MARCH 1978 / $1.25

HAM RADIO HORIZONS

FLYING HAMS AID SEARCH AND RESCUE TEAMS

Call Toll Free 1-800-633-3410 for Kenwood

KENWOOD TS-820S transceiver

The new Kenwood TS-820S features a factory digital frequency readout. • 160 thru 10 meter coverage • Integral IF shift • RF speech processor • VOX • Noise blanker • PLL • Built-in 25 KHz calibrator • CW side-tone & semi-break-in • IF OUT, RTTY, & XVTR • Phone patch IN and OUT terminals • Built-in AC power supply.

1048.00 is list price. Call Toll Free for quote.

KENWOOD TS-520S SSB transceiver

The new TS-520S features: • 160 thru 10 meter coverage • Optional DG-5 frequency display (on top of unit) • New speech processor with audio compression amplifier • Built-in AC power supply (DC-DC converter, optional) • RF attenuator, front panel activated. Provision for separate receive antenna • Provision on back for phone-patch.

649.00 is list price. Call Toll Free for quote.

SAVE NOW

KENWOOD VFO-520

The VFO-520 is designed for high stability. It has a linear dial scale, precision gears, and RIT circuit with indicator. Large knob and dial scale for smooth easy tuning. The external VFO connects to the TS-520 with a single cable, power from TS-520. Closeout priced

98.00 Call for yours today!

NEW ITEM

KENWOOD SP-820 speaker

Now you can have a sophisticated external speaker in your shack that's designed just for your TS-820S transceiver. Matching appearance plus, built-in selectable tone filters and two channel selectable head phone output switchable through the tone filters.

49.00 Call for yours today.

KENWOOD TR-7400A 2m FM transceiver

Features: • CTCS provisions, encode & decode • 25 watt RF output • Solid-state final stage • LED readout • PLL gives 800 discrete channels • Repeater offset circuit • PLL unlock protection circuit • Low power position adjustable, 5 to 15 watts • 2-pole, 10.7 MHz monolithic crystal filter • MOS FET.

399.95 list price. Call for quote.

Remember, you can call TOLL-FREE: **1-800-633-3410** in U.S.A. or call **1-800-292-8668** in Alabama for our low price quote. Store hours: 9:00 AM til 5:30 PM, Monday thru Friday

Your BANKAMERICARD welcome here

Long's Electronics

master charge

MAIL ORDERS: P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS: 2808 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233

More details? Ad Check page 86.

THIS MONTHS HORIZONS

Happy Flyers

Private pilots who are also amateur radio operators are concerned about aircraft mishaps, and also that the signal from a downed aircraft's emergency beacon can be heard and used to find the scene and survivors. The techniques developed have turned out to be a boon to amateurs for other purposes too. W6NIF tells about the organization that grew from the mixing of two great hobbies.

Missouri State Highway Patrol

Many motorists have used CB to spy on Smokey, but what happens when Smokey joins the crowd? The Missouri State Highway Patrol tried it and found that the cooperation was great. Increased safety on highways is a major result, with an added awareness of the helpful role of the Patrol being an important side effect.

Radio clubs

Radio Clubs were, in the 1920-1940 era, the very foundation of amateur radio. Members went there to keep abreast of the latest in technical developments, to teach newcomers what it was all about, and to enjoy the good fellowship of their on-the-air buddies. The war interrupted that way of life and, although many clubs got back together afterward, things were never the same. What is the secret of some clubs' success; where are the pitfalls that caused some to flounder and disappear? *Horizons* is glad to present what we hope will be an open-ended series to explore the health of amateur radio clubs today. Author Knadle leads off with a look at the Suffolk County (New York) Radio Club.

Phased Verticals

Many amateurs must pursue their hobby with a considerable handicap imposed by restricted space for antennas. Vertical antennas that work on more than one band can help you talk to the world, but it helps even more if you can change the direction of your radiation. WA2FLN tells you how he did it in a very small yard with a couple of inexpensive vertical antennas and some lengths of coaxial cable.

Design A Control Circuit

Part of the fun of amateur radio is designing and building circuits to add features to your station or make it more versatile and more convenient to operate. Keyers, timers, automatic identifiers, and remote control devices are examples. Many of these circuits, developed by the experts for their repeaters and remote-control base stations, are quite complex, using elaborate logic circuits or minicomputers. But you don't have to be an expert to develop a useful system for your shack.

Language

There are many ways to learn the Morse code, which is fortunate: a method that works for one person may be completely missed by another. Here is a system that treats it as a new language, composed of two basic sounds that are easy to remember. Go ahead, read it — you'll be surprised how many letters and words you will know by the time you finish the last sentence.

Questions? And Answers!

Some important energy-storage devices are discussed in this part of the series. If you ever pick up a radio magazine or textbook that was written before the modern era, you'll see things referred to as "condensers" and "chokes." They're simply using the then common terms for what we now call capacitors and inductors. Whatever the devices are called, there would be no radio or electronics as we know it without them.

The Infinite Radio Spectrum

The electromagnetic spectrum extends from the infinitesimal to the infinite, but the portion we call the radio spectrum occupies frequencies between 3 kHz and 3000 MHz. K3RXK paints a fascinating picture of what stations may be found there. Even better, he tells you how, where, and when, to listen.

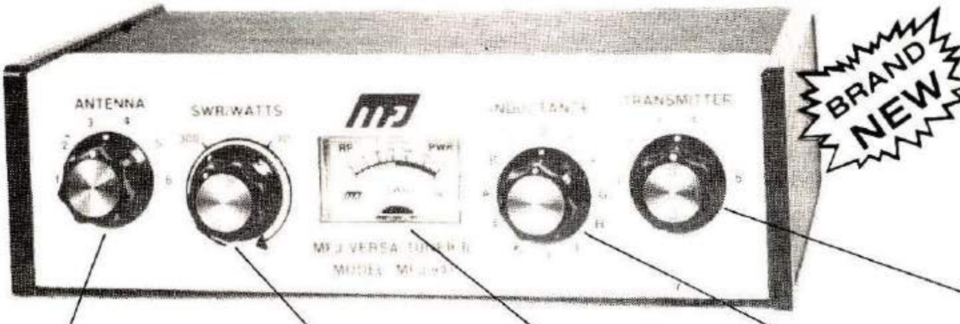
The Cover

Hidden transmitter hunts are interesting activities for many amateurs, but for people involved in searching for survivors of a plane crash it is serious business. Some hams who are also pilots have improved the technique of finding the Emergency Locator Transmitter (ELT), and Alf Wilson got the story for you. Amateur radio benefits from the improvement, as well. Original painting by Wayne Pierce, K3SUK.

HAM RADIO HORIZONS March, 1978, Volume 2, No. 3. Published monthly by Communications Technology, Inc., Greenville, New Hampshire 03048. One-year subscription rate, $10.00; three-year subscription rate, $24.00. Second-class postage paid at Greenville, New Hampshire 03048 and additional offices.

This NEW MFJ Versa Tuner II . . .

has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built in balún. Up to 300 watts RF output. Matches everything from 160 thru 10 Meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines.



BRAND NEW

$79.95

Antenna 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.

Transmitter matching capacitor. 208 pf. 1000 volt spacing.

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

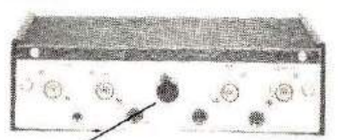
A SWR and dual range wattmeter (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

An antenna switch lets you select 2 coax fed antennas, random wire or balance line, and tuner bypass.

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

A 1:4 balun for balance 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, balance line, or random wire.



ANTENNA SWITCH lets you select 2 coax fed antennas, random wire or balance line, and tuner bypass.

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

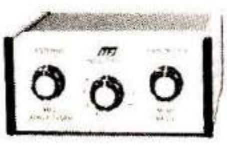
You can even operate all bands with just one existing antenna. No need to put up separate antennas for each band.

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 5x2x6 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 balance line inputs (2), random wire input (1), and ground (1).



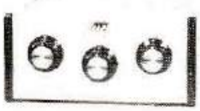
$59.95

BRAND NEW

MFJ-901 VERSA TUNER

New efficient air wound coil for more watts out.

Only MFJ uses an efficient air wound inductor (12 positions) in this class of tuners to give you more watts out and less losses than a tapped toroid. Matches everything from 160 thru 10 Meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines. Up to 200 watts RF output. 1:4 balun for balance lines. Tune out the SWR of your mobile whip **from inside your car.** Works with all rigs. Ultra compact 5x2x6 inches. SO 239 connectors. 5 way binding posts. Ten Tec enclosure.

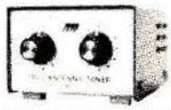


$49.95

BRAND NEW

MFJ-900 ECONO TUNER

Same as MFJ-901 Versa Tuner, but does not have built-in balun for balance lines. Tunes coax lines and random lines.



$39.95

MFJ-16010 RANDOM WIRE TUNER

Operate 160 thru 10 Meters. 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.

$49.95

BRAND NEW

MFJ-202 RF NOISE BRIDGE

This MFJ RF Noise Bridge lets you adjust your antenna quickly for maximum performance. Measure resonant frequency, radiation resistance and reactance. Exclusive range extender and expanded capacitance range (± 150 pf) gives you much extended measuring range.

Tells resonant frequency and whether to shorten or lengthen your antenna for minimum SWR. Adjust your single or multi band dipole, inverted vee, beam, vertical, mobile whip or random system for maximum performance. 1 to 100 MHz. SO 239 connectors. 2x3x4 inches. 9 volt battery.

For Orders **Call toll-free 800-647-8660**

For technical information, order and repair status, and in Mississippi, please call 601-323-5869.

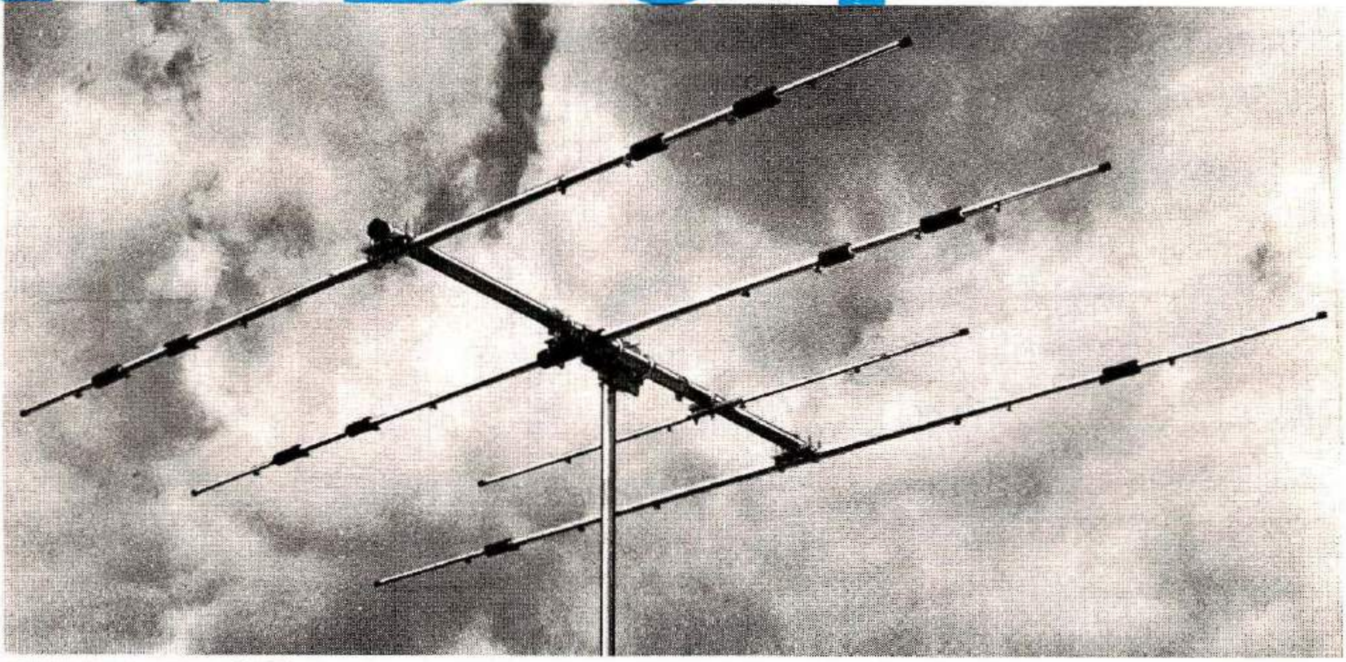
Order any product from MFJ and try it. If not delighted, return within 30 days for a prompt refund (less shipping).

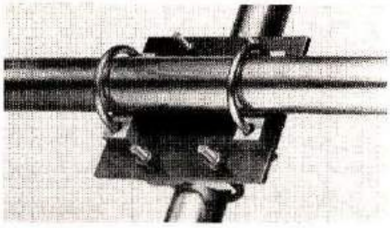
Order today. Money back if not delighted. One year unconditional guarantee. Add $2.00 shipping/handling.

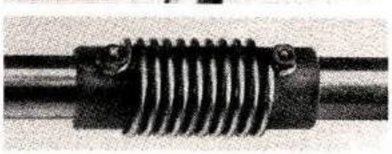
Order By Mail or Call TOLL FREE 800-647-8660 and Charge It On VISA master charge

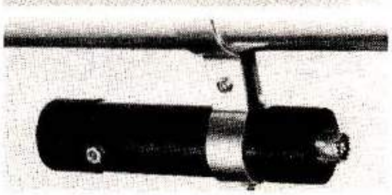
MFJ ENTERPRISES P. O. BOX 494 MISSISSIPPI STATE, MISSISSIPPI 39762

ATB-34









HAM RADIO HORIZONS

March, 1978
Volume 2, Number 3

Subscription rates are $10.00 per year, worldwide

Microfilm copies are available from University Microfilms, International Ann Arbor, Michigan 48103

Cassette tapes of selected articles from *Ham Radio Horizons* are available to the blind and physically handicapped from Recorded Periodicals 919 Walnut Street, 8th Floor Philadelphia, Pennsylvania 19107

Ham Radio Horizons is published monthly by Communications Technology, Inc Greenville, New Hampshire 03048 Telephone 603-878-1441

CONTENTS

Happy Flyers — Helping People 12
Alfred Wilson, W6NIF

Missouri Smokeys Talk to the Public 24
Bill C. Hayward, WØPEM

Radio Clubs — Suffolk County, New York 26
Charlene Babb Knadle, WB2HJD

Phased Trap Vertical Antennas 30
Gene Robbins, WA2FLN

Control Circuit Design 34
Richmond B. Shreve, W8GRG

Learning the Code as a Language 40
Roland Onffroy, W7JE

Questions? And Answers! 46
Thomas F. McMullen, W1SL

The Infinite Radio Spectrum 54
Anthony R. Curtis, K3RXK

Activities Calendar	84	Horizons Locator	76
Ad Check	86	Newsline	11
Ad Scan	81	Post Box	64
Advertiser's Index	86	Product Showcase	70
Benchmarks	66	Propagation Chart	83
DX Forecaster	82	The View from Here	6
Focus and Comment	8	This Month's Horizons	2

THE VIEW FROM HERE

Antennas have always been a problem for amateurs who live in apartments or mobile home parks and in recent years I think the situation has actually gotten worse. When I put my first amateur station on the air it wasn't uncommon to have an outside antenna for the a-m radio; late at night it was a simple matter to hook my transmitter to that same antenna for some surreptitious hamming. There wasn't a television station within several hundred miles in those days, so I didn't have to worry about TVI; few people had ever heard of radio amateurs so the fact that I had a radio transmitter and an outside antenna didn't attract much attention.

I'm afraid those halcyon days are gone forever; nowadays the general public is well aware of the boom in personal communications, so if you have an outside antenna that's obviously too big for television or fm you can bet you're going to hear about it if your neighbors experience any interference — even if it's ignition noise! And while my landlord didn't object to my outside "broadcast antenna," a modern landlord is not likely to be so naive.

This brings up an interesting question, one that has been raised by a number of hams who don't own their own homes: "What are my rights to erect an antenna suitable for use with my amateur station?" According to the Personal Communications Foundation, which has done a lot of research on this and other similar matters, your rights to erect an antenna are very limited, if not completely nonexistent. Laws relating to landlord and tenant relations vary from state to state, but it's safe to say that in no state is a landlord required to allow a tenant to erect and maintain an antenna. And that is true even if permission has been given to other tenants in the same building to install such antennas.

Even though your city or town may not have any ordinances or building codes which restrict the erection of antennas, remember that your landlord has the right to do what he pleases with his property. There are exceptions, of course; he can't allow a health hazard on his property, and in most states a landlord can't remove a tenant without going through certain specified procedures. When it comes to antennas, however, he can allow them or not — it's completely his decision.

If you are moving into an apartment or a trailer park and want to put up an antenna, you should obtain the permission of the landlord before you sign a lease or move in. If you receive permission, get it in writing; if you have a lease the permission should appear as a clause in that document. That will protect you in case the landlord changes his mind or sells the property. During the term of the written lease the new landlord cannot revoke the *written* permission given by the previous landlord. However, when the term of your lease expires, he may order you to remove the antenna or move out.

If the reason you moved into a particular apartment or trailer park was the fact that the landlord gave you permission to put up an antenna, once the original lease expires, so does the antenna permission. One possible way to protect your antenna is to include a clause in the lease which gives you an option to renew the lease subject to the same terms and conditions. The landlord will probably insist on a rent escalation clause if he gives you an option, but that's fine if the object is to protect your antenna — if you didn't have a lease your rent would probably be raised anyway!

If your landlord is reluctant to give you permission to erect an antenna, perhaps you can change his mind by offering to pay some increase in the established rent. You could also try using an "invisible" or hidden antenna, but if the landlord finds out about it and objects, he can order you to take it down.

If you are lucky enough to have an understanding landlord, nuture that relationship. Remember that your landlord's main concern is not your hobby, but the happiness and well-being of all the tenants. Therefore, good public relations with your neighbors is the best way to avoid having your permission to maintain an antenna revoked when it comes time to renegotiate your lease. If you have TVI or rf interference problems, and operate in total disregard of your neighbor's TV viewing habits, you may wind up moving sooner than you think!

Much of this information was provided by the Personal Communications Foundation, a nonprofit California corporation which specializes in legal research for amateur radio and citizens band services. For more information, or to become a member, write to them at 10960 Wilshire Boulevard, Suite 1504, Los Angeles, California 90024.

Jim Fisk, W1HR
editor-in-chief

More details? Ad Check page 86.

FOCUS & COMMENT

If I may paraphrase an old typing-practice line, "now is the time for all good hams to upgrade their license." By rights, I should include non-hams as well, but the sentence structure becomes awkward. However, if you do not have an amateur license, don't feel left out — now is the time to do something about it.

What's behind this word-shuffling bit of advice? Just this: great things are happening in the radio world, and you should be in a position to enjoy them. I'm thinking especially of the increasing solar activity during this part of the new sunspot cycle. Activity is on the upswing, as can be seen by anyone who follows the propagation prediction information in the amateur literature. 1978 should show a marked inprovement over 1977, and the next two years should be even better.

How will this benefit you as an amateur? It's like this — the higher frequency bands will become more active, and stay open for longer hours to more distant places. The same "skip" signals that will make 27 MHz an impossible nightmare of squeals and whistles will open the amateur 28-MHz band to all parts of the world. The difference will be in the space available for all those signals, and the ability to move away from the interference with your vfo and non-channelized receiver.

Sure, those of you with Novice licenses will be able to work ten meters, and it will be mighty interesting, but don't let it stop there. Simply by boning up on a bit of theory you can acquire a Technician-class license, which opens the whole new world of vhf to you. The sunspot activity will make some interesting things happen in that part of the spectrum too. On 6 meters, for instance, there will be some openings that rival anything that 10 or 15 ever offered. (Some of us can remember 4 MHz of wall-to-wall heterodynes during a previous sunspot high.) Two meters will have its share of happenings; in addition to some spectacular tropospheric and sporadic-E openings, solar activity will produce more and more aurora openings, allowing contacts that span half the continent. Additionally, there will be some new satellites to provide communications when the bands are otherwise dead.

All of these opportunities do not depend solely on sunspots, however. Dozens of manufacturers are turning out amateur equipment for the vhf and uhf bands, and amateurs are buying it. That's going to mean that people will be there when the band is open; there have been great band openings in the past, but the amateur vhf population was too sparse to do much about it. Then, too, the equipment of today is much improved over that of yesteryear — the sensitivity is better, and it uses efficient ssb, instead of amplitude modulation — and there are more and bigger antennas now than in the past.

If you need more justification than just having fun with amateur radio to get you moving, consider this: increased sunspot activity, better equipment, and more amateur occupation of the vhf bands will allow those who study such things to determine just what makes this electromagnetic world tick. There are a lot of unanswered questions that amateurs can help solve.

So, again I say, now is the time to move up a step. Be ready to experience something that will be a long time coming around again. Then, in the midst of the next sunspot low, you can tell some newcomer, "Gosh, you just wouldn't believe the openings we used to have in '78-79; I recall the time I worked Argentina on two meters with a 10-watt rig. Gave me a report of 40-over-9, too!"

Start hitting the books now, before the summer distractions get you — a few hours of study will earn you years of participation in the greatest show in the ionosphere.

Thomas McMullen, W1SL
Managing Editor

More details? Ad Check page 78.

Sooner or later . . .

every Ham will probably own at least one

Wilson

Hand-Held

NEW!

Small size . . . giant performance

TWO MODELS AVAILABLE:
2.5 Watt MARK II and
4 Watt MARK IV

SPECIFICATIONS:

- Range: 144-148 MHz
- 6 Channel Operation
- Individual Trimmers on all TX and RX Xtals.
- Current Drain: RX 15 mA, TX - Mark II, 500 mA. Mark IV 900 mA
- 12 KHz Ceramic Filter
- 10.7 MHz and 455 kHz IF
- Spurious and Harmonics: 50 dB below carrier
- BNC (Twist type) Antenna Connector
- .3 Microvolt Sensitivity for 20 dB Queiting
- Uses special rechargeable Ni-Cad Battery Pack
- New improved Rubber Duck included
- One pair Xtals 52/52 included
- Weight: 16 oz. (.45 Kg) inc. batteries
- Size: 6" x 1.770" x 2.440"

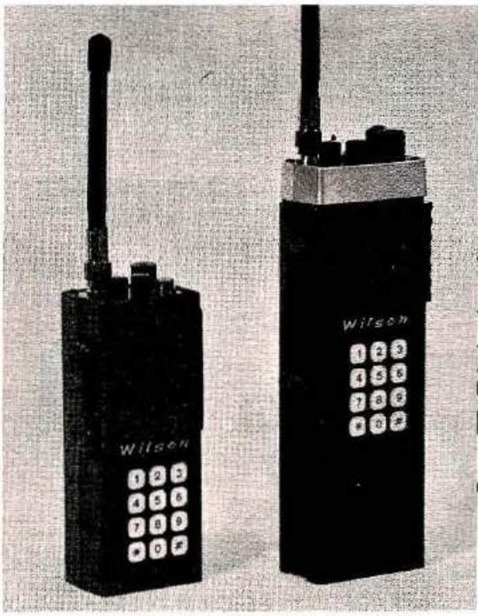
ACCESSORIES AVAILABLE

Include LC-4 Leather Case, WC12 AC Wall Battery Charger, BC4 Desk Type Battery Charger, SM4 Speaker Mic, Touch Tone Pad, Tone Options.

