ohms. After about 15 minutes of trial and error with the circuit of **Fig. 2**, I was able to balance the currents at 2.2 amperes. I achieved a 0.2-volt drop across the resistance combination (0.18 ohms). This gives 1.1111 amperes through regulator U2, and 2.2 through the load, leaving approximately 1.1 amperes through U1. At less than full load the balance is not critical. In my case, with a load of 1.1 amperes, U2 delivers 0.8 and U1 delivers only 0.3 amperes. This is safe because neither regulator exceeds its rating.



As might be expected, the voltage regulation is not as good as in **Fig. 1**, but it is fine for many purposes. Voltage at 2.2 amperes was 11.6 volts and at no load was 11.9 volts, the voltage of the better regulator.

This may not be quite as good as the sophisticated transistor circuit, but it's the cheap and simple method that appeals to me, and I hope you'll like it too. *Caution* — you cannot put two ammeters in directly after the regulators because they do have *some* resistance. When you take them out to build the actual device you no longer have a balanced circuit. You must measure the voltage across the series resistor (on the better regulator) and calculate **I = E/R**. Subtract this from the load current to get the current from the other regulator.

Bob Baird, W7CSD

Earth Currents

Is the conversation in your evening QSO dragging? If so, here's something you can rig up in about five minutes that will open the door to all kinds of conversational possibilities. It is commonly known that the earth's magnetic field sets up currents that flow through the ground. What is not usually known is that these currents can be measured with the simplest of setups: a 50- or 100-μA meter, two pieces of brass welding rod and some wire.

Drive the rods into the ground 30 to 60 feet apart on an east-west line. Connect a wire to each. Hook the eastern rod to the positive meter terminal, the western rod to the negative. When the wires are first connected, the meter reading will be high because of galvanic action on the rods; after a few minutes the currents will drop to the normal value. If the meter reads down scale, install a reversing switch rather than changing the meter connections, because earth current may reverse itself occasionally; or use a 50-0-50 center-zero meter.

Different parts of the country have widely varying readings. It has been noted at several installations near my home that erratic and fluctuating meter readings seem to precede an aurora opening on 6 or 2 meters. It is interesting to note that weather also has some effect on the reading; if the ground is wet the readings will usually be slightly higher. Magnetic storms have a noticeable effect.

One important note: be sure to put a .01 μF bypass capacitor across the meter terminals to eliminate the effects of rf or stray 60 Hz current.

Don Samuelson, W7OUI

Transfer Letters

In the past I have had great difficulty with dry transfer letters failing to adhere to various surfaces, especially unfinished aluminum. There are two techniques which I have found helpful in overcoming this problem. The first is to abrade the surface to be lettered gently with very fine (0000 or finer) sandpaper and water, and then to dry it thoroughly before lettering. Alternatively, swab the area to be lettered with acetone (most nail-polish removers will do). Other solvents probably would work as well, but I have not experimented with them. Either of these methods should always be used before trying to letter a raw aluminum surface that has been handled, or etched in a sodium hydroxide bath (this process leaves a waxy film on the aluminum, and the letters will not adhere to it).

Michael Tortorella, WA2TGL

Soldering Tip

Dig around the lumber yard for a scrap of lumber with a big end-grain knot, the sappier the better. Make a depression in the knot to hold a drop or two of solder. Then, when you want to clean and tin your iron, just rub the tip on the knot. Cover the bottom of the knot to keep it from glopping up your bench.

James T. Lawyer

Certificate Protectors

A beginning collector of award certificates sometimes has a problem — what to do with them. Framing in the usual manner is expensive and wall space is sometimes limited.

A satisfactory substitute for mounting your certificates up to the 8½" by 11" variety can be purchased in any stationery store in the form of clear plastic page protectors. Certificates can be inserted in these protectors, and thumb-tacked to a wall or bulletin board or inserted in a two- or three-ring binder. If inserted in a binder, two certificates may be stored back to back with a sheet of album paper between them. The album paper comes with each page protector. The cost is reasonable — about 80 cents for a pack of six protectors.

George Rulffs, Jr., AA4GR

Tuning Aid For The Sightless

This audio tuning device is uncomplicated by connections other than those required to sample transmitter or exciter output at the coax transmission line. It uses no batteries and may be switched off after maximum rf output is determined. The circuit may also be used as a tone generator for monitoring CW keying; another possible use is as a monitor for determining the condition of your transmission line (*e.g.*, a short circuit between center conductor and shield).

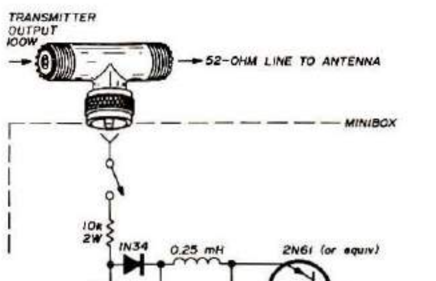


Fig. 3. Audio tuning aid for determining maximum rf output power.