The new arrivals to the Wilson family of quality high performing hand-held radios are the small American-made small sized MARK II and MARK IV. The ultimate hand-held for the amateur who demands quality, performance and value.

FEATURES:

— Lightweight and compact size — fits comfortably in the palm of your hand.
— Rugged Lexan® case.
— Same dependable performance as all Wilson Hand-Helds.
— Microswitch Speaker-Mic built in.



FOR SIZE COMPARISON, THE NEW MARK IV IS ILLUSTRATED NEXT TO WILSON'S 1405SM SWITCHABLE 1 & 5 WATT RADIO.

Other Wilson units available are the VHF Models 1402SM, 2.5 watt, Model 1405SM Switchable 1 and 5 watt and 4502SM, 450 MHz, 2202SM, 220 MHz UHF units and Wilson's WE800 synthesized 2 meter portable rig.

DON'T MISS OUT ON THE EXPLODING HAM MARKET!

ATTENTION AMATEUR DEALERS:
Wilson is accepting new dealers in many areas . . . contact us if you are interested.

For an illustrated Amateur Products Buyers Guide, write:

Wilson Electronics Corp.

P.O. Box 19000 • Las Vegas, Nevada 89119 • (702) 739-1931 • TELEX 684-522

More details? Ad Check page 86.

NEWSLINE

REPEATER LICENSE APPLICATIONS are still arriving at the FCC despite the "deregulation" Report and Order and its subsequent stay. Until a final decision on repeater licensing is made, however, repeater applications are being returned without action.

License Fees are starting to turn up again in some Amateur applications, even though fees were suspended almost a year ago. The Personal Radio Division reports about 20% of applications received now include fees, with most of them from CBers.

FCC's Investigation of improper Amateur license and callsign issuance leaves Washington in April; its second hearing takes place in Indianapolis April 24. The first hearing was held in January in Washington.

Former FCC Commissioner Glen Robinson looks like President Carter's choice to head the U.S. negotiating team at the World Administrative Radio Conference in Switzerland next year. Robinson is presently on the faculty at the University of Virginia but was well respected for his contributions and expertise during his term on the Commission.

FCC Docket Numbers will be much more descriptive from now on with a new numbering system that became effective January 1. The new numbers start with two letters indicating FCC bureaus ("SS" for Safety and Special Services, "BC" for Broadcast and so on), "78" to show it originated this year, plus the serial number of the Docket in that year. Thus this year's first Safety and Special Services Docket could be "SS Docket No. 78-4," showing that it's the fourth Commission Docket of 1978.

FCC Extended its working day to 5:30 PM effective January 3. The new hours (for Washington, D.C. offices only) are from 8:00 AM to 5:30 PM, with employee schedules rearranged to insure adequate staffing of Commission offices throughout the day.

THE FIRST TRANSEQUATORIAL two-meter contact was logged in October when YV5ZZ exchanged signal reports with LU1DAU, who is approximately 50 km south of Buenos Aires. The distance spanned represents a 2-meter DX record of 3180 miles (4446 km). Initial contact was made using CW. Later, both stations switched to ssb on 145.9 MHz, exchanging 5/5-5/7 reports. Signals were steady, with none of the fading experienced during a prior 6-meter QSO. YV5ZZ also worked LU7DJZ, who is about 30 km north of Buenos Aires. The openings continued November 25 and 26, as YV5ZZ (joined by YV6ASU on the 26th) worked seven different LUs with reports reaching 5-9+!

"WHISKEY CLUB" LEADER Jesse Runyan, of El Dorado, Kansas, also known as "34W-1," has had his Technician Class Amateur License WBØRIN suspended for the remainder of its term for his illegal activities. He's also been ordered to show cause why both WBØRIN and his CB license should not be revoked.

OSCAR 7 HAS SWITCHED to its new Mode A every-third-day-only schedule in January as planned, despite the pushback of the AO-D launch to March. The satellite will actually operate in a Mode C (432-145 MHz, 1.25 watts out) — Mode B (432-145 MHz, 2.5 watts out) — Mode A sequence, though users should hardly notice the 3 dB difference between Modes C and B.

The Solar Cell Subscription count is now 2410, only 48 short of enough for one Phase III satellite. Sea-Q-DX, sponsors of last summer's Northwestern Division ARRL Convention, just donated $1000 in behalf of the eight participating clubs.

OSCAR 7's Mode Jumping problem isn't entirely from user abuse, W9VI (ex-W9OII) found when he observed a jump on an early morning pass with no user signals audible. A high noise output, often observed before jumps, has been linked with the problem. One theory is that it's an internal malfunction, while another says it's related to an ionization buildup as it does seem seasonal.

Launch Of The Second Phase III satellite with an early Space Shuttle launch is under active discussion. If approved it would come as early as late 1980, though 1981 is more likely. The first Phase III launch is still bracketed for late 1979 or early 1980.

RESTRICTIONS ON 220-MHZ operation by Amateurs near the White Sands Missile Test Center have been lifted by the FCC. The ban had prohibited Amateur use of 220 in parts of west Texas and New Mexico during weekday working hours to prevent possible interference with missile range communications.

THE ENVIRONMENTAL PROTECTION Agency may be in Amateur Radio's future — the Senate Governmental Affairs Committee recommended giving the EPA authority over radiation hazards, including RF.

AN "HONORABLE MENTION" was awarded to KP4EBO by the National Weather Association at its National Convention last November. He received the award for having established the Puerto Rico Weather Net in support of the National Weather Service Forecast Office in San Juan. Congratulations!

HAPPY FLYERS

The combining of two hobbies creates an organization that is both unique and helpful

BY ALF WILSON, W6NIF

If you're a private pilot and a licensed ham you've no doubt heard of the Happy Flyers. For you non-flyers, I'll explain: it's an international organization that has developed over the past few years under the dedicated leadership and work of Hart Postlethwaite, WB6CQW, who is the International Commander, with headquarters in Belmont, California, near San Francisco.

The Happy Flyers use the amateur vhf bands for providing public-service work through their expertise in using vhf radio direction-finding techniques. Some of the public-service work includes a) saving human lives through locating downed aircraft; b) locating jammers, who delight in obstructing legitimate communications in the amateur vhf bands; and c) providing vhf radio links, for use by paramedics, through the amateur repeater system.

In this article I've outlined some of the work done by the Happy Flyers, although the article by no means covers all of their activities. The material has been taken from the many publications produced by the Happy Flyers and from interviews with WB6CQW; his wife, Janie, WB6ODQ (who is really responsible for it all); and Paul Hower, WA6GDC, who is the Happy Flyers International Vice Commander.

RDF demonstration flights are provided free of charge by the Happy Flyers. Here's Hart, WB6CQW, making preflight checks of equipment.

The material is presented for those with a desire to increase their knowledge of radio direction finding techniques using simple equipment at amateur very-high frequencies (144 and 220 MHz).

How it started

The Happy Flyers (*Happy* derives from *Hams and Pilots Piloting and Yakking*) had a modest beginning in the San Francisco, California, Bay area several years ago. During a QSO between Janie Postlethwaite, WB6ODQ; Bill Cryer, W6RCC; and Ben Autry, K6LHR, they decided to form a group of radio amateurs and pilots for occasional picnic-lunch social fly-ins. At that time, Hart Postlethwaite, WB6CQW, Janie's husband, didn't know anything about flying. However, Hart, at the urging of the others, obtained his pilot's license and became a member of the group. And so the Happy Flyers organization was born.

How it developed

As the organization grew, members felt that something more than social fly-ins was needed to keep the group growing. What about public service? How could this group of hams, which consisted of licensed pilots and licensed radio amateurs, best serve the community? What were the problems that could be resolved by such an organization?

Three immediate problems were apparent. The proliferation of jammers (those who cause malicious interference on the amateur vhf bands) had become quite serious in the San Francisco area. The locating of downed aircraft and saving lives needed some improvement. A third area of concern, that of alerting paramedics through amateur two-meter repeaters, would improve response time to emergencies. The Happy Flyers have responded to these needs through implementation of their electronic knowhow and dedication to public service.

A jammer is apprehended through the efforts of the Happy Flyers. Plane pilot is the Happy Flyers Commander, Squadron 1, Vic Borgnis, WB6EVH. On the ground are (left to right) Andy Memmel, WA6CBN; Hart Postlethwaite, WB6CQW, Happy Flyers International Commander and Electronic Search Coordinator for the Western States Sheriffs Squadron; the culprit; a policeman from the San Carlos, California, police department; and Roy Everhart, WB6GWQ.

The jammer problem

This category includes not only jammers but also radio-frequency interference (RFI) in general. RFI consists of:

1. Spurious emissions and intermodulation products from transmitters, or both. Causes can include mistuned equipment, component failure, mixing of multiple signals caused by poor equipment design, and interference caused by poor electrical connections.

2. Accidental emissions from radio transmitting equipment caused by shorted key lines, inadvertent closing of microphone switches, children flipping switches, inadequate dummy loads (causing radiation), and an unknown inoperative receiver, to name a few.

3. Intentional interference, which includes two basic categories:

A. Identified transmissions, which are made at a time and in such a manner as to interfere with communications in progress. If the amateur call sign being used is legitimate,

Late News Item — Just as this article was being set in type the Happy Flyers sent us a bulletin about a rescue that their technique and training made possible. The life of a ten-year-old girl was saved after an ordeal of nearly two days.

An airline crew reported hearing the signal from the Emergency Locator Transmitter (ELT) on the second day after a light plane was reported missing. The San Diego Sheriffs Office dispatched Grady Gaylord and Lee Gillard to seek out the ELT site. Both Gaylord and Gillard had received training in the search methods developed by the Happy Flyers.

Heavy cloud cover forced them to fly above 12500 feet, but they obtained a fix on the location within three minutes of first contact, and with an accuracy of better than 1/8 mile. They descended below the clouds to obtain another fix on the crash site. Working with a second plane above, they guided a rescue helicopter to the wreckage and the injured girl.

The girl, Michelle Robson, was thrown from the plane, and spent 42 hours in the rain of heavy thunderstorms that hampered earlier searchers looking for the plane. Her grandparents were killed in the crash. To Gaylord, Gillard, and the Happy Flyers, a much deserved "well done."

View of amateur equipment mounted on the floor of W6RCC's Bonanza airplane. W6RCC, Bill Cryer, is one of the co-founders of the Happy Flyers.

and the amateur is aware of the interference being caused, such action is a violation and is a matter to be resolved by the FCC. If the call sign is not legitimate (a bogus call sign), then a means must be used to search and locate the illegal station. Radio direction finding (RDF) is a potent weapon for these cases. RDF at vhf has been developed to a high degree of proficiency by the Happy Flyers. The methods and techniques are described later in this article.

Bogus call signs are sometimes used by licensed amateurs as a coverup. Such call signs are also used by unlicensed operators (bootleggers) and jammers (often with stolen radios).

B. Unidentified illegal transmissions, which may include a dead carrier, noise, incessant button pushing, music, or just about anything you could think of to disrupt legitimate amateur communications. The people causing this type of RFI are the jammers. The Happy Flyers, using vhf RDF equipment designed and operated by members, have been able to locate jammers with a remarkable degree of success.

The RDF techniques for locating jammers have also been used by the Happy Flyers for locating stolen radios and downed aircraft. The operation of the RDF equipment requires some degree of expertise, which can be obtained through the many publications offered by the Happy Flyers. Techniques vary for locating signals by air and on the ground, but the general idea is the same for both. The equipment needed for RDF work at vhf is quite reasonable in cost and can be readily adapted to your vhf gear. A complete set of instructions on how to build and use the equipment is available together with other useful information for those interested.*

*A self-addressed stamped envelope to Hart Postlethwaite, WB6CQW, International Commander, Happy Flyers, 1811 Hillman Avenue, Burbank, California 94002, will bring much useful information on RDF techniques developed over the past few years.

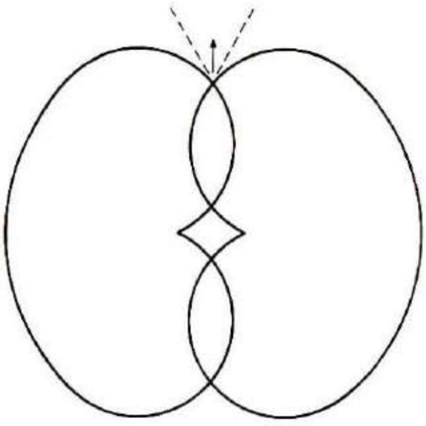


Fig. 2. Response of the switched-cardioid antenna, phase-sensitive RDF system developed by the Happy Flyers. A 90-degree delay line is switched with the antennas, which results in the overlapping cardioid pattern.

RDF techniques — location of downed aircraft

Many thousands of private aircraft occupy air space in the United States. A law passed by Congress in 1974 requires all

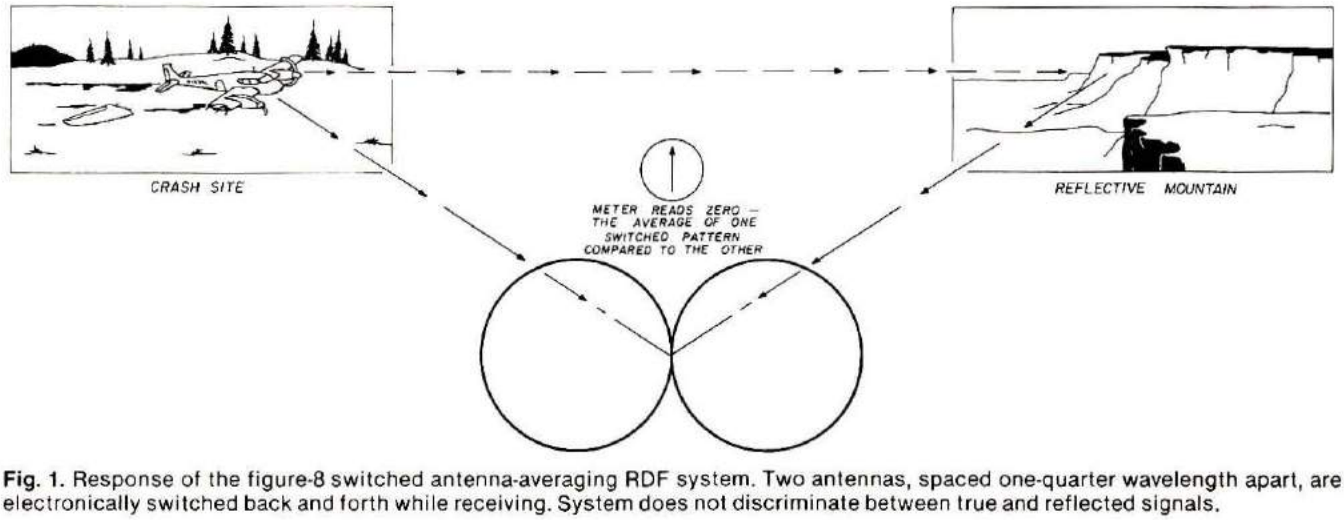


Fig. 1. Response of the figure-8 switched antenna-averaging RDF system. Two antennas, spaced one-quarter wavelength apart, are electronically switched back and forth while receiving. System does not discriminate between true and reflected signals.

piston-engine airplanes operating in this country to contain an emergency locator transmitter (ELT). The ELT is a self-powered radio transmitter designed to become activated on impact, as during a crash situation. The ELT emits a signal on 121.5 MHz, which is one of the international emergency frequencies monitored by the Federal Aviation Administration (FAA), the Civil Air Patrol (CAP), and others.

The idea is a good one, except that problems exist involving electronic know-how in *using* DF facilities for finding downed aircraft within a minimum of time — lives may be at stake in a crash situation, and time is important. The usual tracking procedure, which is employed by the Civil Air Patrol (CAP) in California, for example, is to fly a so-called grid pattern over the suspected crash site while following the ELT signal with RDF equipment.

The grid-pattern technique has generally resulted in a very low degree of success in rapidly locating downed aircraft. The San Francisco Happy Flyers squadron, led by WB6CQW, decided to try to improve the low success rate of locating ELT transmissions quickly by adapting the commercial equipment used by Government search and rescue (SAR) organizations to the two-meter amateur fm band. The advantage offered by two-meter repeater stations as "geometric levers" for extending communications range was extremely significant in the success of this project.

Inside a Happy Flyers' airplane showing, lower right, a Drake TR22 with GLB, Heathkit digital clock, touchtone for autopatch, rotary dial and silent monitor, tone-burst encoder, and subaudible dial tone. The installation is in Hart's Cessna 182.

Airborne RDF — how it works

A comprehensive explanation of airborne RDF techniques used at vhf is available from WB6CQW, as mentioned previously. Here I'll present some of the highlights of the techniques developed by the Happy Flyers to acquaint you with the work that has been done to date.

Automatic direction finders. The automatic direction finder (ADF) is common on airplanes and is used for navigation on the low frequencies. ADF is used on many of the CAP search missions in type C130 airplanes. Happy Flyers originally planned to develop an ADF for ELT search and jammer hunting but abandoned the ADF principle in favor of the present scheme after finding that conventional ADF would not work reliably at vhf because of propagation phenomena and signal reflections.

ADF automatically points a relative bearing to the *strongest* signal source to which the receiver is tuned. This idea works well at the lower frequencies (below 500

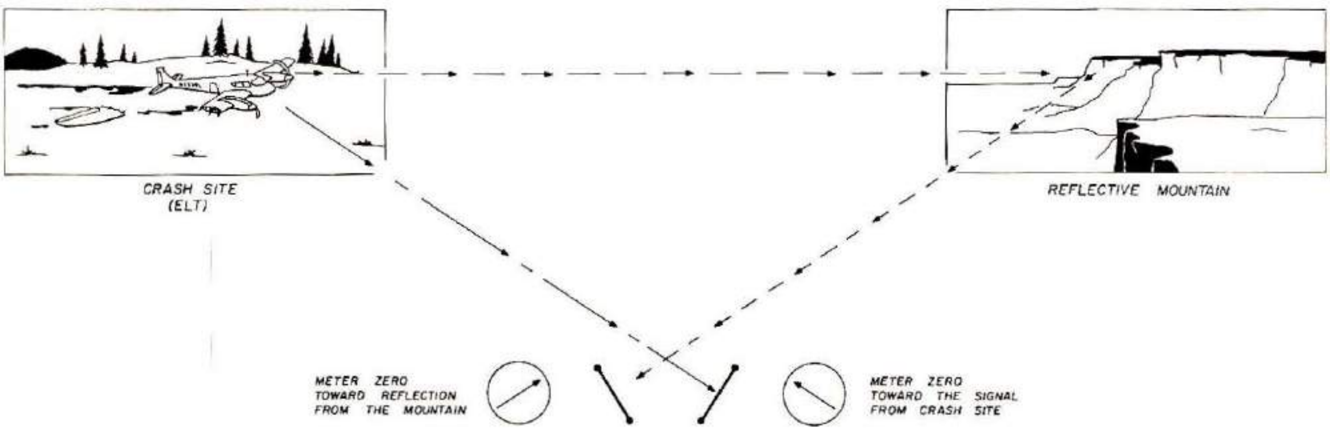


Fig. 3. Example of how the switched-cardioid RDF system responds to reflected and direct signals from an ELT. Each antenna is turned toward each zero indication on the meter. With practice, it's possible to distinguish between the reflected and direct signal.

Bill Cryer, W6RCC, at the controls in his Bonanza airplane. Equipment includes low-band and vhf radios. A longwire antenna can be extended from the back of the airplane in flight. An ICOM 230 radio is used for vhf.

kHz), but at the frequencies we are interested in, namely around 145 MHz, reflections of the signal from objects such as mountains and buildings cause problems to the search operator trying to find the signal source. For example, if an airplane is at a point midway in signal strength between a reflection and the true signal, ADF will search back and forth, attempting to indicate the strongest signal. At vhf, the *reflection* can be the *strongest* signal arriving at a given point. The ADF principle is therefore unreliable for vhf cross-bearing triangulation and can cause wasted time while the search operator follows reflections. ADF is excellent, however, when used for navigation in the frequency range of its design.

Beam and loop antennas. These antennas are sometimes used for direction finding with a receiver that has a signal-strength meter. Some operators rotate these antennas until the signal-strength meter reads maximum; others use the minimum reading. (Maximum readings are usually superior on extremely weak signals; nulls are superior on stronger signals.)

These antennas, when used for direction finding, also suffer from the problems of reflections and multipath at vhf and uhf. (Multipath is a phenomenon you've no doubt experienced with TV signals radiating from buildings in your vicinity that cause "ghost" images on the TV screen. Multipath transmissions can cause all kinds of problems to the fellow trying to locate a signal source.)

If a direct signal and a reflection are near each other, the field-strength meter might average the two signals. On the plus side, however, gain antennas (beams) will allow you to acquire starting directions on signals that are too weak to be heard on switched-antenna arrays. (Loop antennas are generally too insensitive for this application and are not considered.)

Field-strength devices. These instruments serve a purpose, but they are of limited use for serious work in locating signal sources. For example, Hart, WB6CQW, has used a surplus military field-strength unit, which is tunable between 100-160 MHz, to locate the exact signal plane within a field of many reflected signals. The unit works well when trying to locate jammers at close range — say within one city block. The S-meter on a handheld transceiver can also be used in the same fashion. Again, this scheme is good only at close range. (The equipment should be reasonably well shielded.)

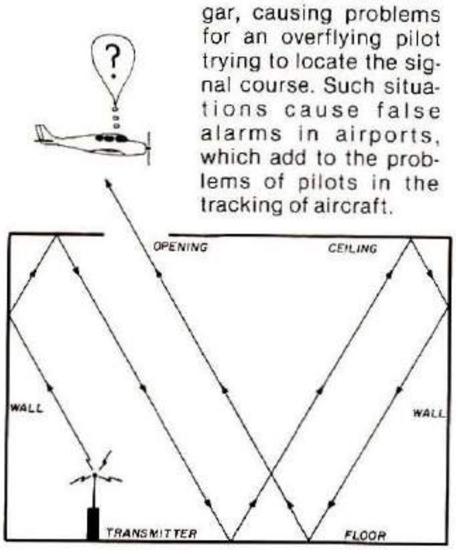


Fig. 4. An example of multipath signals radiating from an ELT inside an airplane hangar. Signals bounce off walls, floor, and sides of the hangar, causing problems for an overflying pilot trying to locate the signal course. Such situations cause false alarms in airports, which add to the problems of pilots in the tracking of aircraft.

A paste-on DF antenna that can be fastened to an airplane windshield makes an easy and effective temporary installation. Note phasing line in the center.

Switched antenna arrays. Systems using these antennas can be divided into three categories:

1. Multielement electronically rotated arrays (such as the Adcock system).
2. The figure-8 pattern averaging RDF array.
3. The switched-cardioid, phase-sensitive, RDF array.

The last-mentioned system is that used by the Happy Flyers in their RDF work, after extensive experiments and development of the associated hardware.

The Adcock array is extremely expensive for use in amateur work. Commercially available equipment runs between about $2000 and $8500. Briefly, the system electronically switches antennas between received signals, and the resolved data is displayed on a cathode-ray tube. The system will indicate various instantaneous directions to rf sources; the actual signal source is indicated by a line, displayed on the CRT, that is the most

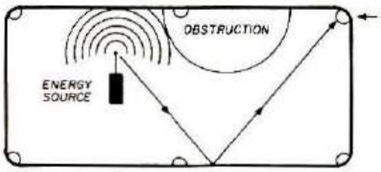


Fig. 5. An example of the "pool-table" effect on reflected signals. The angle of incidence always equals the angle of reflection. Here the signal passes around the obstruction by reflecting from the side of the table to the receiving point — an example of single-source reflection. The RDF gear will indicate *toward the reflection* point rather than toward the rf source.

consistently shown magnetic bearing to the source. The same general information given by these expensive units is available from the switched-cardioid RDF units designed by the Happy Flyers.

The figure-8 system uses left-right indicators to guide the pilot during a search operation. Two antennas, spaced about one-quarter wavelength apart, are electronically switched back and forth while receiving signals. This action results in a figure-8 pattern, as shown in **Fig. 1**. Most systems of this type compare data obtained during the time each antenna is switched on. The difference is displayed on a zero-center meter. If the meter indicates left, you turn in that direction; if the meter indicates in the center, you are supposed to be pointing at the signal source. However, if you have two sources of rf, each of which is 45 degrees to your heading and of about equal strength (such as a reflection and a true signal from a crash site), the unit will indicate *straight ahead*. This

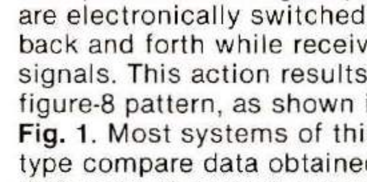


Fig. 6. An example of two-source multipath. The obstruction has been removed, and there are two possible paths over which the signal can reach the receiving point (RDF gear). The problem now becomes much more difficult in locating the true direction of the signal source.

action occurs because there is little or no difference between the information arriving from both sources (*i.e.*, true and reflected signals).

Such a situation can cause tremendous bearing errors when used for triangulation — that is, when using geometric plotting to determine the true source of the signal. It can also cause you to fly endlessly in circles.

Signal reflections follow scientific laws: the angle of incidence must equal the angle of reflection. As you move, the angle of incidence and reflection will cause a continuous change on the reflection side — including complete signal disappearance at times. This will usually cause a continuing change in indicator needle position, which is not necessarily related to the actual signal source, unless you can get completely away from signal reflections.

The switched-cardioid, phased RDF units are used by the Happy Flyers for search and rescue operations. This system works similarly to the switched figure-8 system, but the difference is in *how the antennas are switched*. A 90-degree delay line is installed in the switching network. When the delay line is switched, two overlapping cardioid patterns occur, as shown in **Fig. 2**. Varying the degree of phase delay will also vary the overlap, which affects system sensitivity and selectivity.

How the phased-antenna system works

The antennas are switched at a rate of about 80-120 times per second. The delay line is also switched, so that two cardioid antenna patterns are produced. The antenna switch-rate chops the audio entering the receiver and establishes a reference (similar to a clock or timing pulse).

Detected audio is fed into the RDF unit, and its phase angle is compared to the reference. The RDF unit looks

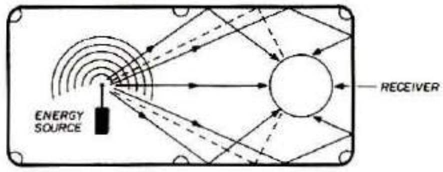


Fig. 7. Multiple-source multipath. This situation would create an extremely difficult tracking problem and one that is more likely than not to occur during an actual ELT search. The problem can be resolved with the proper equipment and techniques.

at the crossover of the switched-cardioid pattern. Any phase difference is indicated by needle deflection. Accuracy is a function of the audio-phase relationship between the antennas. (The distance from the rf source for a variation in signal strength, or amplitude, does not change the accuracy of this equipment.)

Because it looks only at the narrow aperture of the cardioid-pattern crossover slope, the cardioid-system is capable of showing more than one source of signal toward a given location (**Fig. 3**). In the example given for the system using the figure-8 pattern, two signals 45 degrees apart were indicated. This phenomenon can often be seen on the switched-cardioid type RDF units. This needle will vibrate as it goes toward center position instead of deflecting smoothly. Even a disturbed direct-path can be detected with practice.

Front-to-back resolution

Both the switched figure-8 and the switched cardioid RDF systems can distinguish between front readings (*toward*

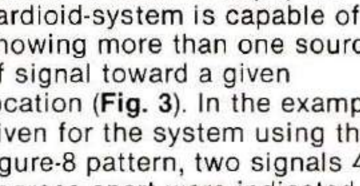


Fig. 8. The cancellation effect caused by two rf paths, in which the signal arrives at the same point from opposite directions. Theoretically, they would cancel at point **C**. Actually there could be many points of signal cancellation and addition in a real-world situation.

Hart, WB6CQW, and Larry Reed, W6CTH, beside Hart's Cessna. Larry did the copy work for the free film shows given by the Happy Flyers for public relations seminars across the country.

the source) and back readings (180 degrees *from* the source). By turning toward the needle, you'll always be facing the target when the needle comes to zero. With the switched-cardioid phased system, you'll be facing a source of rf, but not necessarily the correct source. With the figure-8 system you'll be looking at the direction of the *average* rf source.

In summary, when a no-reflection, no-multipath situation exists, both systems will point to the actual rf source. In a multipath situation, the figure-8 system will show the average path; the phase-switched cardioid system will show many paths of the signal, which is indicated by each meter zero you find during a 360-degree turn. With the switched-cardioid system, only the zero reading is a valid bearing in multipath situations.

The multipath problem

You'll notice the emphasis that has been placed on the propagation phenomenon known as multipath. Multipath occurs when a signal reaches a receiver over two or more different paths. Often one path is direct to the receiver and the other arrives as a reflection (as from a mountain, building, or other object). Either signal can be the strongest received, depending on the circumstances of the paths to the receiver.

Usually one bit of signal information arrives at the receiver slightly later or earlier in time. An example is the ghosts often seen on a TV receiver, in which the picture is displaced slightly on the TV screen. In communications receivers, multipath is noticeable as a fuzzy audio reception.

Coping with multipath propagation is extremely important in RDF work — the indicating meter will try to show you the direction of all signals, including the desired signal. And the desired signal isn't necessarily the strongest signal! Consider **Fig. 4**, which illustrates reflected paths from a transmitter located in a building. The signal bounces off walls, floor, and ceiling through a hole in the ceiling to the pilot in the aircraft above. Situations such as this have occurred during the Happy Flyers' airborne ELT search program. In this case the multipath causes false alarms when ELTs have been accidentally actuated in airplanes stored in hangars, for example.

A helpful fact to remember when working with signal reflections is that such signals do not violate the laws of physics: the angle of reflection *must* always equal the angle of incidence. The sketch of **Fig. 5** shows this principle, in what is known as the "pool-table" effect. For simplicity, only one path of energy from the source is shown; however, radio-frequency energy radiates in every direction from a whip antenna. Note that the RDF equipment at the receiving point would indicate toward the reflected point rather than toward the actual source.

By removing the obstruction and showing two rf paths, as in **Fig. 6**, we can illustrate one type of multipath. Signal 1 is the direct signal, and signal 2 is the reflected, or multipath, signal. This phenomenon is known as two-source multipath.

Another form of multipath transmission, which is not uncommon in RFI and jammer hunting in metropolitan areas,

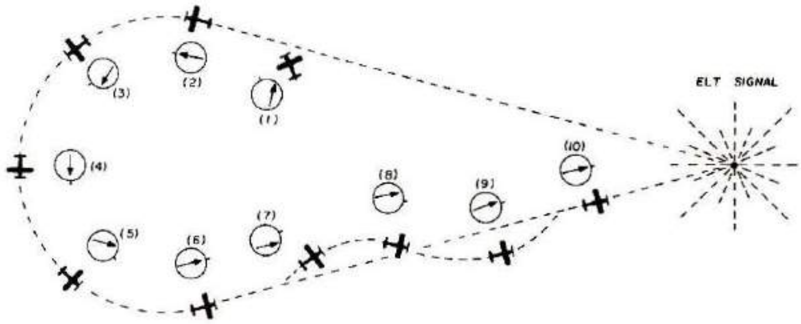


Fig. 9. An example showing the procedure used during normal homing on an ELT signal with no multipath. A 360-degree turn is made from the beginning of signal reception. The procedure is straightforward in this situation, as explained in the text. The meter indications are shown as they would be seen on the panel in the airplane.

is shown in **Fig. 7**. The sketch shows multiple reflections from the energy source, all arriving at the receiver at different times because of path differences. Such a problem can be resolved with proper equipment and techniques.

So far we've illustrated rf paths as if each had no effect on the other. We know this isn't true, because each path interacts with the other. When we use gain antennas, we can arrange them in such a way to take advantage of phase addition and cancellation. **Fig. 8** is an example of multipath transmission that shows the cancellation effect. This is known as two-source cancellation. In this example, two rf paths are shown arriving at the same point (**C**) from opposite directions. In theory the two signals would cancel. However, in the real world, there could be many points of signal cancellation and addition.

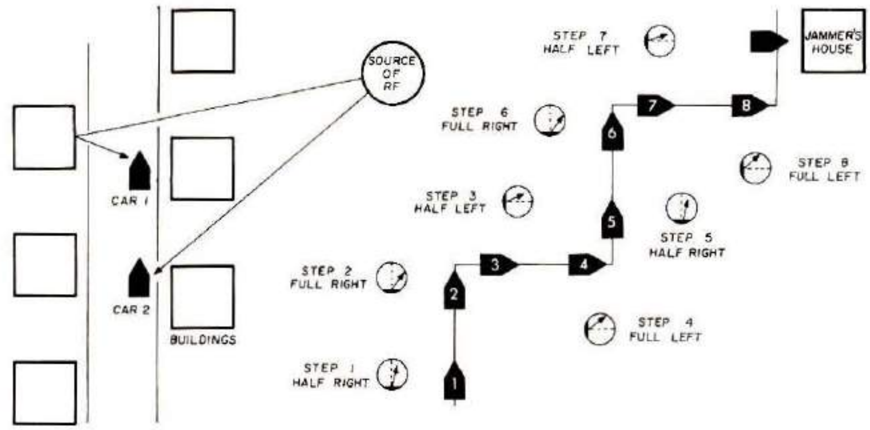


Fig. 11. A method for locating ground-based jammer signals suggested by WA5TRS in Oklahoma. The switched delay line, cardioid antenna system is used in autos. The RDF system only looks at the narrow aperture of the signal crossover, which helps tremendously in resolving multipath problems. A high success rate is claimed for this method.

Procedures for beginning an airborne ELT search

The following procedures for a typical search have been developed by the Happy Flyers for those who are interested in using private airplanes equipped with RDF equipment.

1. Turn on your RDF unit and verify that the indicator needle points in the proper direction. An S-turn is suggested to further verify that the needle passes through zero and indicates the proper direction. (Some dual installations require flipping a switch for meter reversing. Be sure the switch is in the correct position for the radio in use.)

2. Be sure you are *high* enough above surrounding terrain for initial readings. A minimum of 2000 feet (610m) above ground level is recommended for the first reading; 4000 feet (1220m) above ground level is suggested for enroute search in average terrain. In hilly and mountainous areas, much higher altitudes are recommended to minimize the possibility of wasting time following reflections.

3. Start a level, 360-degree turn *away* from the direction of needle indication. This will allow you to check for signals within the entire 360-degree circle without turning the entire distance. Remember that for each signal bearing, there should be a *to* and a *from* zero reading; therefore, any turn more than 180 degrees will show multiple signals in your immediate area.

Normal homing — 360 degrees with no multipath: assuming you receive the direct signal from the ELT, the procedure would be as in **Fig. 9**. In this figure it's assumed that no wind condition exists. Remember that when the needle centers when you turn away from the needle's direction, a *from* bearing is indicated; when turning toward the needle's direction, a *to* bearing is indicated. Always make an S-turn on the zero reading to verify that you're not at a 90-degree null. True bearings will always deflect to both sides of zero on the indicator. Referring to **Fig. 9**, proceed as follows:

1. Needle indicates *right* — a turn to the left should be made.

2. Needle indicates zero, indicating a *from* bearing.

3. Needle indicates maximum *left* deflection (maximum signal strength). This is the 135-degree point.

4. Needle indicates minimum (it could be almost *zero* or slightly left of *zero*). This is the 90-degree point.

5. Needle indicates maximum *left* deflection (maximum signal

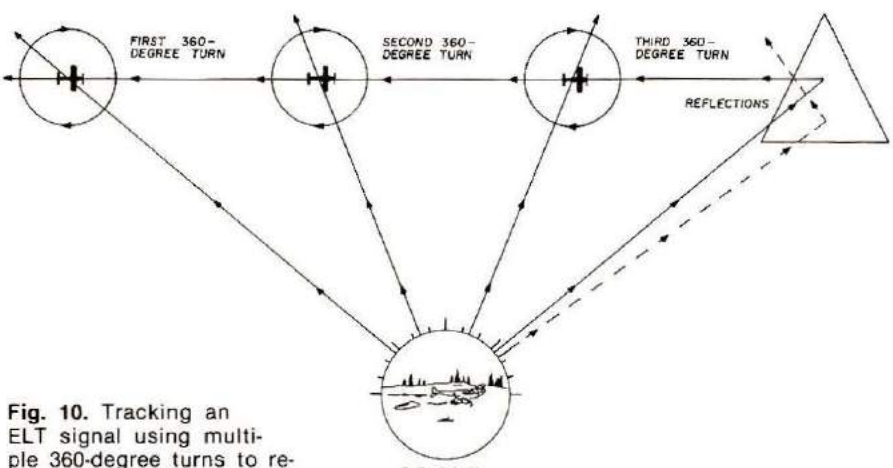


Fig. 10. Tracking an ELT signal using multiple 360-degree turns to resolve the multipath problem. Altitude is important during these flights — pilots try to fly as high as possible.

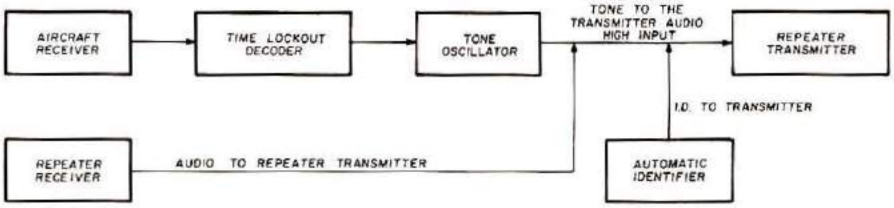


Fig. 12. Block diagram of a tone-alert time-lockout decoder system for amateur repeater stations for participating in search and rescue work.

strength). This is the 45-degree point.

6. Needle indicates *zero* while turning toward needle indication of step **5**. This indicates a *to* bearing.

7. Continue the left turn; indicator needle moves to the right.

8. Make a right turn toward needle indication of step **5**. Needle returns to *zero*.

9. Continue the right turn through zero meter indication. The needle will then indicate *left*.

10. Center the needle and follow it to the target. Keep the needle at zero center. (Note that no wind corrections are indicated for this case.)

Complex plotting situations — multipath and reflections: You'll notice the indications of S-turns after steps **2** and **6** in the example above. (These are the zero points.) After verifying a bearing, establish a course on zero long enough to obtain a magnetic heading. Write down the heading and the bearing (such as: 300 degrees *from*.) Then continue your left turn, as in step **3** above.

In a complex situation you would find more than two zero points. Each suspected zero should be verified by the S-turn procedure and a *solid zero crossing* of the indicator needle. Write down each bearing, as 300 degrees *from*, 240 degrees *to* and 60 degrees *from*, for example.

The logical procedure would be to draw lines on your map in these directions from your location. Choose a line you think to be a logical bearing, and begin a climb enroute on your chosen course. Climb 2000 feet (610m) or so, then repeat the 360-degree procedure. If you obtain only one *to* and one *from* reading, proceed as on normal homing. (Your altitude and location change, or both, will have eliminated the reflection.) If you get another (or more) *to* bearings in addition to the one you're following, plot these bearings on your chart. Extend all lines and compare them with the previous lines. If the lines intersect, then you would home on the most likely course.

Again, *climb* enroute on your chosen course until you're further and higher than the last check point to make a new 360-degree turn. With sufficient altitude and proper geometrically spaced 360-degree checks, you should have at least one intersecting point on your chart.

It's not possible to cover every complex homing situation here; however, if you follow the procedures outlined above, and with logical thinking, you should go far toward solving even the most unusual problem in search procedures for downed aircraft.

As a further aid, **Fig. 10** is presented, which shows 360-degree turns, without showing the S-turn procedures for simplicity. Always use S-turns to verify *to* and *from* bearings, as well as signal nulls.

Ground tracking — an example

Several ground-tracking techniques have been developed by the Happy Flyers, and these are well documented in their publications (available from WB6CQW as mentioned previously). The mode known as "maximum-deflection homing" is described below as one of the more effective tracking schemes for ferreting out jammers.

The method was suggested by Joe Buswell, WA5TRS. It works well when there's little time for triangulation (as with stolen radio searches). Operation in this mode is simple and effective and is also used by the FCC.

Fig. 11 illustrates WA5TRS' suggested method. The

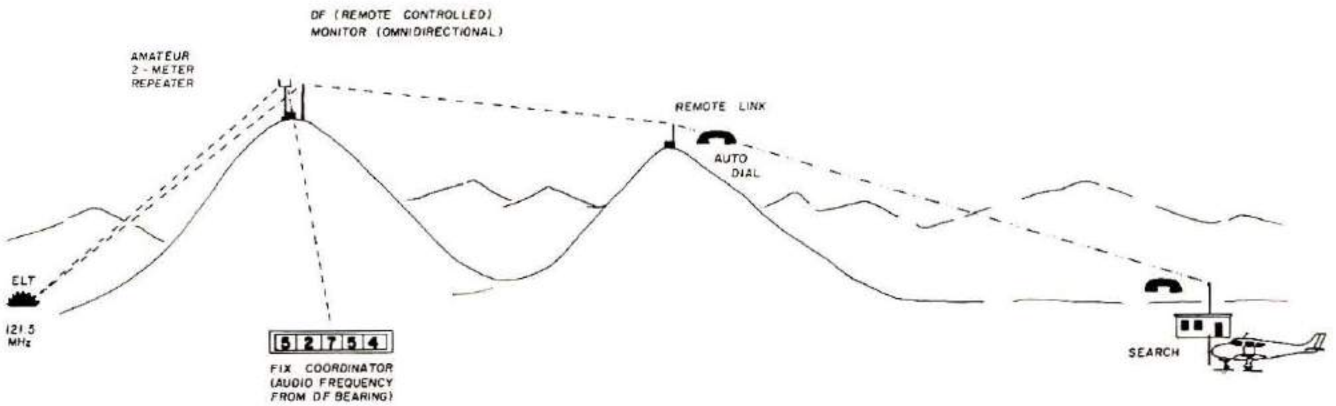


Fig. 13. Typical ELT-repeater scenario showing up-down links between an emergency signal (ELT) and an airborne search team.

switched-cardioid RDF looks only at the narrow aperture of the crossover, as explained previously. The indicator needle will pin somewhere between 15 and 25 degrees per side, depending on the setup used. This means the needle will pin long before the source bearing can become 90 degrees from your heading.

As you drive along with your fixed DF antenna hidden on your car windshield, a jammer comes on. When you first turn on your equipment, the indicator needle indicates to the right about half scale. You continue driving down the street while observing the indicator needle. As you pass between tall buildings and vacant lots, the needle jumps from side-to-side. However, each time the indicator needle swings to the right, it goes a *little more* to the right. Finally, it will always go to the extreme right *when not indicating a reflection*.

You turn right at the next intersection, and the average indication changes to the left side of the meter. You then continue until the meter reads to the extreme left most of the time. Then, a turn to the left moves the meter to the right again. You repeat this operation until you're at the jammer's door. The entire procedure averages about five turns, depending on terrain.

Notice in **Fig. 11** that the signal path to car 1 is reflected, and car 2 is shown receiving the signal over a direct path. It will readily become apparent how this will work as you drive down the street. The method, according to Hart, WB6CQW, hasn't been tried in San Francisco (many hills in the city), but it works well in the Oklahoma flat country.