The circuit is shown in **Fig. 3.** A high-resistance voltage divider samples rf from the coax. The rf is rectified by a diode. This rectified voltage, which varies during transmitter tuning, is fed to a form of relaxation oscillator. Output varies in tone pitch as a function of voltage on the line: low voltage causes a high-pitch tone and high voltage causes a low-pitch tone, which indicates maximum transmitter or exciter output. The tone indication is similar to a dip in transmitter plate current.

The input voltage divider uses about 1 watt for 100 watts into a 50-ohm line. For higher power, the divider may be switched to higher values. For 1 kW, the input resistor should be about 100k, 2 watt. The schematic shows a voltage divider suitable for 100 watts output.

The 1N34 diode feeds about 2 volts to the transistor emitter, which draws less than 2 mA at maximum transmitter output. Any audio-type transistor may be used. If an npn device is used, diode connections should be reversed. The transformer is from a 5-watt transistor amplifier. Base and collector connections to the transformer can be reversed for needed feedback voltage. The color code on the transformer I used is: green to collector, red to base. The other connections in the collector circuit are: green/white to brown; brown/white and blue to ground. The transformer windings measure 22 ohms dc (high impedance); the other two, in series aiding, are each 4 ohms dc. Any transformer with similar resistance measurements should work. Audio output can be heard several feet from high-impedance phones.

D. H. Atkins, W6VX

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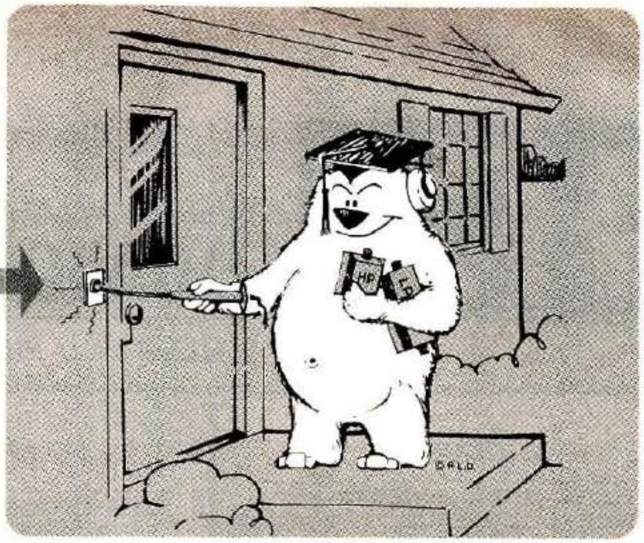

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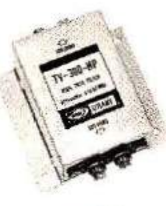

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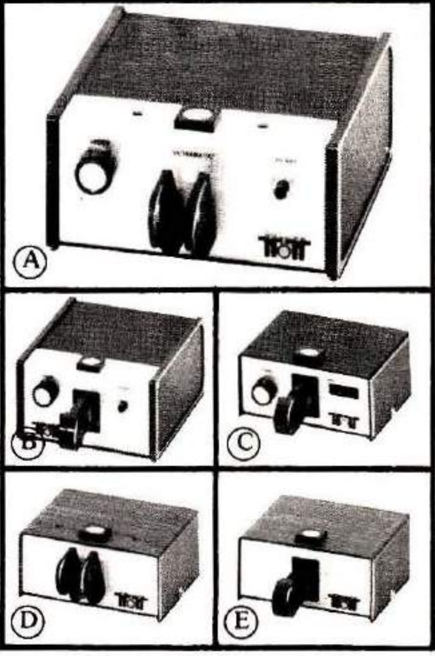

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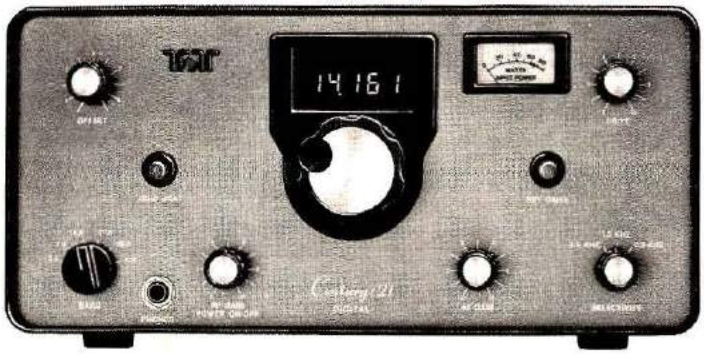

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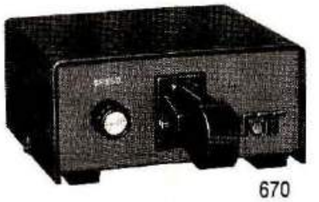

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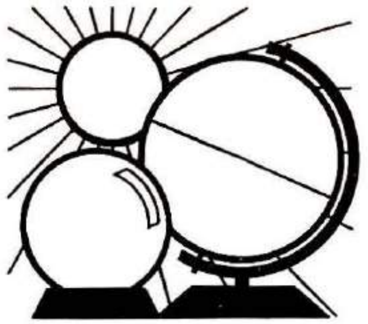

DX FORECASTER

It is expected that there will be an ionospheric disturbance of a major nature, with accompanying geomagnetic and possibly atmospheric effects between the 4th and 8th of the month. Another disturbance, of a minor nature, may take place between the 12th and 14th; perhaps just in time for Valentine's Day. Finally, another disturbance is likely between the 25th and 28th — most probably occurring around the time of moon perigee on the 26th. New moon is also on the 26th, while full moon occurs on the 12th.