Repeater monitor programs

Use of the amateur vhf repeaters to monitor emergency traffic for search and rescue (SAR) has been a significant part of the work done by the Happy Flyers. Hart, WB6CQW, and his wife, Janie, WB6ODQ, have made many presentations to repeater groups throughout this country and Canada, describing methods of using repeaters to augment SAR activity. These presentations include slide shows and talks on amateur

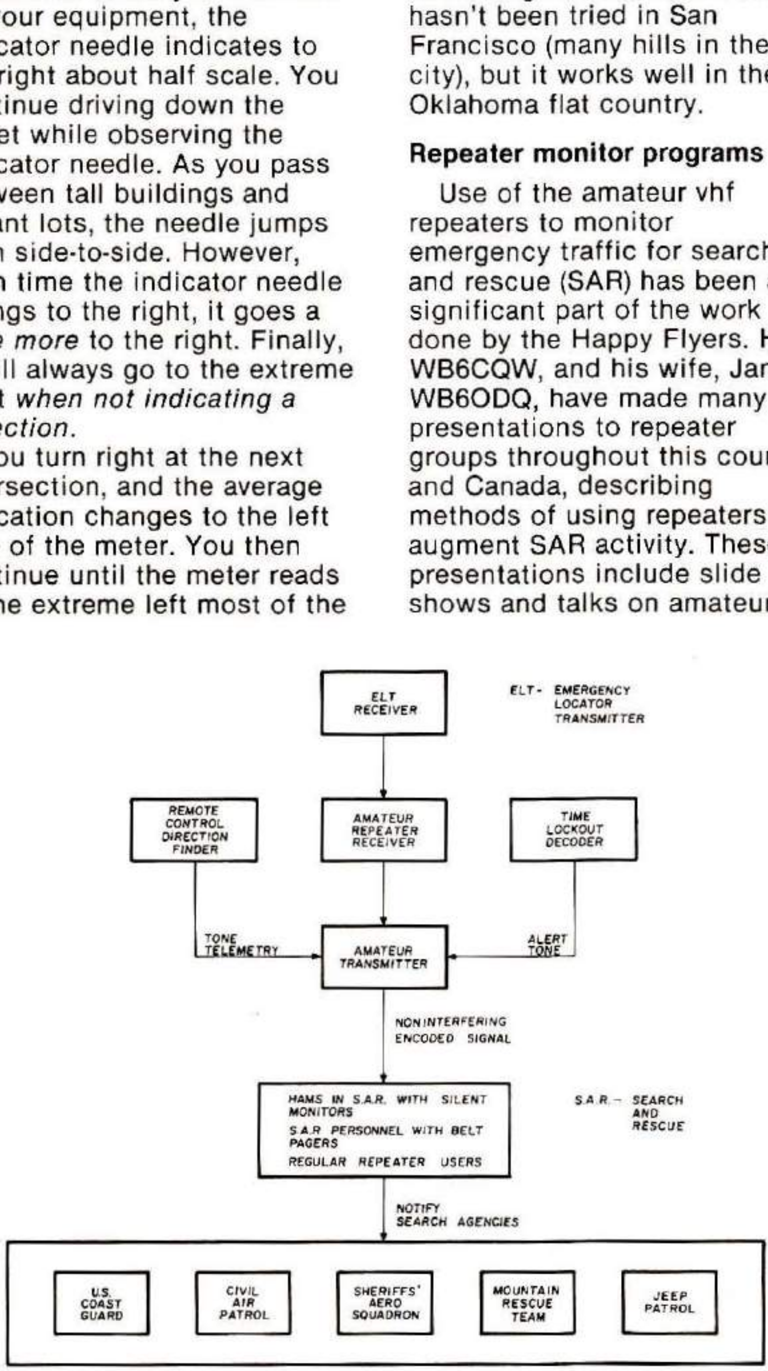


Fig. 14. Relationship between amateur radio and search agencies. This interface is now operating in many parts of the country.

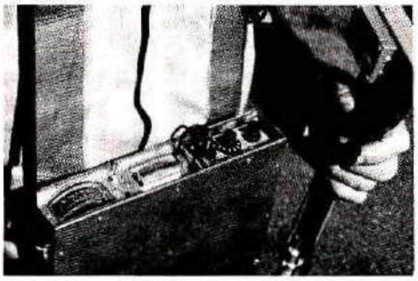
Andy Memmel, WA6CBN, stands beside his car, which has been fitted with a demountable roof rack containing a pulley system that allows him to change antenna direction and read azimuth bearings from the driver's seat.

radio participation in SAR as well as ideas for resolving the problem of interfacing SAR hardware and operating techniques with amateur repeater stations. A comprehensive discussion of the problems of SAR-repeater interface is given in the Happy Flyers' *Repeater Monitor Manual*, which may be obtained by sending a self-addressed, stamped envelope to WB6CQW (address given elsewhere in this article). Here are some of the highlights that make up the SAR-repeater monitor interface.

The basic idea is to install a receiver that monitors 121.5 MHz (the international emergency frequency) at the repeater site, with appropriate control circuits to alert participating SAR teams. The monitoring equipment, of course, must not interfere with normal repeater traffic.

An essential part of the SAR repeater installation is the time lockout decoder. The purpose of this circuit is to require the presence of the ELT signal (a continuous downswept tone) for a prescribed period before the alarm circuit is activated. The reason for this circuit is that, according to law, all ELTs may be tested during the first five minutes of each hour. Obviously, if an ELT test is made without some kind of lockout system, false alarms can cause problems.

High-level repeaters, such as



Close-up of the "tummy toter," which is carried by a strap around the neck. It contains the portable 2-meter receiver and DF unit. The box is made of copper-clad steel for isolation.

those on the mountains of the West Coast, have coverage of many hundreds of square miles. Some repeaters are located in areas that have many line-of-sight airports. So the lockout time must be selected to avoid additive decoding from tests made at these airports — again, to avoid false alarms.

Fig. 12 shows a block diagram of a tone-alert, lockout decoder system that is effective during normal repeater up time. A tone oscillator can be turned on for a short time, or it can remain on continuously. The tone can be low level so that normal repeater traffic won't be interrupted. The tone can be in the subaudible range, so that only SAR people with decoders will be aware of its existence. On the other hand, others may prefer an audible tone, so that all users will be aware of its existence and can participate without decoders. For this reason, many prefer that all participants can hear a tone at, say, 2000 Hz at low level. Some repeaters have rebroadcast the actual downswept ELT tone, but this becomes annoying to repeater users and is difficult to adapt to an inexpensive, automatic callup scheme.

Other circuitry for enhancing repeater participation in SAR activities has been developed by the Happy Flyers, such as an automatic key and alert system, an audio command for 121.5-MHz receivers, and a silent monitor, which can be used as the tone oscillator as well as the command decoder. These circuits are inexpensive to build and information is available from Hart, WB6CQW, if you're interested.

Fig. 13 depicts an SAR-amateur repeater link using interface systems developed by the Happy Flyers. This system is presently operating in San Jose, California. An override is provided for jammer hunting.

An ELT signal from a downed aircraft is received by the amateur 2-meter repeater, which has a receiver tuned to 121.5 MHz. The ELT signal is rebroadcast to a remote link some distance away. Communications between the SAR team occur through an auto-dial link between the SAR base and the repeater. Bearing information is passed to the SAR team, again through the amateur repeater station, and rescue is on the way.

An overview of how the Happy Flyers have designed an effective search and rescue scheme, using amateur radio, is shown in **Fig. 14**. Credit for this illustration goes to Paul Hower, WA6GDC, the International Vice Commander of the Happy Flyers organization. It shows the elements of a team-coordinated organization of dedicated amateur-radio operators interested in helping people. It works; it has saved lives; it shows what hams can do.

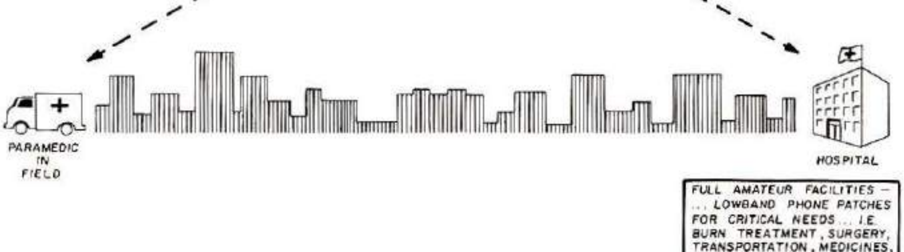


Fig. 15. An airborne, voice-operated (audio coupled) relay system using amateur repeaters for communications between paramedics and a hospital. Such a system is designed for national emergencies.

Paramedic relay system

Fig. 15 shows another aspect of the work being done by the Happy Flyers. An airborne voice-operated relay system (audio coupled) relays information from a paramedic through his transceiver (operating at 47 MHz). The signal is relayed through an amateur 2-meter repeater to appropriate circuitry at a hospital. At the hospital, full amateur facilities are available: low-band phone patches for medical advice regarding burn treatment, surgery and related needs.

The hardware for the paramedic relay system is being built by amateurs. The system is designed for use in catastrophic incidents, such as a major earthquake.

Help is needed

The Happy Flyers welcomes ideas and suggestions from hams interested in perpetuating the basic premise of the organization: helping others. If you have any ideas about improving existing methods, or if you would like to know more about the many facets of this part of ham radio, feel free to write to Hart, WB6CQW, who will be happy to provide literature. The possibilities are endless for an improved image of amateur radio in the public eye. Let's hear from you! **HRH**

FREQ. OUT.

CSC's done it again.

Broken the price and performance barriers with new MAX-100. The multimode, professional portable frequency counter that gives you more range, visibility, accuracy and versatility than any comparable unit at anywhere near its low, low price.

MAXimum performance. MAX-100 is a cinch to use. It gives you *continuous readings* from 20Hz to a *guaranteed 100MHz*, with 8-digit accuracy. Fast readings with 1/6-sec. update and 1-sec. sampling rate. Precise readings, derived from a crystal-controlled time base with 3ppm accuracy. High-sensitivity readings from signals as low as 30 mV, with diode overload protection up to 200V peaks.

Input signals over 100MHz automatically flash the most significant digit. And to indicate low-battery condition and extend remaining battery life, the *entire* display flashes at 1Hz.

MAXimum versatility. Wherever and whenever you need accurate frequency readings, MAX can do the job. Use it with clip-lead cable supplied. Mini-whip antenna. Or low-loss in-line tap with UHF connectors. For AM or FM; CB, ham, business radio and R/C transmitter or receiver alignment. Monitoring audio and RF generators. Checking computer clocks and other digital circuits. Repair of depth sounders and fish spotters. Troubleshooting ultrasonic remote controls. For these, and hundreds of other applications, you'll find it indispensable.

MAXimum visibility. MAX-100 features a big, bright 0.6" multiplexed *8-digit* LED display, with leading-zero blanking. So you don't have to squint, or work up close. And, MAX's flip-up stand is *built-in.*

MAXimum flexibility. MAX-100 operates from *four* power sources, for use in lab or field. Internal alkaline or NiCad batteries. 110 or 220V with charger/eliminator. 12V with automobile cigarette-lighter adapter/charger. And external 7.2-10V supply.

MAXimum value. With all its impressive specs, you'd expect MAX to cost a lot more than a low $134.95, complete with clip-lead cable and applications/instruction manual. But that's another nice thing about MAX: though it's accurate enough for lab use, it's well within the reach of hobbyists' and CB-ers' budgets.

Try MAX for yourself at your CSC dealer—or contact us for full specs and your local dealer's name. Once you see how handy MAX is, you'll want to "freq out" too. With CSC.

Specifications.

Range: 20 Hz to 100 MHz, guaranteed. **Gatetime:** 1 sec. **Resolution:** 1 Hz. **Accuracy:** ± 1 count + time base error. **Input Impedance:** 1 MΩ/56 pF. **Coupling:** AC. **Sine Wave Sensitivity:** 30 mVRMS @ 50 MHz. **Internal Time Base Frequency:** 3.579545 MHz crystal osc. **Setability:** ± 3 ppm @ 25°C. **Temp-Stability:** Better than 0.2 ppm/°C, 0-50°C. **Max. Aging:** 10 ppm/year. **Display:** Eight .6" LED digits; anti-glare window. **Lead-zero blanking:** decimal point appears between 6th and 7th digit when input exceeds 1 MHz. **Overflow:** with signals over 99,999,999 Hz, most significant (left hand) digit flashes, allowing readings in excess of 100 MHz. **Display update:** 1/6-second plus 1 sec. gate time. **Low Battery Indicator:** When power supply falls below 6.6 VDC, all digits flash @ 1 Hz rate. Flashing display extends battery life. **Power:** 6 AA Alkaline or NiCad cells (internal); **External:** 110 or 220/VAC Eliminator/charger; Auto cigarette lighter adapter; 7.2-10 VDC ext. supply; **Bat. Charging:** 12-14hr. **Size (HWD):** 1.75"x 5.63" x 7.75" (4.45 x 14.30 x 19.69 cm.) **Weight:** Less than 1.5 lb. (0.68 kg) w/batteries. **Accessories Included:** Clip-lead input cable; manual.

CONTINENTAL SPECIALTIES CORPORATION

CSC

70 Fulton Terrace, Box 1942, New Haven, CT 06509
203-624-3103 TWX 710-465-1227
WEST COAST: 351 California St., San Francisco, CA 94104,
415-421-8872 TWX 910-372-7992
GREAT BRITAIN: CSC UK LTD.
Spur Road, North Feltham Trading Estate,
Feltham, Middlesex, England.
01-890-8782 Int'l Telex: 851-881-3669

MISSOURI HIGHWAY PATROL TALKS TO MOTORISTS

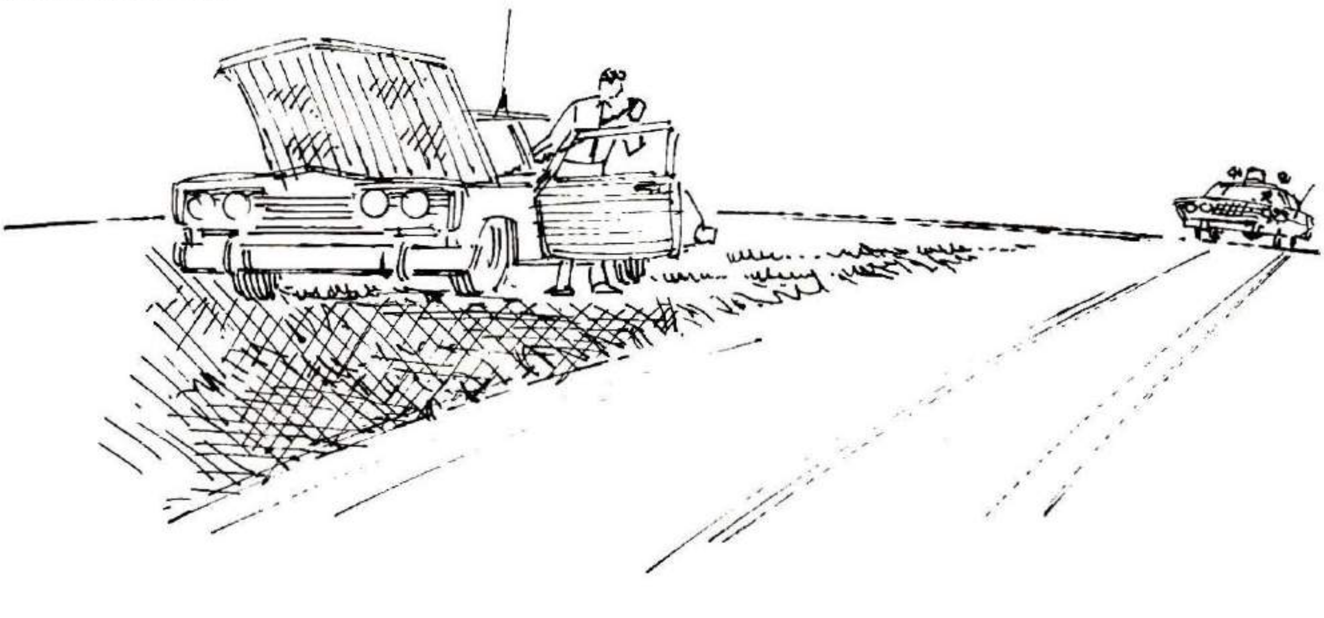
BY BILL HAYWARD, WØPEM

In August 1974, Missouri became the first state to use CB transceivers in State Highway patrol cars. Col. Sam Smith, then superintendent of the Missouri State Highway Patrol, started an experimental installation of CB transceivers in some patrol cars and in one of the troop headquarters stations. These CB sets were installed at the officers' own personal expense. Col. Smith, a CBer himself, wanted all reports directed to him for action. It turned out that the Missouri State Highway Patrol found that cooperation between citizens and law-enforcement personnel resulted in far better service to the public. So an FCC permit for the Missouri State Highway Patrol was obtained — the call sign was KGY-5621.

During the last three months of 1974, 478 CB contacts were made between Missouri State Police and motorists. Most of the CBers were truckers, but soon other motorists with CB sets found that Smokey had ears! Most of the reports concerned accidents, stranded motorists and wrong-way and drunk drivers.

By January 1975, 85 privately owned CB mobile radios were in operation by the Missouri State Highway Patrol. We were trying to obtain Federal funding during this time to equip all of our patrol cars with CB sets.

In June, 1975, a new call sign was issued for all Missouri State Highway Patrol operations: KMO-0911. This call sign was chosen because MO is the two-letter postal zip identifier for Missouri, and the numbers constitute the national emergency telephone number being adopted by many law-enforcement agencies in the United States.*



In July of 1975, Col. Smith announced that Federal funding had been obtained to equip 700 Missouri State police cars with mobile CB transceivers. CB base stations were also installed in all of our nine troop headquarters offices, at two satellite troop-headquarters stations, and at 15 "weigh stations" throughout Missouri. (The "weigh stations" are used to determine load weight of large tractor-trailer rigs passing through the state.)

All of the mobile transceivers are Cobra units with a built-in scanner, with a priority for Channel 9, which is used by the patrol for direct communications with citizens who need assistance or for reporting traffic violations.

Sgt. Jim Happy of the patrol's Troop A headquarters says, "One of the negative things is hearing your position on the highway being reported faster than lightning; but this, in turn, causes everyone to slow down, so maybe it isn't so bad after all."

In August, 1975, a month after most of our patrol cars were equipped with mobile CB transceivers, 8443 contacts were made with the public. By October 1975, this number had increased to 22,489, and by April 1977, about 156,000 CB contacts had been made. This is an increase of more than 300 per cent since our modest beginning in December, 1974!

Colonel Al Lubker, now superintendent of the Missouri State Highway Patrol, stated "An average of 7800 CB contacts per month have been made with citizens by our officers since the beginning of the program. The public's willingness and ability to work effectively with law enforcement officers to make our highways safer has been continually demonstrated during this period. CB reports of accidents, stranded motorists, traffic violations, and felonies have no doubt saved lives. I urge all citizens to continue their participation in this program."

So remember when traveling through Missouri, Smokey in a blue wrapper has his ears on: Channel 9, KMO-0911. **HRH**

*The practice appears to be spreading — we've received reports that New York State patrol cars have been seen bearing the tag KNY-0911. ***Editor***

Sgt. Jim Happy of the Missouri State Highway Patrol operating his mobile CB equipment, a Missouri State Highway Patrol officer operates the CB base station at the Troop A headquarters. You can rest assured that "Smokey is monitoring CB Channel 9 and is ready to help" (*photos courtesy WØPEM*).

The Suffolk County Radio Club, of Long Island, New York.
Activity to apathy; doldrums to dynamic action

BY CHARLENE KNADLE, WB2HJD

The Suffolk County Radio Club ranks among the more dynamic radio clubs — at least in the opinion of some of its members. According to Frank Tressa, W2TVN, who edited the club's newsletter for seven years, it began in 1947 with 48 members, and it affiliated with the American Radio Relay League (ARRL — amateur radio's official representative body) right away. Meetings were held monthly. With the advent of television in the fifties (and the inevitable TVI problems that accompanied it), the club's membership dropped off dramatically. But as filters were devised and single-sideband rigs improved, the membership grew again, so that by 1960 there were over 100 members.

The club was extremely active then, Frank says, having more than sixty entries into contests, with sweepstakes (an annual on-the-air event) points running well over a million. Field day operations drew more than fifty people.

The growth of CB and the FCC's introduction of incentive licensing created a new set of issues for the club. But in spite of raging debate, the membership adjusted to incentive licensing, as did hams everywhere. The CB issue was not so easily resolved, and indeed is an ongoing theme. Dialogue was at least attempted, with SCRC members attending CB meetings and inviting CBers to attend amateur radio meetings. Some CBers joined SCRC, and by 1970 the club had grown to 200 members. New interests, such as RTTY and two-meter repeaters, were adopted. At this point the membership gradually began to decline. (The causes were multiple — the gas shortage, a change of meeting place that didn't please everyone, etc.)

A frustrated organizer

When Bob Marsten, WA2ATL, joined SCRC, the club had dwindled to a mere forty members. At that time Bob was a ham who was content to keep to himself and simply enjoy his own amateur operation. But his son wanted the stimulus of a group. So Bob accompanied his son to a meeting of the Suffolk County Radio Club. There he found the members to be "disorganized and inconsistent, and in some cases disgruntled." So Bob, who now characterizes himself as a "frustrated organizer," stayed on to join the group and work with it.

"I felt the club had a lot to offer," Bob says. "I enjoyed watching the club perform. I found the guest speakers to be entertaining and informative. But there was a lot of ill feeling that some people were not doing their part."

Bob is definitely doing his part. Now vice-president, he does much of the editing of the club's newsletter, which is printed by Doug Seaman, WA2TAP, the club's president. "I wanted to help build a system that could perpetuate itself," Bob says, to avoid squabbles and to prevent the club from depending heavily on its current leadership for its status. The first step was to create a consciousness of the importance of keeping to a schedule. Now, programs of interest are scheduled a year in advance. First, the topics are chosen, then the speakers who will be invited to present them. Committees of three to five people are heavily relied upon for planning. The results are presented to the executive committee for a decision. Once the agenda has been agreed upon and speakers have been obtained, a letter of reminder is sent a month in advance to each speaker who has agreed to make a presentation. In addition, a follow-up letter of appreciation is sent to the speaker afterwards, letting him or her know of the club's reaction.

The monthly meetings are the club's major attractions, and these also are conducted according to plan. They are started on time, and no more than a half hour is devoted to club business, in order to retain the interest of people who come to see what's going on and to be entertained and taught by the guest speaker.

Periodically, a fifteen-minute segment of the meeting is set aside for education; for example, one recent segment was devoted to a review of integrated circuits. The meeting is ended in time to leave space for informal talk and eyeballing. All of the members get involved. The general attitude, now, is one of helpfulness. In fact, sometimes informal after-the-meeting "classes" are conducted — for example, Hans Napfel, WB2ZZB's class on computers. This attitude of unity and helpfulness is to Bob Marston, "one of the nicest things about the club."

Cliques

Ed Mentz, K2LCK, agrees that SCRC is a good club. "As long as the present leadership remains," he says, "SCRC will do okay." As for unity, Ed has distilled a general observation: "A club is good so long as it's run by one clique. For a club to be very good, the number of members in the clique should equal the number of members in the club. If the club gets too big for the clique to handle, the clique will probably leave and form a new club, placing the original club in the hands of a new clique."

In addition to regular meetings, SCRC conducts other activities to encourage the spirit of cooperation. There is the annual field day, a holiday dinner-dance, demonstrations at the county fair, a clambake, and contest operations. The social activities are considered important as ways to involve the members' families and friends in an amateur-radio atmosphere.

As a club, SCRC attracts members that run the gamut of occupations, as well as ages. Distance does not presently seem to be a barrier, either; interest is the key. Amateurs come from the city or the extremity of the Island to participate in a program that appeals to them. But a majority of SCRC members seem to concentrate on the lower

Frank Tressa, W2TVN, club newsletter editor — "The club was extremely active in the 1960s, with sweep stakes points well over a million."

Doug Seaman, WA2TAP, SCRC president — "I'm pleased that 30% of the membership has proved its involvement by contributing towards our 220-MHz repeater." It will be open and oriented towards public service.

Bob Marsten, WA2ATL, SCRC vice president — "I felt the club had a lot to offer; I enjoyed watching the club perform."

Ed Mentz, K2LCK — "A Club is good so long as it's run by a clique; for a club to be very good, the number of members in the clique should equal the number of members in the club."

Arnold Benton, WA2AHB, volunteer teacher — "I felt a desire to be of service to the amateur community. It bothered me to receive stimulation and information from the club meetings without giving something tangible in return."

bands, though a few members are on vhf. Other clubs, such as LIMARC (Long Island Mobile Amateur Radio Club) attract primarily vhf operaters. This situation has evolved in spite of the fact that neither club places any such restrictions on its members.

Members who had once dropped out of SCRC are now being attracted back. But the present membership consists of sixty percent new people, mostly CBers. As a whole, the CB portion of the membership "is less technical, not from lack of ability but from lack of exposure," says Bob Marsten. "They are now able to consult with people who can help them technically. In a year or two, they will be strong members of the club." This is borne out by SCRC's president, Doug Seaman, WA2TAP, who was a CBer until ten years ago. CBers also seek out amateur radio in order to get away from crowded conditions.

What motivates a person to volunteer his or her own spare time to teach an amateur-radio class?

I asked this question of Arnold Benton, WA2AHB, who teaches novice and general theory and code to fifty potential hams, through the sponsorship of the American Radio Relay League and the Suffolk County Radio Club. (He is assisted by Art Greenberg, W2LH; Bob Reilly, WB2FHN; Bryson Davis, WB2BFE; and Sal Fiorentino, WB2TZE.)

Arnold is a physicist, working at the State University of New York at Stony Brook, Long Island, New York. He gave one succinct answer to my question: he was motivated by an impulse for public service.

Arnold has been a member of the Suffolk County Radio Club for many years, but his work as a physicist kept him too busy for much involvement in club activities. Still, he felt a desire to be of some service to the amateur community. Knowing that he was capable, it bothered him to be receiving stimulation and information from the club meetings, without giving something tangible in return. He knew that a class for prospective licensees was needed. There had not been a class offered by the club since the one taught by Dick Knadle, K2RIW, several years earlier, and Arnold felt that teaching new members and prospective hams was one of the responsibilities that should be borne by a radio club. But he also knew that he could not spare enough time to work up a teaching curriculum. So he kept his interest in teaching to himself.

Then circumstances worked together to propel Arnold behind the podium. The ARRL announced in its official organ, *QST*, that it would provide speakers, and materials of various kinds, to affiliated clubs. Suffolk County Radio Club qualified, and invited ARRL's Chod Harris, WB2CHO, to be a guest speaker. Chod spoke on the topic of "CB and Amateur Growth." He assured the membership that they should not be afraid of an influx of CBers into amateur radio, because the CBers who would be interested would be those who would make very good hams. They would simply need to be given accurate information in palatable doses to be initiated well.

Arnold remembered, as he listened to Chod Harris speak, that ARRL's President Harry Dannals had said it would be desirable to increase the number of radio amateurs. Arnold was convinced that CBers were good prospects for the amateur-radio community and he would be

"By the time the class had its first meeting, there were fifty-three people, at least two-thirds of them CBers."

just the person to teach them. If only he had time to work up the material!

But Chod Harris answered that, too. He had brought along samples of a curriculum prepared at ARRL, designed to teach prospective hams enough theory and code to pass the test for their licenses.

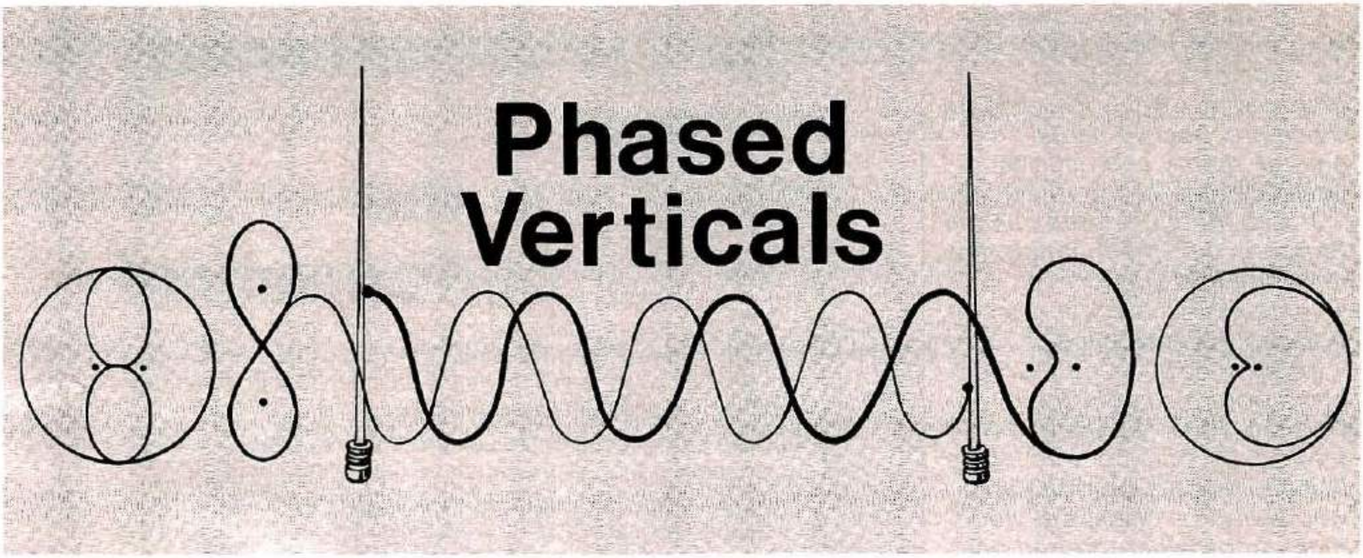
It was all that Arnold needed. Before he left the meeting that night, he had publicly volunteered to teach a class of prospective new hams.

Notices advertising the class were placed in the Harrison Radio Shops and in the Hall of Science in Flushing, Queens. People from the area who wanted a class, but who didn't know where to find one, were referred to Arnold. Word-of-mouth advertising brought more people.

By the time the class had its first meeting, there were fifty-three people, at least two-thirds of whom were CBers. It was clear to Arnold that he had found the right niche in which to fulfill his desire to be of service to the amateur community.

Not everybody is entirely pleased with the club's new image, though nearly everyone sees it as an improvement. Frank Tressa would like more possibility of a hands-on experience for new members. "But I have champagne tastes," he admits. "Ideally, we should have our own building and our own club hardware, not just club call letters. Then, new hams could have immediate experience to learn from, at each step of their development. As it is, our club is too sedentary. Most of us come to be entertained by speeches, instead of being active."

Partly to accommodate the influx of new members from among the CBers, SCRC offers classes for prospective hams. These are taught on a volunteer basis, on the teacher's own time. The Suffolk County Radio Club is not perfect. But with classes, good speakers and well-planned activities, it's a pretty well-rounded club. **HRH**



Phased Verticals

Some directivity makes life easier in a small yard

BY GENE ROBBINS, WA2FLN

As a Novice I used a trap dipole antenna. When I obtained my General-class ticket, I decided that a better antenna was in order — one that would provide some directivity and gain, and most important, one that didn't cost an arm and a leg. After talking with many friends and reading many books and articles, I decided that a two-element quad met all my requirements — except one. The cost of a tower, antenna, and rotator was more than I could spend on an antenna system. Since the quad was financially out of the question, I was almost resigned to staying with the trap dipole until I got into a three-way radio conversation with W1WSB and WA1EAJ, both of whom were using phased verticals.

How it all started

Phased verticals? Most comments I'd heard about vertical antennas were negative. Then I had a repeat radio contact with K2LV, an antenna engineer with one of the major radio and TV networks. He convinced me that phased verticals might be just the answer to my antenna problem.

Back to the books — the *ARRL Antenna Book* and Bill Orr's *Radio Handbook*. This plus a landline call to ARRL headquarters indicated that the phased vertical system was practical and relatively inexpensive.

I reviewed the technical data and decided to use a commercially available antenna. I bought two Hy-Gain four-band verticals that covered 10-40 meters. These antennas were type 14AVQ/WB. For 75-80 meters, I decided to use the trap dipole and a Matchbox antenna tuner.

The antenna site was a small side yard, 22 by 14 feet (6.7x4.3m), directly below the attic location of my station. The site was bounded on three sides by a chain-link fence; the longest section ran northeast-southwest.

Antenna spacing and transmission lines

Ideally the two vertical antennas should be spaced one-half wavelength apart at the lowest operating frequency. Minimum spacing should be at least one-quarter wavelength at the most-used frequency. The formula for physical spacing is

$984/f\ (0.25)$ for quarter-wave spacing (in feet)
$984/f\ (0.5)$ for one-half wavelength spacing (in feet)

where f is the frequency in MHz. For spacing in meters, the constant 984 should be changed to 3.02.

The transmission line between the antenna coaxial switch and each antenna must be equal in length and should be a multiple of one-eighth wavelength at the operating frequency. My basic design was for 20 meters, and available space limited spacing between the two verticals to one quarter wavelength at this frequency.

As indicated in **Fig. 1**, the antennas are spaced 17.5 feet (5.3m) apart. The transmission line, RG-8/U coax, is 56.8 feet (17.3m) long from the coax switch to each antenna. The transmission line is thus a multiple of one-eighth wavelength at 7.150, 14.300, 21.450, and 28.600 MHz.

The phasing line connecting the two transmission lines consists of two 5.7-foot (1.7m) sections of RG-8/U coax, which equals one-quarter wavelength at 14.300 MHz. (All line lengths should be based on the preferred band and frequency). The coaxial antenna switch, **Fig. 2**, is a five-position ungrounded switch manufactured by Barker and Williamson.

Phasing

As indicated in Fig. 2, on 20 meters for example, with the switch on **Position 1** (the north antenna), the south antenna lags this antenna in phase by 90 degrees. The strongest lobe of the signal therefore radiates south over a 180-degree area. (The opposite is true when the switch is on **Position 3** — the south antenna).

A smaller lobe also radiates from the back of the antenna; and on more than one occasion I've aimed the antenna south and received calls from W7s — WØs. The reverse also occurred with W4s and W5s. Initial signal reports in such cases have ranged between S4 and S7; but after switching to the correct direction, the reports changed to S6 to S9 and 10 dB. I've also switched antenna directions on purpose to get an idea of the change, and on one occasion the signal report went from S9 and 20 dB to S9 and 10 dB. The normal difference, however, is usually two S units.

Phasing line

Ideally you should have a one-quarter wavelength phasing line for each band; i.e., one each approximately 22.6 feet (6.9m), 11.4 feet (3.5m), 7.6 feet (2.3m) and 5.6 feet (1.7m), respectively, for 40, 20, 15, and 10 meters. Being slightly lazy, however, I used the same one-quarter wavelength line for 40, 20, and 15 meters. On 10 meters, however, I disconnected half of the line for one-quarter wavelength phasing on that band.

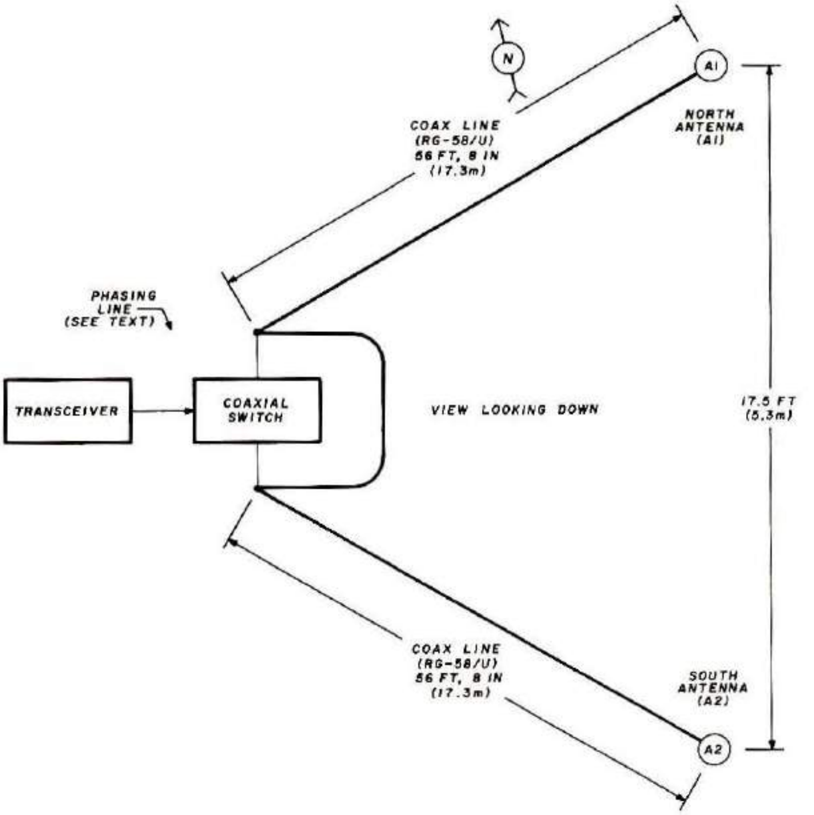


Fig. 1. Plan view of the phased-vertical antenna system. The vertical radiators are separated by one-quarter wavelengths at 20 meters and are fed by two equal lengths of RG-8/U coax cable, which are a multiple of one-eight wavelength at the bands of interest.

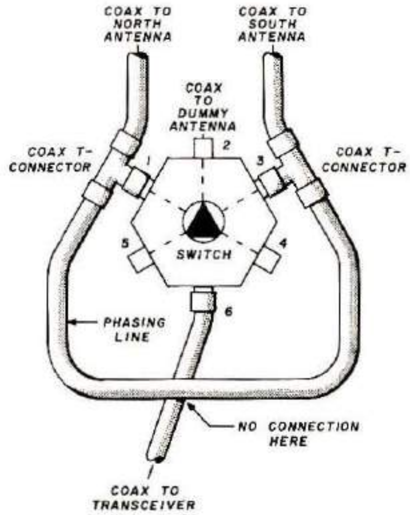


Fig. 2. Details showing switching and phasing-line arrangement for the phased-vertical antenna system.

Radials and swr

The instruction manual for the Hy-Gain antennas is well written and provides three options for construction. Whether ground or roof mounted, the antennas can be constructed for your preferred operating mode — CW, phone, or midband. My system was constructed using midband specifications with each antenna mounted on a TV mast 6.5 feet (1.2m) above ground.

Two radials per band per antenna were cut to the specifications in the manual, using 12-gauge (2.6mm) *Copperweld* wire. Because of limited frontal space and no space behind the antennas, all radials are parallel to the plane of the antennas and buried about 3 inches (77mm) below ground.

I've used this system, mounted 8 inches (204mm) off the ground without radials, and 3 feet (0.9m) off the ground with some radials in addition to my present setup. Signal reports, increased signal distance, and swr levels *suggest radials as a must* and as much height as practical for the antennas.

With the exception of the top portion of 10 meters, the swr on all bands is lower than 2:1 and in most cases is the same, regardless of which way the system is phased. There are some cases, however, where the swr will vary. At my location, the reasons for these variations are the negative influence of the chain-link fence, the close proximity of large trees, and a neighbor's garage. Representative swr levels are:

upon the desired signal-radiation pattern.

I have used this system since April of this year with only one recent 20-meter modification — a three-eighths wavelength phase line which produces a larger elliptical pattern than does a quarter-wave line. This change resulted in swr levels of 1.5:1 across the 20-meter band for both antennas. Signal reports,

Frequency (MHz)	North Antenna (swr)	South Antenna (swr)
7.100	1.5	1.4
7.250	1.3	1.3
14.100	1.5	1.8
14.300	1.8	1.8
21.100	1.1	1.1
21.400	1.1	1.0
21.100	1.4	1.3
28.400	1.4	1.3
28.600	1.5	1.4
28.900	1.6	1.6
29.200	2.0	2.0
29.600	2.1	2.1

Gain, referred to a single vertical quarter-wave radiator, is about 5.7 dB, with a 10-dB front-to-back ratio.

The cost of the total system — antennas, coax, coax switch, and all connectors, is about $200-225. The system can be built for less with home-brew antennas and RG-58/U coax cable.

The antenna configuration described is a basic end-fed phased vertical system which can be altered for any desired band by inserting or deleting sections of coax. For example, four 5.7-foot (1.73m) sections using PL-258 connectors will give you quarter-wave phasing on 40 meters. Two sections are needed for quarter-wave phasing on twenty meters, one on 10 meters, and a 7.6-foot (2.3m) length for quarter-wave phasing on 15 meters. These sections can also be used in a variety of combinations for different phasing, depending

although not numerous enough at this writing to adequately assess the modification, are very encouraging.

It should be kept in mind that experiences with any type of antenna system will vary for several reasons: in the final analysis, it really depends on what you want your system to do, and how much time and money you are willing to spend on building the system.

Does it work?

Yes — very well indeed! You won't compete with the big guns, but if band conditions are reasonable and the pileups aren't too unreasonable, you'll work all states and all the DX you like.

Although not a rabid DX hunter, I've worked, for example, HA, EI, G, EL, F, DJ, ON, MM/2 — 300 miles (483km) off the coast of Guatemala, EA, 6W, and YV stations, to name a few. **HRH**

DSI

DSI INSTRUMENTS INC.

Be the one who's on FREQUENCY!!

With your *DSI Counter*. . .save the shop cost of tweaking xtals. . . know your frequency. . .from 160 meters through 450 MHz. Now *DSI* offers *the most* counter for your dollar. Latest state-of-the-art technology. . .*DSI* advanced LSI design far exceeds outdated TTL. Go with the leader . . .buy a *DSI FREQUENCY* counter and *SAVE TIME & MONEY!!*

NOT A KIT

MODEL 3500 $139.95

500 MHZ Frequency Counter

- Includes 500 MHz Prescaler — Not an addon
- 7 Large bright — ½ inch LED Readouts
- Temperature compensated crystal timebase
- Accuracy 1 PPM Typ
- Sensitivity 50 MvRms 150 & 250 MHz 150 MvRms 450 MHz
- Gate time light
- No direct RF connection Required
- AC or DC operation
- 50 Hz to 500 MHz typ
- Comprehensive owners manual with complete accurate schematics
- Factory assembled & tested

MODEL 3600A $189.95
Includes oven timebase

600 MHz Frequency Counter

- Includes oven compensated crystal timebase
- Includes built-in 600MHz Prescaler-Not and addon
- 8 Large bright — ½ inch LED Readouts
- Two timebases 0.1 sec & 1. sec
- Resolution 1 Hz Direct 10 Hz Prescaled
- Sensitivity 20 MvRms @ 150 & 220 MHz 100 MvRms 450 MHz
- Accuracy .5 PPM over temperature
- Oven light & Gate time light
- Automatic Decimal point placement
- NO DIRECT RF CONNECTION Required.
- Comprehensive owners manual with complete accurate schematics
- AC or DC operation
- 50 Hz to 600 MHz Typ.
- Factory assembled & tested

Use it in the car or on the bench. . .take it to the repeater site. . .high-impact case. . .light weight—but rugged. . .Designed with the latest readily available LSI, CMOS, Schottky, Mecl-integrated circuits.

NEW PRODUCTS

- 250 MHz 7 Digit Battery operated hand held counter $109.95 available mid-January.
- 3½ Digit Bench Degital Multi-meter AC or Battery operated $99.95 available mid-February.

Visit us at ORLANDO, FLA. ARC ARRL Convention Feb. 17, 18, 19
Booths 37, 39, 40 (Sheraton Towers)

Strongest Warranty in the Counter Field. ONE Year Parts and Labor we pay the return shipping plus. . .if not satisfied, return in ten days for full refund. . . Dennis Romack. . .WA6OYI.
VP-Marketing, DSI

TO ORDER *CALL* COLLECT (714) 565-8402

Name ____________ Call ____________
Address ____________
City ____________ State ____________ Zip ____________
Phone: ____________
Order: ____________
☐ Check enclosed ☐ Please send more information on your full line of Instruments and Accessories.
☐ BankAmericard ☐ MasterCharge ☐ VISA ☐ R.E.
Credit card # ____________ Card expiration date ____________ Signature ____________

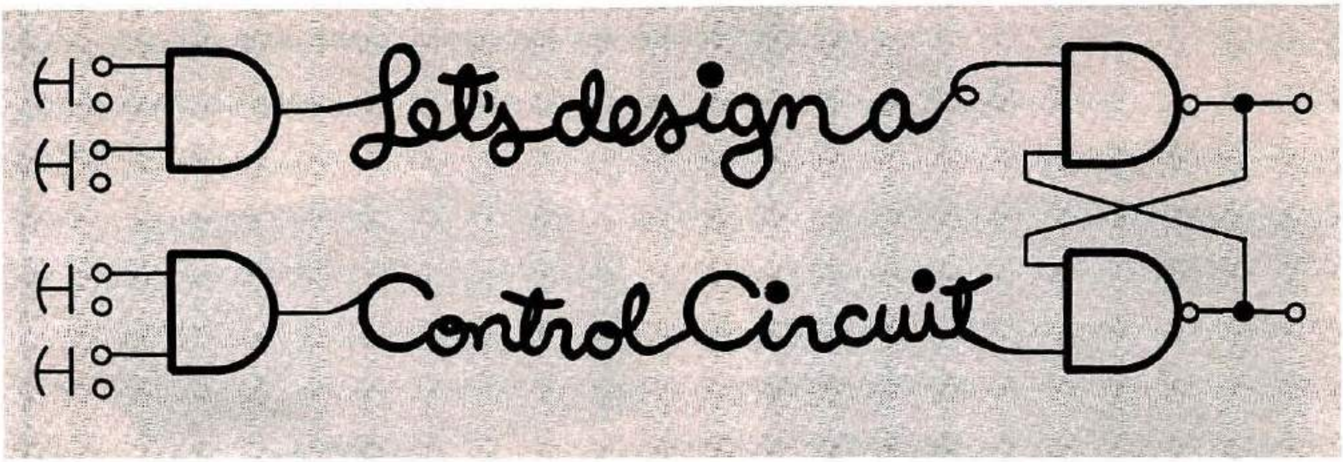
DSI INSTRUMENTS INC.
Div. Diversified Security Ind, Inc.

We pay shipping charges anywhere in the U.S.A. UPS Brown or P.P. — CA Residents please add 6% state sales tax.

- American Express
- MasterCharge
- Bank of America
- VISA

7914 Ronson Road No. G, San Diego, CA 92111

More details? Ad Check page 86.



You can do a lot of things and have a lot of fun with a few inexpensive components, and simple circuits, and you don't have to be a logic expert

BY PAT SHREVE, W8GRG

You can design and build even the most complex control circuits using separate components — resistors, capacitors, diodes, and transistors — if you want to take the trouble. It's a lot easier to take advantage of the work others have done to preassemble useful packages of these components in convenient modules called integrated circuits. These modules are miniaturized electronic building blocks designed to perform various functions someone wanted to do over and over again in different control applications. The most useful ones in the repeater controls and other automatic systems I've built are some common gates, a flip-flop, a counter, a timer, and a simple tone decoder. Let's take a look at them and consider how to approach putting them together.