Special information

This year there will be four eclipses; two lunar and two solar. The first of the solar eclipses will occur on February 26th, beginning at about 0947 EST, and lasting until after 2 P.M. Maximum darkness will occur along a path stretching across the northern United States and southern parts of Canada, while the rest of the country will observe varying degrees of darkness, depending upon which part of the shadow they are in. The eclipse will become full at noon local time. There will be ample opportunity for those of you who go home for lunch to observe the changes between daytime and nighttime DX conditions when solar radiation is cut off by the moon as it passes between the earth and the sun. For you who wish to observe the eclipse, *do not look at the sun directly*, even when it is nearly covered by the lunar disk. Do not look at the sun through telescopes and/or binoculars, or any other magnifying device. If you wish to observe the sun, do so only through heavily smoked glass, or several layers of exposed and developed photographic film sandwiched together. It is an exciting and interesting event, but you must be extremely careful during observation.

Band-by-band forecast

As solar cycle 21 swings toward its peak sunspot condition, *ten* and *fifteen* meters will become more and more active. This, coupled with the fact that the spring equinox is less than a month away, means that DXing will be fantastic! Keep your ears glued to your *six-meter* gear as well, because the MUF is likely to rise above 50 MHz!

Look at the charts for the best time to work DX on your favorite bands. You will see that *80 meters* is not listed, because there is so much activity on the higher bands. However, we have indicated *40-meter* openings on the charts so that you can try some DXing there at the appropriate times.

Ten and *fifteen* meters will be the best DX bands from the standpoint of low-power operation, while twenty meters will be open to some part of the world or other for better than 18 hours each day. In some spots, *twenty* will be open for the entire twenty-four hour period, particularly when enhanced solar conditions occur during the month.

It is still not too late to use *eighty* and *forty* meters for early morning and late evening DXing, because — even though solar radiation has increased the signal absorption levels on these bands — you are at a good time of year to take advantage of seasonally low absorption levels while enjoying good propagation.

HRH

FEBRUARY

WESTERN USA

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

MID USA

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

EASTERN USA

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

HAM CALENDAR February 1979

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.		See February 1, 3, 5, 7, 10, 19, 21 		West Coast Qualifying Run (W6OWP prime, W6ZRJ alternate) 10-35 WPM at 0500Z 1	2	New Hampshire QSO Party — By the Concord Brasspounders, Inc., W1OC — 2000Z 2/3 - 0500Z 2/4 — 1400 2/4 - 0200Z 2/5* Novice Roundup — 3-11 3
4	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 8PM PST 3540 kHz, A-1, 22 WPM 5	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 6	W1AW Qualifying Run 10-35 WPM at 0300Z* 7	8	Texas VHF/FM Society Winter Convention — Ponderosa Motor Inn — Temple, TX Hosted by the Temple ARC 9-11 9	Cherryland ARC Swap-N-Shop — Northwestern Michigan College Technical Center, Front Street — Traverse City, MI Interstate Repeater Society, Inc. Auction/Hamfest — National Guard Armory — Manchester, NH — Regardless of weather QCWA Membership QSO Contest — CW — 0001Z 2/10 - 2400Z 2/11 10
Frequency Measuring Contest 11	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 12	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 13		15	16	Martin County ARA "Fifty Cent" Hamfest — Tri-County Rehabilitation Center — Stuart, FL — K4ZK YL-OM Contest — Phone — 1800Z 2/17 - 1800Z 2/18 17
Lancaster Hamfest — The Guernsey Sales Pavilion — U.S. Route 30 & PA Route 896 — Lancaster, PA 18	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 8PM PST 3540 kHz, A-1, 22 WPM 19	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 20	W1AW Qualifying Run 10-35 WPM at 2100Z 21	22	23	French Contest — Phone — 0000Z 2/24 - 2400Z 2/25* 24
Livonia ARC Swap-N-Shop — Churchill High School — Livonia, MI — WA8GWL Vienna Wireless Society Winterfest — Vienna Community Center Vienna, VA 25	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 26	AMSAT Eastcoast Net 3850 kHz 8PM EST (0100Z Wednesday Morning) AMSAT Mid-Continent Net 3850 kHz — 8PM CST (0200Z Wednesday Morning) AMSAT Westcoast Net 3850 kHz 7PM PST (0300Z Wednesday Morning) 27	28			

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