A gate uses a combination of input signals to produce the signal you want at its output. If *high* inputs cause a *high* output you have an AND or OR gate; if *high* inputs cause a *low* output it's a NAND or NOR gate. As you will see when we start putting components together, NAND and NOR gates can be used to make a flip-flop, which is a self-latching switch that can be turned on and off by remote control. The other type of flip-flop I use a lot is an IC especially designed for the purpose, with control inputs that increase its versatility. The counter I use most is called a *divide-by-ten counter* because its output makes one complete cycle for each ten cycles of its input. It also has control inputs that make it useful for many things besides counting.

Gates, flip-flops, and counters require a signal input to produce a useful output. The timer does not; it is an oscillator that can be made either to run free or to start and stop in response to an external signal. The tone decoder has an oscillator whose frequency can be set by external components and frequency-matching circuits that can compare an external frequency with the internal oscillator frequency. An output that indicates when the two frequencies match can be used to control other logic components.

Each of the ICs we're going to work with has an identifying number. Don't worry about differences in the letters that precede and follow the number; an LM567 made by National Semiconductor works just like an NE567 by Signetics; Texas Instruments SN7400 is the same as a Motorola MC7400, National DM7400, or Signetics N7400 for the circuits with which we'll be working. Get the ICs that cost the least. You'll find it much easier to design and experiment with your own control circuits if you use a *"breadboard"* like the one shown in the photographs, into which ICs and other components can be plugged and connected together without soldering.

In many parts of the country the National Weather Service broadcasts continuous weather reports, forecasts, and bulletins on 162.40 or 162.55 MHz. Special bulletins and warnings are inserted as needed, preceded by a 1050-Hz tone lasting several seconds. Some of the more expensive monitor receivers have a tone-controlled squelch circuit that permits the receiver to stand by in silence until alerted by a tone, when the audio output is turned on. You can add a similar feature to one of the less-expensive weather monitors with a tone decoder, two NAND gates, and a relay.

The tone decoder is an 8-pin 567 IC. The top view of the rectangular plastic encased model is shown in **Fig. 1**; you may also find it in a metal can with the terminals arranged in a circle. It requires a maximum of 15 milliamperes of current at +5 to +10 volts supplied to pin 4; pin 7 is the negative ground terminal. The internal oscillator frequency is determined by the value of the resistor connected between pins 5 and 6 and by the capacitor between pin 6 and ground. Filter capacitors are connected to pins 1 and 2 to limit the desired frequency response. When a tone of the frequency to which the internal oscillator is set is applied to pin 3, output pin 8 is internally grounded. With no tone, or one of a different frequency at pin 3, the internal resistance between pin 8 and ground is very high.

The tone transmitted by the National Weather Service is only a few seconds long, so we need something to keep the audio on after the tone is gone. We can do this with part of a 7400. This IC is shown in **Fig. 2**. The circuit diagram of a self-latching flip-flop made with two of the NAND gates is shown in **Fig. 3**. Each gate has a low output (0.4 volt or less) when both its inputs are high and a high output (2.4 volts or more) if either input is low. Remember, when you work with TTL logic like these ICs, an input is high if connected to a source of 2 volts or more, *or if it is not connected at all*. To be sensed as low it must be pulled low by being connected to ground or a voltage of less than 0.8 volt (such as the low output of another IC).

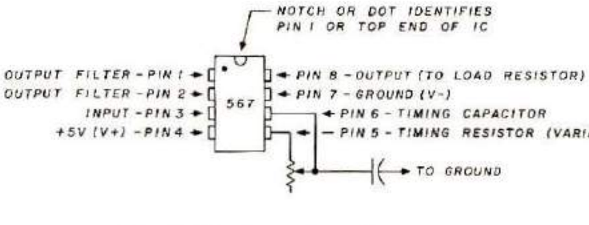


Fig. 1. LM567 or NE 567 Tone Decoder IC.

Now let's look at **Fig. 3** and see what happens as we connect a low to first one input and then the other. Note that the output of each gate is connected to one of the inputs of the other gate. Starting with the other inputs (pins 1 and 5) high, when pin 1 is pulled low pin 3 will go high and pin 4 will also be high. The two highs at pins 4 and 5 drive pin 6 low and this low applied to pin 2 will hold pin 3 high even if the low is removed from pin 1. The only way to get pin 3 low and pin 6 high is to make pin 5 low.

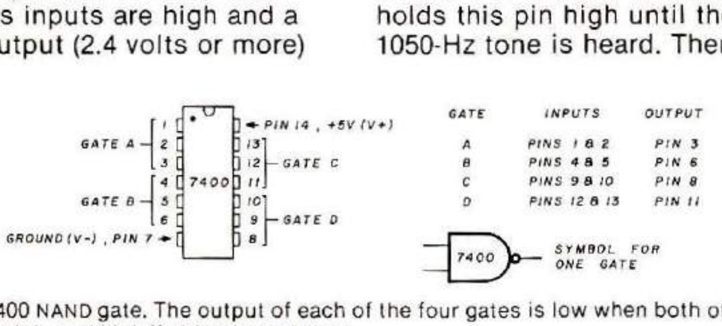
To make the tone-alert circuit for the weather monitor radio, you can connect the tone-decoder output to one of the flip-flop inputs and use its output to operate a relay in the receiver speaker circuit. The complete diagram is shown in **Fig. 4**. The 3.3k resistor connected to pin 8 of the 567 holds this pin high until the 1050-Hz tone is heard. Then pin 8 goes low, pin 3 of the 7400 goes high, the 2N3904 transistor conducts, and the relay closes.

The transistor is used because most relays require a current too large for the IC to handle. Once the relay is closed by the tone, it stays closed until you push the button that grounds pin 5 of the 7400.

Using a timer

Suppose instead of having the receiver remain on until you turn it off, you want the control circuit to give you time to hear the weather bulletin and then return the receiver to standby. You can add a simple timer based on an NE555 that will give a wide range of time intervals. Its pin arrangement is shown in **Fig. 5**. It will operate on any supply voltage from +5 to +15 volts, drawing less than 15 mA. Its cycle time is determined by two resistors and a capacitor. One resistor is connected between V+ and pin 7, another between pins 7 and 6, and the capacitor from pin 6 to ground. The larger the values of these components, the longer the timing cycle. A variable resistor connected between pins 7 and 6 will allow adjustments.

You can use the 555 alone as a timer, triggering and resetting it with suitable inputs to pins 2 and 4. To time an interval of 10 seconds or more you'll need a large capacitor, however, and accurate setting of the time can be difficult. I prefer to let the 555 timer run faster and use one or two counters to get the timing I want.



GATE	INPUTS	OUTPUT
A	PINS 1 & 2	PIN 3
B	PINS 4 & 5	PIN 6
C	PINS 9 & 10	PIN 8
D	PINS 12 & 13	PIN 11

Fig. 2. 7400 NAND gate. The output of each of the four gates is low when both of its inputs are high, and high if either input is low.

The 7490 divide-by-ten counter I use is shown in **Fig. 6**. It operates on a +5 volt supply, drawing about 50 mA. If a series of pulses is applied to input **A** (pin 14), output **A** (pin 12) will go from low to high on the first pulse, back to low on the second, high again on the third, and so on. A similar pulsed signal applied to input **BD** will cause output **B** to alternate between low and high on successive pulses, output **C** to go high on the second pulse and low on the fourth, and output **D** to go high on the fourth and low on the fifth.

You can see from this sequence that the 7490 is really two separate counters on one IC: a divide-by-two in section **A**

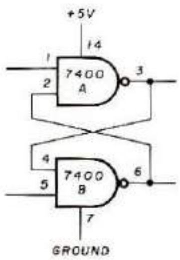


Fig. 3. Flip-flop made from two NAND gates.

and a divide-by-five in section **B**. Connecting output **A** to input **BD** makes it a divide-by-ten counter.

The reset inputs make it possible to use 7490 counters in all sorts of control circuits. Pins 6 and 7 are called NINE RESET inputs because when both are in a high state (+2 volts or more, or not connected at all, remember?), outputs **A** and **D** will be high and outputs **B** and **C** will be low regardless of the condition of the other inputs. This is the state the counter would be in after the ninth pulse if it had started counting at zero. If either pin 6 or pin 7 is low and both ZERO RESET inputs are high, all outputs will be low. The counters will count the pulses at inputs **A** and **BD** *only* when one or both of each

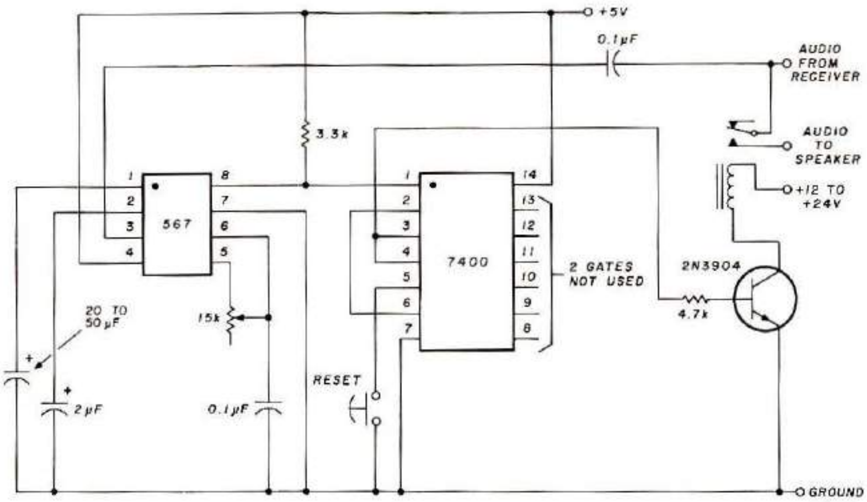


Fig. 4. Weather monitor ALERT TONE decoder with manual reset.

pair of reset inputs is low.

To make the timer that will shut off your weather monitor audio output after you've had time to hear the bulletin we combine the timer, counter, and tone decoder as shown in **Fig. 7**. The timer drives a divide-by-100 counter made of two 7490 ICs; the counter controls a relay in the speaker audio circuit.

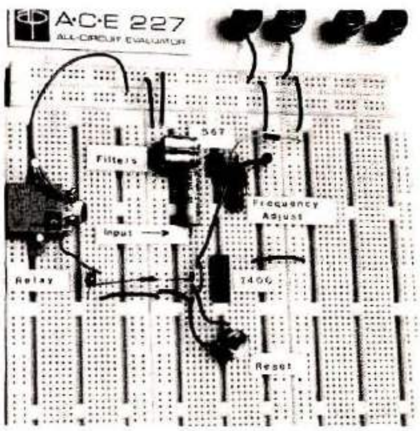
The 567 decoder starts the counter when the alert tone is received. The trigger of the 555 timer, pin 2, is connected to pin 6, which makes the timer run continuously as long as the ALERT/MONITOR switch is in the ALERT position. Its frequency can be varied between 6 and 0.7 Hz by the 1-megohm control, which will give a time interval of from 15 to 140 seconds.

The tone decoder is adjusted with its 15k control to respond to the 1050-Hz tone transmitted by the National Weather Service.

When the unit is first turned on, the counter will run until it reaches a 99 count.

Remember I said the **A** and **D** outputs, pins 11 and 12, are high at the count of nine. These four highs are combined by the two 7409 AND gates to make one high, which is conected to one pin of each reset pair on both counters. The other pins of the reset pairs are also high, so the counter will stop in the NINES position. The high output of the AND gates also turns on the transistor, which opens the normally closed relay contacts and mutes the speaker.

The decoder tone input is connected to the receiver audio output ahead of the relay. When the 1050-Hz alert tone is received, the 567 output at pin 8 changes from high to low, which resets both counter ICs to zero and starts them counting. They continue to count after the tone stops and pin 8 of the 567 goes high, because as soon as the NINES are cleared the AND gate output (connected to the other reset inputs) goes low. The relay is



Breadboard layout of the latching flip-flop circuit shown in **Fig. 4**.

also released, turning the speaker on for the planned interval.

You can start the timing cycle without a 1050-Hz tone by pushing the START button,

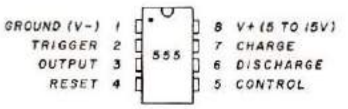


Fig. 5. NE 555 Timer IC.

which acts like a low output from the decoder. If you want to monitor the broadcast continuously, turn the switch to MONITOR. This action stops the timer by grounding its reset input, pin 4. Now, when you push the START button, the counter has nothing to count, and the relay contacts will stay closed until the switch is put back in the ALERT position.

You can connect the outputs of the two 7409 gates together because they have what we call "open collector" outputs — there's no internal current source to the collector of the output transistor. Don't try this with logic outputs where there's an internal current source or you are likely to burn up an IC!

Single-tone control

There's another variation of these simple control circuits with which you can have fun. Suppose you have a remote receiver and you want to turn it on and off and also switch frequencies over a single pair of wires. Many do this with *Touchtone* controls, but this requires decoders for seven tones. Let's see how we can do it with less.

The key component is the flip-flop with the special control inputs I mentioned earlier. The one I use most is a 7473, shown in **Fig. 8**. It's actually two flip-flops on a single IC, with common V+ and ground pins. Like the other ICs we've been working with, it requires a +5 volt supply and draws about 50 mA.

Each of the flip-flops has six terminals. The two marked Q and $\overline{Q}$ are outputs. $\overline{Q}$ is called NOT Q, because whatever the Q output is (high or low) $\overline{Q}$ is the opposite. In what is called the SET condition, Q is high and $\overline{Q}$ is low; in the RESET state Q is

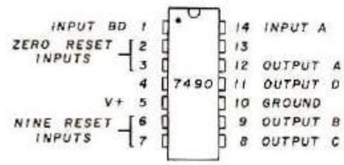


Fig. 6. 7490 Counter IC.

low and $\overline{Q}$ is high. Grounding the CLEAR input resets the flip-flop regardless of the state of the other inputs.

In normal operation, the flip-flop will change state from RESET to SET or SET to RESET each time the CLOCK input makes a complete cycle from low to high and back to low, as long as the J and K inputs are either high or open. If the J input is low the flip-flop cannot change from RESET to SET: if K is low it can be changed from SET to RESET only by grounding

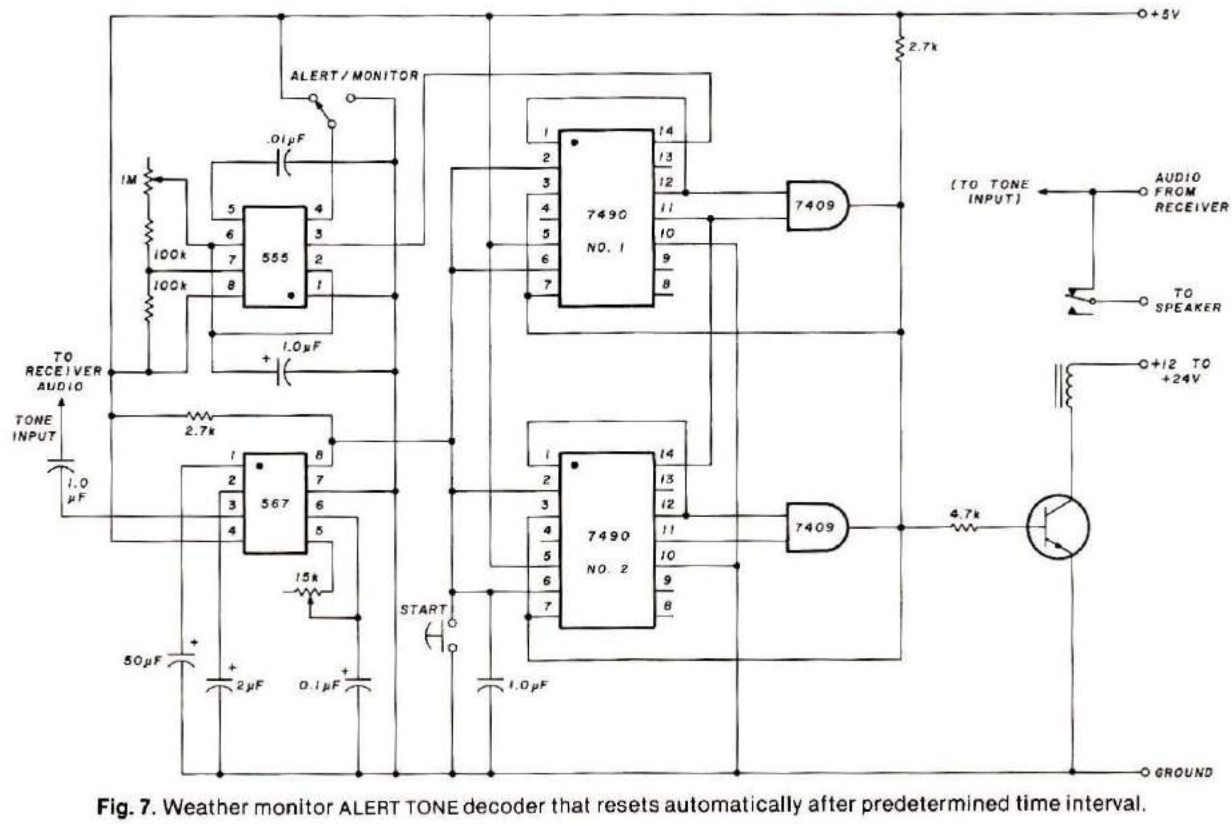
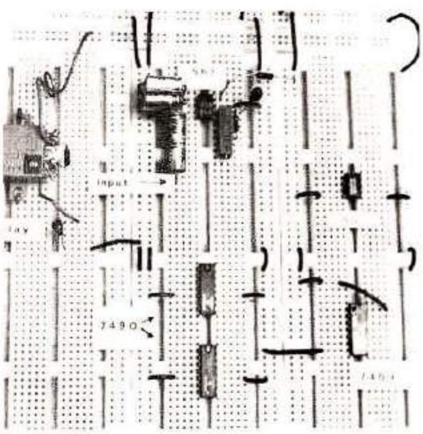
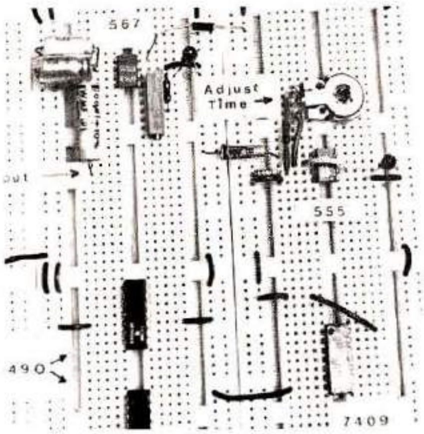


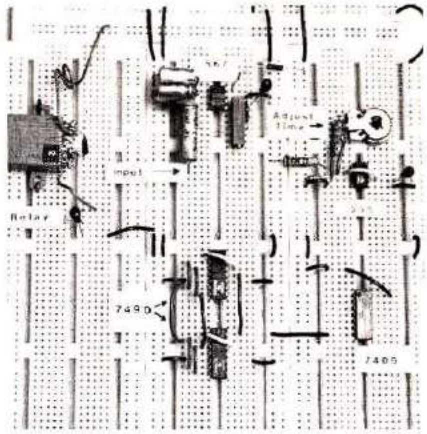
Fig. 7. Weather monitor ALERT TONE decoder that resets automatically after predetermined time interval.



567 and relay left from circuit of **Fig. 4**. Other integrated circuits and their power connections are in place.

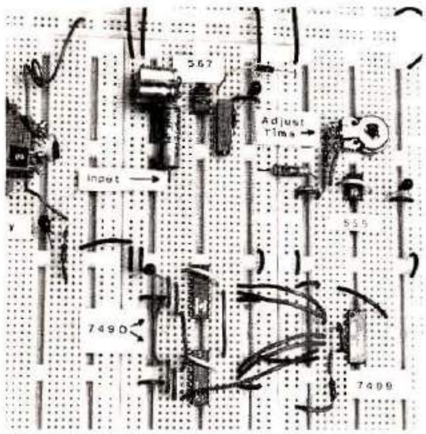


Timer components and wiring in place.

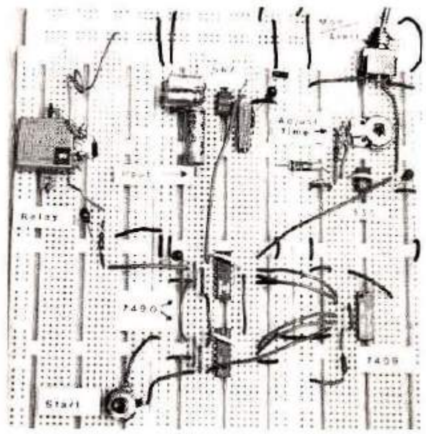


Counter interconnections added.

Step-by-step construction of the circuit shown in **Fig. 7**.



Counter outputs connected to the 7409 gate



The complete decoder and timing circuit

the CLEAR input, not by a clock pulse. The internal circuits look at the state of the J and K inputs when the clock moves from low to high and carry out the instructions when the clock moves back to low.

You can see how easily you can turn a receiver on and off with a single tone — just use the decoder output to drive the flip-flop clock input and use the Q output to operate a relay driver transistor like the one in **Fig. 7**. The first tone signal will set the flip-flop activating the relay. Repeating the same tone will reset the flip-flop and drop the relay.

If you want to use a second tone to change the receiver frequency, the circuit of **Fig. 9** will select one of four, each repetition of the tone moving the receiver from one frequency to the next in a predetermined sequence. The trick is to wire the outputs of each flip-flop to the control inputs of the other: $\overline{Q}_A$ to J_B and Q_A to K_B; Q_B to J_A and $\overline{Q}_B$ to K_A. I've separated the parts of the IC and drawn the lines a little heavier than the others in the diagram to make it easier to follow these connections.

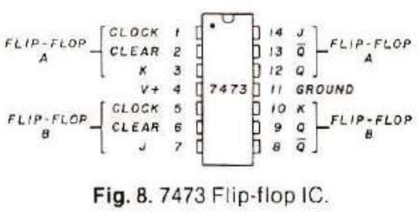


Fig. 8. 7473 Flip-flop IC.

Starting with both flip-flops reset, both $\overline{Q}$ outputs are high and both Q outputs are low. On the first clock cycle flip-flop B can be set because its J input is high. Flip-flop A cannot be set because its J input is low. On the second cycle A can be set; B cannot be reset. On the third cycle B resets, A does not, and on the fourth cycle A resets to bring us back to where we started.

Each of the four possible output combinations is wired to an AND gate, so that one of the four gate outputs is high while the three others are low.

You can use these outputs to select the crystal for the frequency to which you want to listen. If you need one low output and three high, use a NAND gate IC. The 7400 NAND gate shown in **Fig. 2** and the 7408 AND gate have internal current sources to their outputs; a 7403 NAND has the same pin arrangement as the 7400 but with open collectors like the 7409. Light-emitting diodes (LEDs) can be connected to the outputs of a 7408 or 7400 to show how the circuit operates.

In theory you can connect the output of a 567 decoder directly to the clock input of a 7473 flip-flop. In practice the 567 output is likely to chatter a little each time it detects a tone, and the "bounces" can make your 7473 skip a few stops. Rewiring the filter on pin 1 as shown in **Fig. 9** helps, but a 555 between the 567 and 7473

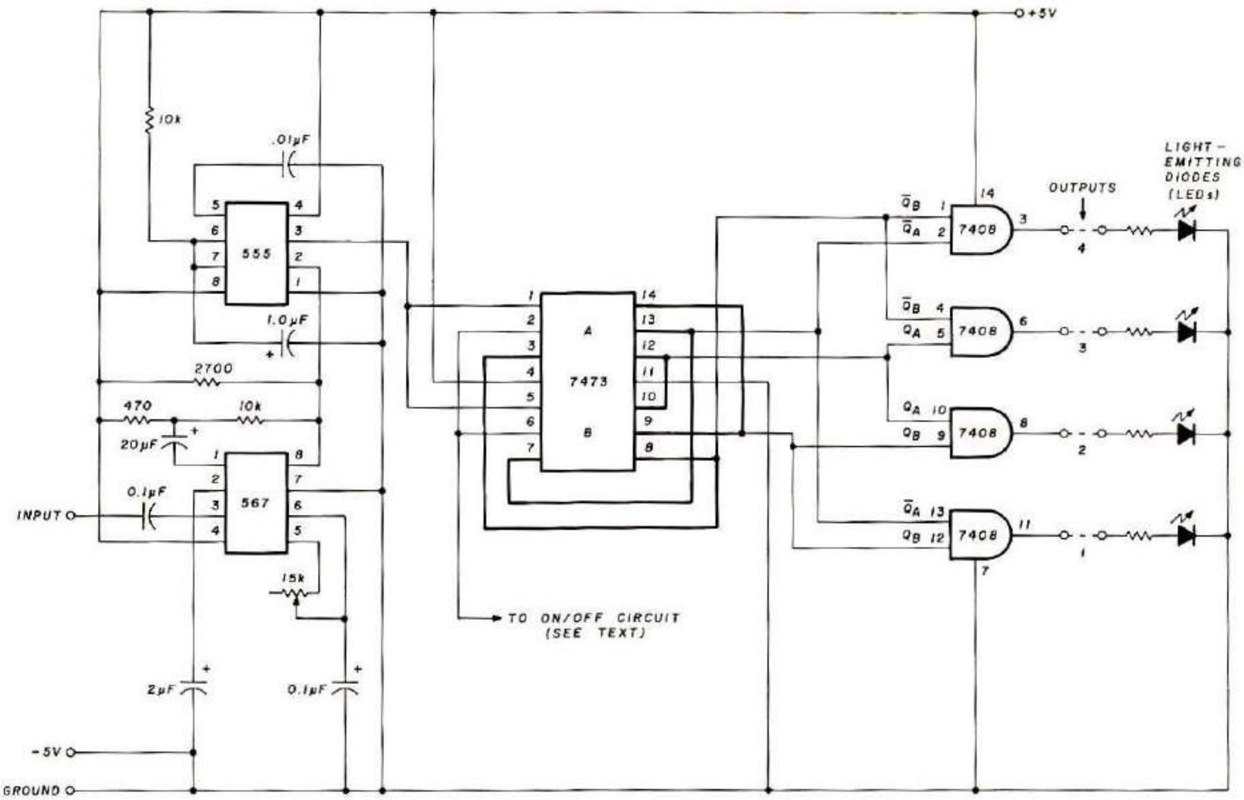
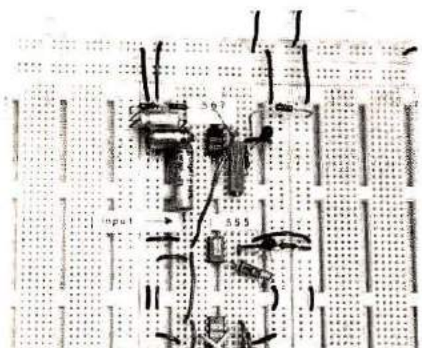


Fig. 9. Circuit to select one of four outputs by repetitive transmission of a single tone.

can save you a lot of grief and frustration. The 555 is connected as a one-shot, not a timer. It will be triggered by the 567 output, and by the time it completes its cycle, the 567 will have settled down. The 7473 gets only one clock pulse



Circuit to select one of four sequential functions by repetition of a single tone, shown in **Fig. 9**.

for each tone you transmit.

You can connect additional tone decoders to the same signal source. If you use another tone and flip-flop to turn the receiver on and off, you can connect whichever of its outputs is low in the off condition to pins 2 and 6 of the 7473 in **Fig. 9**. Thus the frequency control will be reset to position 1 when you turn the set off, so you'll always know where you are starting when you turn it on.

You can use a *Touchtone* pad for a tone generator. It's not necessary to decode both of the tones the pad generates each time a button is pressed. You can tune one decoder to 697 Hz and it will respond to a 1, 2, or 3; the other decoder can be tuned to 852 Hz and will respond to a 7, 8, or 9.

Construction and power supply

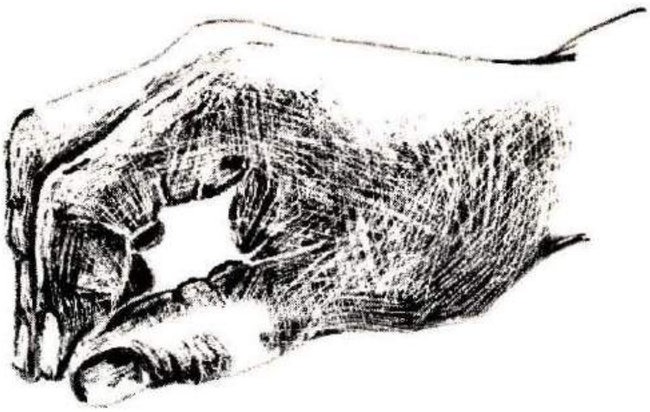
The circuits shown in the illustrations were built on an integrated circuit breadboard I use for testing new circuits. Several sizes are available in kit form and fully assembled.*

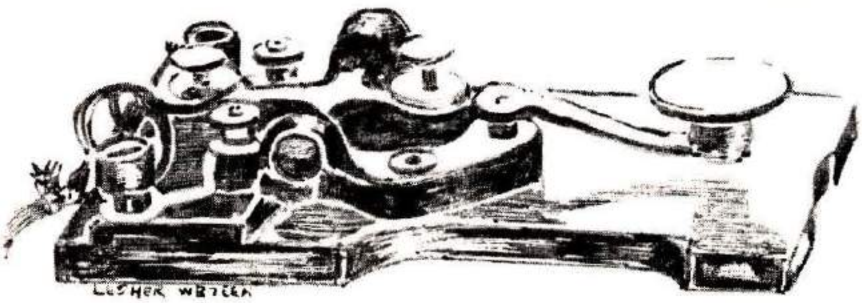
When you assemble your working unit you can lay out a PC board or use the "dead bug technique" — stick all the ICs upside down on a flat surface with epoxy cement and connect the pins with wires. I think PC boards are easier.

Practically any reasonably well-regulated power supply capable of delivering 5 volts at 500 mA will power these circuits. The simplest supply, particularly if you're going to control a radio that runs on 12 volts, is to use one of the monolithic regulator ICs such as an LM109 (Signetics), LM123 (National Semiconductor) or comparable unit. The same regulators can be used on ac with an inexpensive transformer and diode rectifiers. **HRH**

*A P Products, Inc., Painesville, Ohio 44077. (Prices from $18.95 - $79.95; or call toll free 800-321-9668 for a dealer near you.)

Learning The MORSE CODE





BY ROLAND ONFFROY, W7JE

A combination of just two sounds, at the same musical pitch, will enable you to say anything you like

Yes, it's true that you have to be able to send and receive Morse code to get an amateur license, but let's forget about that part of it for a moment. Learning something because you *have* to isn't nearly as much fun as if you *want* to. So, come on, pretend you don't even want to become a ham — you want to learn the language so you can understand what they are saying, just like when you were little and heard some grown-ups using big words. Or, you were riding on the bus one day and heard the couple behind you talking in Spanish — how you longed to understand what they were discussing. No, you don't *have* to learn this language I'm going to tell you about, but wouldn't it be great fun to just sit by as your husband (wife, brother, friend, etc.) is using that code stuff, and then catch the look on his face when you told him what he had just said! Good! That's what I thought you would say.

Your decision is a big step forward because you *are* going to learn a *language*. It is an unusual and very special language in that it is one with which you can speak to people in all the countries in the world; it's the only *international language*. It is used on land, in the air, and under the sea, and with it you can express any idea you wish to convey, and understand what some unknown person in a far-off land is trying to tell you. Think of *that*!

Naturally, this language has to be simplicity itself. Do you realize that there are only two sounds? Yes, just two sounds — a dit and a dah — and these are at the same musical pitch.

With these two sounds, you can spell out any word in the dictionary. You can transmit the entire stock market report, today's baseball scores, or a famous recipe from an Italian chef. Further, you can translate into Morse the French, Italian, Spanish, and other dictionaries, and speak to these people in Morse and understand them. It is a fine language and you will enjoy it.

You can convey a foreign expression even though you can't pronounce it. And, what's more, the stranger, whom you may never meet, will understand you. The person to whom you speak in Morse may be a lonely operator in a ship in a remote ocean, or a pretty girl in a country you have never heard of.

Well, now that you've made the decision, let's learn what it's all about. The two basic sounds are both letters of our alphabet. The dit is an **E**, and the dah is a **T**. In our Morse language there are just forty combinations of these sounds. My job is to tell you how to recognize these combinations. Here we go.

Combining the sounds

The two letters, **E** and **T** comprise 2/40 or 0.05 (5 per cent) of the total; let's put them together. There are four combinations: you have didit, **I**; dahdah, **M**; or, you can combine them as didah, **A**; or dahdit, **N**.

You now have learned 6 letters. Three of them are vowels, and three of them are consonants. These comprise a big 15 per cent of the total. So, you see, you are making fine progress.

Having vowels and consonants opens up new possibilities — the formation of *words*. For example, two-letter words **AT**, **IT**, **ME**. Keep going with three-letter words: **ATE**, **MIT**, **EAT**. Try some four-letter words: **MITE**, **MATE**, **NEAT**. See how easy it is? In the five minutes you have been reading these lines you have learned to communicate, that is, you are using your new Morse-code language, and with only six letters!

With just these six combinations, only 15 per cent of what we learn, you can make bigger and bigger words; **ANTENNA**. Try making some of your own from these six letters.

Listen, don't look

At this point, I must caution you to learn the letters by sound. You must *not* associate a letter with the mental image of a string of dots and dashes.

If you hear a letter which you don't recognize and find yourself searching for its visual image, you are committing a grave and common mistake, made by most beginners. Why? Because after you have translated the sound of a letter to its visual image, you must then mentally search all the visual images of the letters you have learned in order to identify the particular image with its letter. This takes time (which you cannot afford). Meanwhile, another two or three letters are coming through and you are not ready to receive them. The correct way is to learn each letter by its own distinctive *sound*, skipping the mental image completely.

Here I will digress for a moment from the alphabet, and look at some other characteristics of this new language.

First, the length of the character. A "dah" is three times as long as a "dit." You now bring into play your code practice oscillator (CPO) and key, because you want to learn to send as well as to receive. Send a series of dits, about 20 of them. See if you can space them evenly. Make sure they all sound like "dits." Now, send about 20 "dahs." Are they three times as long? Send a single "dit" for **E**. Now, a single "dah" for **T**. Repeat this several times, then try to combine a "dit" and a "dah." It should sound like "didah," (**A**), not "dit" and "dah," (**E** and **T**). Try sending an **N**, "dahdit" (not "dah" and "dit"). Keep going. Send an "I" which sounds like "didit," and an **M**, which is "dahdah." Repetition is the name of the game.

When you meet a new person for the first time, who has an unusual name, do you generally ask him to repeat it, and perhaps even spell it? The same principle applies to code. These new sounds are all strangers to you, and you learn them by repetition. Send the letters as fast as you comfortably can, but they must be distinct and unmistakable. If you are sending two T's, don't push them so close together that they sound like M.

You may put as much time between letters (up to four hours, if need be!), as you wish, but each letter must be distinct and recognizable. (Notice that I said "time between the letters," not the *elements of the letters*.)

More combinations

Let's rush on. If you put the dits and dahs into 3-element combinations you'll find there are 2 to the 3rd power, or 8. All of these eight combinations are used in the Morse alphabet and make up a big 20 per cent of it.

Here are the letters using 3 elements:

dididit	S	dahdahdah	O
dididah	U	dahdahdit	G
didahdah	W	dahdidit	D
didahdit	R	dahditdah	K

Notice the ones on the left. They all start with dits while the ones on the right start with dahs. We have also picked up our two remaining vowels, **U** and **O**. Also notice that I still have not given you a visual image.

Now you can learn to recognize the sounds of these letters. Let's compare the sound of a 2-element letter, **A** (didah), with a 3-element letter, **W** (didahdah). Listen again; didah, **A**; now, didahdah, **W**. Hear the unmistakable difference? Let's go on to other letters. Listen to **I**, didit (2-elements), and **S**, dididit, (3-elements).

Many beginners tell me, "They all sound alike to me." The sounds are not alike; it's just that the beginners have not learned to listen. The similarity is there, but each letter is unique. Sort of like the difference between A and A flat on a piano.

One of the biggest "hang ups" in learning Morse code is "turning letters over." Students will hear an **A** (didah), and copy it as **N** (dahdit). They often copy **U** for **D**, **G** for **W**, etc. Make sure you don't fall into this trap. Learn each letter thoroughly; take all the time you need, but learn it.

Two letters in this three-element group are easy to learn. The "odd" element is in the middle: **R** (didahdit) and **K** (dahdidah). Do not "turn them over." Now combine them with other 2-element and 3-element letters you have learned so far. At this point there is no reason why you can't start putting words together. You now have all five vowels and nine consonants.

Do you realize that so far we have learned fourteen letters out of forty, which is a whopping 35 per cent of our total? Not too bad, eh? Who said Morse code is difficult?

Syllables and accents

The words in any language can be broken down into *syllables*. Generally, one of these is accented. Take the word "possible." It is a 3-syllable word with the accent on the first syllable: pos-si-bul.

Let me point out that the letters in the Morse code have similar rhythms, with the stress or accent on one of the elements. For example, say the word "audit." The accent is on the first syllable (au-dit). Notice its similarity to the letter **N** (dahdit). Take the 3-element letter **D** (dahdidit). It has the same rhythm as the word om-e-let.

When you study Morse letters with four elements, which I'll tell you about shortly, you will notice that the letter **L** (didahdidit) has the same rhythm as the word in-ad-e-quate. The letter **Y** (dahdidahdah), sounds the same as the word a-vo-cado. Each letter in the Morse code has its own lilt or rhythm. At first, some of the letters *may* sound alike but if you listen carefully, you will discover that each has its own unmistakable sound which positively identifies it alone. This might be called the "fingerprint" or "trademark" of the letter.

Meanwhile, back at the farm, you can tackle a new group of letters. These letters contain 4 elements. If you combine the two sounds into all possible groups of 4 elements, the result is 2 to the 4th power, or a total of 16 combinations. Here is where you get a break; out of these sixteen combinations Morse code uses only twelve. (You curious old timers who have been reading this, see if you can figure out the combinations which are not used. That will give the beginner time to get ahead.)

Probably the easiest way to learn these letters is to list them as we did the 3-element letters, with the ones starting with the dits on the left, and those starting with the dahs on the right:

dididit	H	dahdahdidit	Z
dididah	V	dahdahdidah	Q
dididahdit	F	dahdididit	B
didahdahdah	J	dahdididah	X
didahdahdit	P	dahdidahdah	Y
didahdidit	L	dahdidahdit	C

I still haven't given you a visual picture of the dots and dashes, and I forbid you to make one.

How do you learn this group? It's easy! Notice the first letters on the left, **H**, **V**, and **F**; they all begin with dits. Now use your hand key and oscillator. Say the sound of the letter as I have written it and send it with your key.

If you have a cassette recorder, record your own keying. Send and record this first group of 4-element letters as many times as it takes to satisfy yourself. Resist the temptation to study the other groups until you learn this group thoroughly. Play back your recording. Are you satisfied with it?

At this point, I recommend that you bring in an amateur friend to verify your work. There are many tapes of good Morse code on the market. Listening to some commercial tapes will instill in your memory what good code really sounds like (how sweet it is!).

Now, another most important point: the letters should be sent as fast as you can handle the key. Put lots of space between the letters, but make each letter fast and distinct. Avoid sloppiness. When I listen to Novice bands, I am amazed how the new operator will spend two to three seconds sending each letter. He drones on for what seems like hours, just sending a report, his name or QTH. It's enough to make you climb a tree!

If you learn to recognize the letters sent at a rapid rate *now*, later you will pick up code speed by closing the gaps between the letters. Thus, you will not have to re-learn the sound of a letter sent at a higher speed.

I hope you haven't forgotten that "way back when," you learned the five vowels. Make up some words using these three new 4-element letters and record them on your tape recorder. Some examples are: HAVE, SAVE, HEAVE, HEART, FAVORITE. I also encourage you to use the 2-element and 3-element letters in your words. The new 4-element letters will contrast sharply with the others. After you have recorded about 50 words, destroy the paper you've written them on. Put everything away for today. Do *not* play the words back. Sleep on it. Play these words back tomorrow. Can you read them? Can anybody else "get the message?" Do you get *my* message? *Words* are the name of the game. We *communicate* with *words*, not letters. The letters simply make up the words. Words are made up of syllables, and sentences are made with words, figures, and punctuation marks. This is how your new Morse language all goes together.

Sentences express ideas, thoughts, feelings, and other information. This is *communication*. It works in all languages, including Morse, and it has been around for a long, long time.

When you have mastered the four 4-element groups (12 letters in all) you are due for a pat on the back. You have learned the alphabet completely; it should make you feel good. Just think, there are no more letters to learn.

The next group of characters to study will be the numbers. They each contain five elements, but are put together so beautifully that you'll enjoy learning them.

Numbers one through five all start with dits:

1 contains 1 dit and 4 dahs;	didahdahdahdah
2 contains 2 dits and 3 dahs;	dididahdahdah
3 contains 3 dits and 2 dahs;	didididahdah
4 contains 4 dits and 1 dah;	dididididah
5 contains 5 dits;	dididididit

Numbers six through ten all start with dahs:

6 contains 1 dah and 4 dits;	dahdidididit
7 contains 2 dahs and 3 dits;	dahdahdididit
8 contains 3 dahs and 2 dits;	dahdahdahdidit
9 contains 4 dahs and 1 dit;	dahdahdahdahdit
0 contains 5 dahs;	dahdahdahdahdah

Notice the beautiful ascending order of lead elements. Caution: do *not* learn these by counting the elements. Learn to recognize them by their *sound*; by the ratio of lead to end elements.

Learn these, five at a time: first 1 through 5, then 6 through 10. Now for some fun: you are going to send just numbers. Get your telephone book, your key and CPO, and your cassette recorder. Pick any page and start recording telephone numbers only. Notice the beautiful rhythm of these numbers and how nicely they flow as you send them. Again I must warn you not to turn them over. Remember 1 to 5 start with dits, and 6 to 0 start with dahs.

The numbers are probably the easiest part of the Morse code, and there are ten of them which is 25 per cent of our total.

As before, send and record about 50 telephone numbers. Then close the book. You might jot down the page number for later use. Take a break and come back to it in a couple of hours, or tomorrow. Play your work back. Can you read it? No? Well, try the recording bit again.

Now another word of warning. You probably will find that some of the numbers are very similar to the letters you have learned.

For example, you may copy a "J" for a "1" or an "H" for a "5." This is the same situation you had when you learned to distinguish the letter "I" from "S," and "M" from "O." The solution is practice and repetition. Constant practice and very close attention to the characteristic sounds will aid you in overcoming this hurdle.

You have now reached 90 per cent of your goal. You still have to know how to punctuate. There are four of these characters. Punctuation marks contain six elements. The easiest is the period (.), didahdidahdidah, like three of the letter **A** sent all in one group.

Next learn the comma (,) dahdahdididahdah. How do you send a question mark (?)? Easy, it's dididahdahdidit. Sort of like the comma turned inside out. Still with me?

The last character to learn is the slant bar, which is used in fractions and "portable" designations; dahdididahdit (/). Try sending some fractions with this one.

Well, now you have learned the language, and can eavesdrop on the hams as much as you like. And, if just by chance, the bug really bites and you get the itch to become a ham — well, you're already ahead of the game. Just study a few questions about rules and simple theory, then go take the exam.

In your Novice exam, code will be sent at five words per minute. If you count an average of five letters per word, this figures out to 25 letters in 60 seconds. You have almost 2.5 seconds to recognize and write down each letter (60/25 = 2.4 seconds). I recommend that you use long-hand (legibly, of course); it's faster than printing and is more normal for you. Copy any 25 consecutive letters out of 125 in the 5-minute test and you're home free.* It's a nice feeling.

Well, there you have it; you've learned the alphabet, you can make words and sentences, and you can communicate. And that is what Morse code is all about.

I'm looking forward to seeing you on the air; I'd like to be your "first Idaho" contact. **HRH**

*In the comprehensive exam that is currently in use by all FCC examiners, you just listen to (and copy) a tape recording of a somewhat typical contact between two amateurs, sent at the 5-word-per-minute rate. You then answer multiple-choice questions about things that were said in the exchange. Volunteer examiners *may* use the comprehensive method, although most find it easier to follow the regular "send for one minute to see how you copy" technique. **Editor**

REFLECTIONS of FR

DenTron antenna tuners give you the freedom to experiment with antennas. Whether you're using a beam or a vertical, a piece of wire or the gutters on your motel room; our tuners provide continuous tuning 1.8 - 30 MHz.

Let DenTron amplifiers give you the power to stand out in a crowd and be heard around the world. The MLA-1200 and MLA-2500 are an exceptional source of power, offering understated luxury exemplifying pride in design and workmanship.

A The MT-3000A $349.50. The MT-3 professionalizing his station. It is a It has built-in dual watt meters, and (a) enables you to by-pass the tune systems.

B NEW! The MT-2000A 3KW PEP $19 on the amateur market. It includes f protection grounding switch, and t feedline.

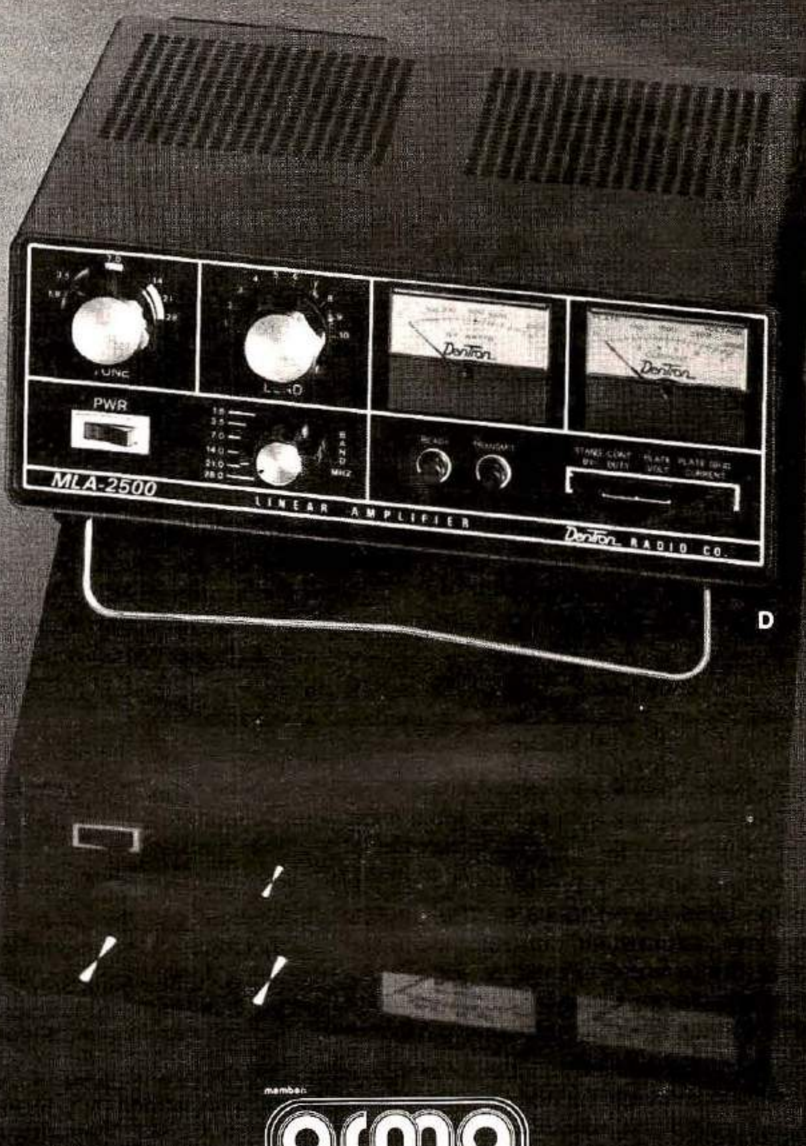
C NEW! MLA-1200 $399.50, external shares many fine features with its distinctive features of its own. It em 1KW DC. It incorporates the same 1200 watt linear amplifier on the m

D MLA-2500 $799.50. The MLA-2500 amateur amplifiers. It was designed ates precision plus power. Coast a watts DC input on CW, RTTY, or S contained power supply, and it fea

EEDOM and POWER

DenTron
Radio Co., Inc.
2100 Enterprise Parkway
Twinsburg, Ohio 44087
Phone (216) 425-3173

C



D

)0A was designed for the serious ham interested in
rugged antenna tuner that easily handles 3KW PEP.
a built-in dummy load. The antenna selector switch:
direct; (b) select the dummy load or 5 other antenna

.50. The MT-2000A is the most versatile, basic tuner
nt panel coax bypass switching, front panel lightning
e ability to match coax, random wire, and balanced

C supply, $159.50, DC supply $199.50. The MLA-1200
mous big brother, the MLA-2500, but also has a few
loys a single Eimac 8875, running 1200 watts PEP or
ilt-in ALC as the 2500. The MLA-1200 is the smallest
rket, great for your mobile home, boat or car!

one of the world's finest high performance military
or the discriminating buyer who knows and appreci-
ong with a full 2000 watts PEP input on SSB, 1000
TV. The heart of the MLA-2500 is a heavy duty, self
res 2 Eimac 8875's.

member
arma
amateur radio manufacturer's association

QUESTIONS & ANSWERS

Capacitors and Farads; Inductance and Henrys

BY THOMAS McMULLEN, W1SL

Last month I talked about devices that caused energy to flow (in the form of electron movement), such as chemical cells or batteries, or a wire moving through a magnetic field. Thus you are able to change the energy of chemicals or of a waterfall (or steam pressure) into a form that you can use in your home for heating, lighting, cooking, and, of course, amateur radio.

Then I told you about a device that controlled or limited the flow of electrons — the resistor. Some resistors are used to turn electrical energy into heat or light, but a more important use in electronics is to allow a change of electron flow to cause a change of potential (voltage) across that resistor.

Now I'll tell you about a couple of energy-storage devices that are very important to electronics — in fact, it would be hard to imagine how we could get along without them. These are the *capacitor* and the *inductor*. In earlier days, these were called *condensers* and *chokes* (the term choke is still used in certain applications). Let's take a look at how they work.

Capacitors

Capacitors come in many shapes and sizes, but for the purpose of explanation I'll assume that a basic capacitor is made of two flat plates (electrodes) separated by air (the dielectric), see **Fig. 1**. If you connect a capacitor across a source of voltage the surplus electrons present at the minus terminal see this as a possible path to get to the other terminal, so they begin a temporary rush to get there. Fortunately (for us), they come to the barrier (dielectric) and cannot get across to complete their journey. Naturally, when the electrons at the negative terminal started their rush, the whole circuit was affected, so that the electrons in the plate that was connected to the positive terminal had to move too, and this created a shortage of electrons (positive charge) on that plate. When the electrons have stopped moving into or out of the capacitor, the capacitor is said to be charged up — it has the same potential across the plates that is present at the source to which it is connected.

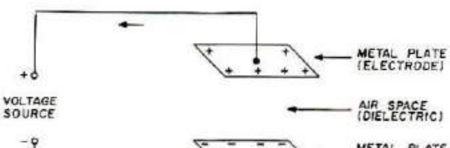


Fig. 1. A capacitor consists of two metal electrodes with a form of insulation or dielectric between them. Electrons cannot cross the non-conductor, and become "stored" on the plates. A change in size of the electrode, or a change of composition of the dielectric, will change the amount of electrons that can be stored.

Obviously, the larger the area of the two plates that are facing each other across the gap, the more electrons can accumulate there, and the greater the "charge" the capacitor will accumulate. Note that the *voltage* cannot be greater than the source, but the increased number of electrons can allow a greater momentary *current* flow out of the capacitor when its stored energy is released. A more dense dielectric, such as oil, will also increase the charge-storing ability.

The unit of capacitance is the *Farad*, named after Michael Faraday, a British chemist and physicist. He died in 1867, so you can see that this electron stuff is nothing new. A Farad is a pretty large unit, being equal to a charge of 1 coulomb at a potential of 1 volt. (A coulomb is equal to the quantity of charge transferred in one second by a current of one ampere — which, if you remember, is 6.25×10^{18} electrons per second.) A Farad is so big that, for practical purposes, it must be broken down into fractional units for use in radio calculations. The two most common units are the *microfarad* (μF), or 0.000001 Farad; and the *picofarad* (pF), or 0.000000000001 Farad. There is also a *nanofarad* (nF), which is 0.000000001 Farad. The nanofarad is not often used in this country but does appear in foreign literature, notably from European countries.

Of course, there are exceptions to the following, but in general the higher values of capacitors are used in power-supply filtering circuits (1 μF, 4.7 μF, 10 μ F, or 100 μF, etc.) and usually are polarized. That is, they are constructed with voltage-sensitive dielectric and

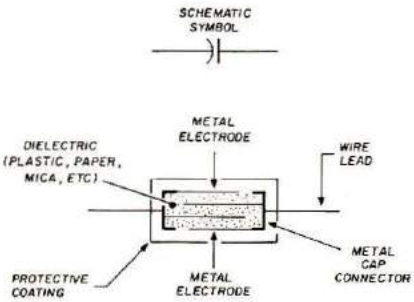


Fig. 2. A cutaway view of a capacitor that might be used in modern audio circuitry. The electrodes are often made of metal foil, thinner than paper, rolled up into a cylinder with the dielectric between the layers of foil. The dielectric can be treated paper, a film of plastic, or sometimes a layer of oxide on the foil. If the dielectric is voltage-sensitive, the capacitor is said to be "polarized," meaning that the voltage must be applied in the correct direction to prevent damage to the capacitor. Polarized capacitors will have a + and − sign to signify which lead is which. In schematic diagrams, the curved portion of the symbol is usually toward the ground, low-impedance, or more minus point.

electrode material so they can be made of small size. Because of this construction, the voltage must be of the correct polarity to avoid damage to the capacitor. These are usually called *electrolytic* capacitors, or in the jargon, *electrolytics*, see **Fig. 2** and caption.

Values of capacitance in the range of .01 to 1 μF are often found in audio circuits as bypass, coupling, or tone-control elements. Most radio-frequency circuits use values that are less than 0.01 μF, that is, 0.001 μF or 1000 pF, 500 pF, 10 pF, etc. How the correct value for a circuit is determined is a process that we'll not get into here — you can learn about that when you get ready for a higher class of license.

Parallel and series

Capacitors that are connected in parallel simply add in value; a capacitor with a value of 1 μF, hooked in parallel with another of the same value, is just as effective as a single one that had a value of 2 μF. However, capacitors in series have the opposite effect — the total value is always less than the smallest. A 1 μF capacitor in series with another of the same value is equal to a single unit with a value of 0.5 μF. There are some handy formulas that enable you to work out the exact value of effective capacitance in a circuit. For parallel capacitors:

$$C_{total} = C1 + C2 + C3 + C4,\ etc. \quad \textbf{(1)}$$

For *two* capacitors in series use the simplified formula:

$$C_{total} = \frac{C1 \times C2}{C1 + C2} \quad \textbf{(2)}$$

If you have more than two capacitors hooked in series it becomes slightly more complex:

$$C_{total} = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4}}\ etc. \quad \textbf{(3)}$$

Let's work out a couple of examples just to see how it's done. You have two capacitors hooked in series, one of which is 4 μF, the other is 3 μF. According to formula (2), 4 x 3 = 12; 4 + 3 = 7; 12 ÷ 7 = 1.714 μF, which is smaller than the smallest, just as theory predicts. How about three capacitors? Let's try it. (This should be easy for those who have calculators). Assume that the capacitors have values of 1, 4, and 5 μF: $\frac{1}{1} = 1$; $\frac{1}{4} = 0.25$;

and $\frac{1}{5} = 0.2$; $1 + 0.25 + 0.2 = 1.45$.

As the final step,

$1 \div 1.45 = 0.689$ μF,

again smaller than the smallest.

There are two important things to remember here: first, the total capacitance is always less than the smallest for series capacitors, and second, the voltage across each capacitor is proportional to the *total capacitance* divided by the value of the *individual capacitor* in question. If you think about it a moment you'll see that you cannot exceed the supply (source) voltage, so each capacitor must share the total. Since the capacitance (amount of electrons that can be stored) is different in each capacitor, then each will be allotted only that share of the total which it can safely store.

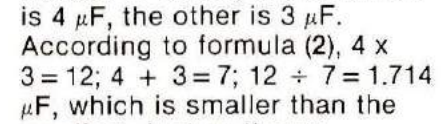


Fig. 3. A current (electron) flow through a wire sets up a magnetic field around the wire. If you grip the wire in your left hand, with your thumb pointing in the direction of current flow, your fingers curl around the wire in the direction of the north pole of the magnetic lines of force. A compass placed on the wire will indicate the lines of force by aligning its pointer with the field, at right angles to the wire.

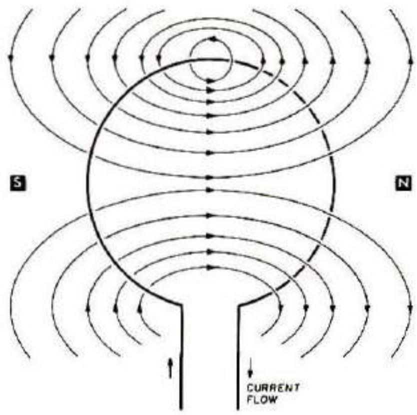


Fig. 4. If the wire carrying a current is looped in a partial circle, the magnetic lines of force are more concentrated on the inside of the circle.

Inductors

Now I'll tell you about another energy storage device, the *inductor*. It stores energy by means of a *magnetic field*, whereas the capacitor stores it in the form of electrons. In part seven of this series I mentioned that electrons at rest have a magnetic field that is effectively cancelled by that of the nucleus, but that when an electron is forced to move, the field is no longer cancelled, but extends outward from the path of the electron. This can be proved by placing a compass on top of a single piece of wire, and then connecting the wire to the terminals of a battery. Caution: if you want to try it use only a flashlight cell or two and wire

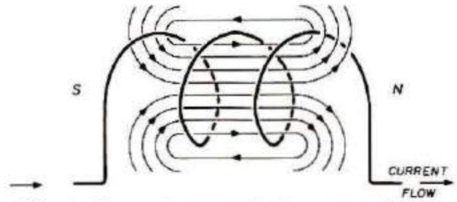


Fig. 5. Several turns of wire, wound in a coil with a hollow center, will greatly concentrate the lines of force inside the coil.

of approximately no. 18 size; a battery that has too much stored energy, or wire that is too small, would result in the heated wire causing damage or even a fire. Don't hold the wire to the terminals very long or you'll drain the battery in a hurry — a lot of current is flowing through the wire to set up a strong magnetic field. The compass needle should move until it is at right angles to the wire. **Fig. 3** shows the direction of the polarity of the magnetic lines of force.

When several turns of wire are wound in close proximity to each other, then the lines of force are concentrated in the core or hollow within the coil, see **Figs. 4** and **5**. You can verify this by winding several turns around a hollow tube and connecting the ends of the wire to the battery again (the wire must be insulated with fabric, plastic, or enamel). Your compass should show a strong field at the end of the winding, a weaker field by the side, and of opposite polarity as you move the compass to the other end of the coil. You can also reverse the connections to the battery to make the compass needle turn around.

There are two things going on here which you cannot easily determine with the compass because they are happening too fast. The first thing is that when current tries to flow through the wire, it starts to set up a magnetic field around the wire. However, there is another turn of the same wire nearby, and when that magnetic line of force begins to cut across that wire, it has the same effect that moving the wire through a magnetic field does: it causes a flow of electrons. When the wires in the coil are wound in the same direction, and adjacent to each other as shown in **Fig. 6**, the direction of electron flow created is *opposite* to that which you applied in the first place! This is called *counter* emf, or reverse electromotive force. As long as the magnetic field is increasing, cutting across the adjacent turns, it will create this counter emf, making it difficult for the electrons from the source to get through.

However, the field will eventually reach a point where it is no longer moving, if the source is steady direct current, and no more counter emf will be generated. As long as the current flow is steady, and the field stands still, nothing further will happen. But let's disconnect the source and see what happens. Without a supply of electrons to move through the wire, there is nothing to sustain that magnetic field around the wires or coil, and it begins to collapse. Now, this gets interesting: the collapsing field

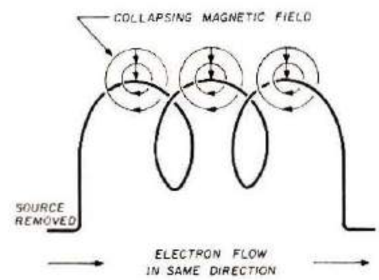


Fig. 7. When the electron flow from the source is discontinued, there is nothing to maintain the magnetic field around the wire. It must therefore collapse inward to the wire, and in doing so it cuts across the wires again, but in a direction opposite to what it did when energy was applied from the source. This creates an electron flow in the *same direction* as that from the source, thereby returning stored energy from the magnetic field to the circuit.

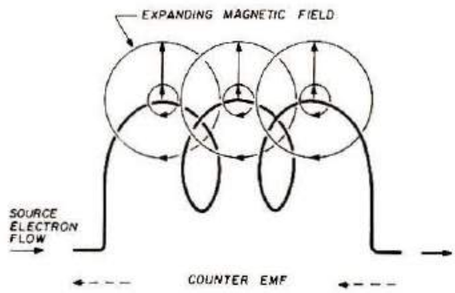


Fig. 6. When a magnetic field starts to build up in a coil, the lines of force cut across adjacent wires, which creates an electron flow that *opposes* the flow from the source. The emf from the source is greater, so it eventually overcomes the counter emf from the coil.

is again cutting across the wire, but in a direction *opposite* to the one before. Once again it is creating a movement of electrons, but this time *the flow is in the same direction as the flow from the source* while it was connected! In this manner the energy that was stored in maintaining that magnetic field is released back into the circuit. Of course the circuit must be complete for the electrons to move, but for purposes of clarity I have omitted the return path from the drawing. Normal electronic circuits would have several resistors, coils, capacitors, or other devices that would use the power supplied by the collapsing field. The one important thing to remember about an inductor is that it *resists change*: it tries to maintain the *status quo*. When you apply voltage to try to force a current through it, it fights that change, but, when you remove the voltage and let the electrons stop, it doesn't want that to happen either.

The unit of inductance is the henry, which is abbreviated **H**, and the letter **L** is used to represent inductance in mathematical formulas. The unit is named after the American physicist Joseph Henry (1797-1878), who did much pioneering work with electromagnetic phenomena.

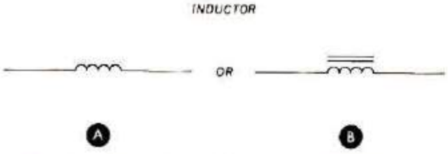


Fig. 8. The schematic symbol for an inductor is a series of loops, representing the turns of the wire in it. If it has two bars adjacent to the turns, it has a metallic core, usually of iron or an iron compound. This helps to concentrate the magnetic field inside the windings.

Strictly speaking, a henry is that amount of inductance which will produce an electromotive force (emf) of one volt when the current through it is varied at the rate of one ampere per second. A henry is a rather large unit, and inductors with a value of several henrys are used in power-supply filters, audio circuits, and transformers. **Fig. 8** shows the schematic symbol for an inductor. Fractional units (millihenry or mH, microhenry or μH) are used in radio-frequency work.

Inductors are referred to as "chokes" in many instances — a term that was derived from their ability to "choke off" or stop any *changes* in the current flow, such as hum, ripple, ac, or abrupt variations, and allow steady dc to pass. In radio-frequency circuits chokes stop the rf energy but allow the dc to pass. In this manner they keep the rf confined to the part of the circuit where it belongs, but prevent it from getting into the power supply or audio sections, where it can cause great mischief. A power-supply choke is a heavy thing, consisting of a great number of turns of large-diameter wire, wound on an iron core (which concentrates the magnetic field). An rf choke is wound with many turns of small-diameter wire, usually without a metallic core, or perhaps with a very small one of powdered iron or ferrite.

When inductors are hooked in series, their values add, just as is the case with resistors. Also, when they are connected in parallel, they behave in the same way that resistors do, *i.e.*, if two 1-H inductors are placed in parallel, their effective value is 0.5 H. In both cases it is assumed that there is no mutual coupling between them; the magnetic field from one does not intercept the other.

Incidently, a prime example of the energy in a stored magnetic field being returned to the circuit is in the ignition coil that is used to fire a spark plug in gasoline engines. When the points open, the current ceases to flow from the battery through the coil; the magnetic field collapses, creating a surge of electrons through the windings, which is stepped up by the high-voltage secondary winding. The voltage produced is so high that it will jump across the gap in the spark plug, igniting the fuel mixture. The capacitor across the open points provides a temporary storage facility for the rush of electrons from the collapsing field. If the capacitor is missing, open, or otherwise defective, the voltage from the coil will be too weak to jump across the spark-plug gap.

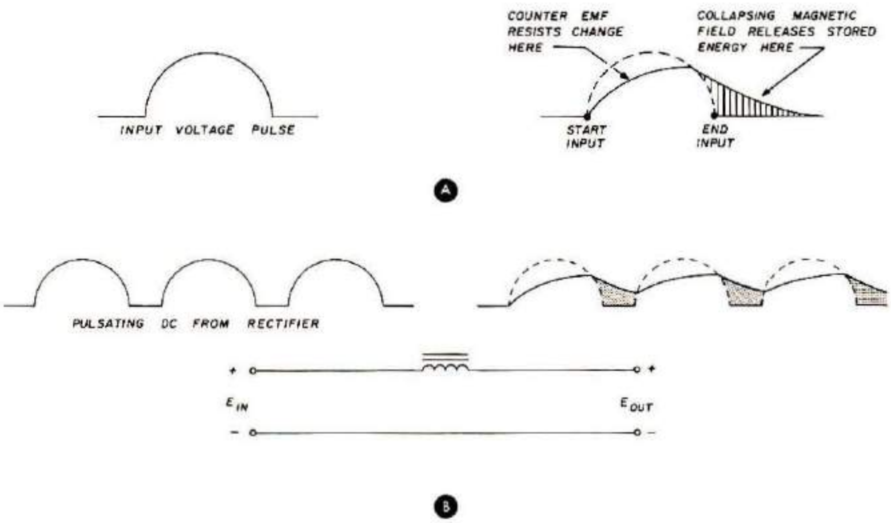


Fig. 10. As an energy storage device, the inductor performs in a manner similar to the capacitor, except that it has not reached a maximum storage point until a large part of the input pulse has gone through it. It, too, releases the stored charge back into the circuit.

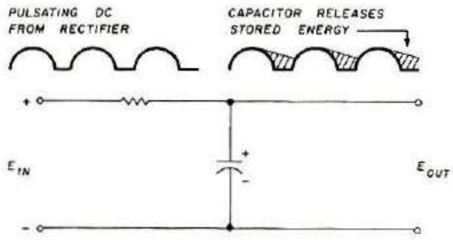


Fig. 9. A capacitor is an energy-storage device that finds great use in power supplies, among other things. It "charges up," or stores electrons, during an applied input pulse, then releases the stored energy after the pulse has stopped.

Combinations of L and C

Inductance and capacitance can be teamed up to provide a lot of benefits in electronic circuits. The easiest to visualize is in a power supply. This is a good circuit to work with because things happen slowly enough (60 to 120 times per second) that an experimenter can see what is happening by using an inexpensive oscilloscope. Inductors and capacitors work at radio frequencies up into the billions of cycles-per-second, but it is difficult (and expensive) to build instruments that will monitor what they are doing.

The output from a rectifier (**Fig. 9**) is a series of pulses of one polarity. In the case of a positive-voltage supply, the pulses all start from a zero reference and extend upward in the positive direction. This is what we call pulsating dc. If you attempt to use this as a source of voltage for any circuits, you would hear a very loud buzz or hum in the speaker or earphones, caused by the current flow starting and stopping with each pulse out of the supply.

Obviously, what is needed is an energy-storage device that will capture part of the energy from each pulse and release it when there is no pulse — in effect maintaining a steady supply of electrons for our circuits. Enter the two energy storage devices I have just told you about — inductance and capacitance! A capacitor connected across the output of the rectifier will store some of the electrons from each pulse, and release them after the pulse has stopped (**Fig. 9**). An inductor in series with the flow of electrons will oppose the flow for part of the pulse, then release some energy after the pulse has stopped, similar to the action of a capacitor, see **Fig. 10**. The combined action of the capacitor and the inductor tends to smooth out the overall flow of electrons so that instead of a series of pulses, you now have direct current that has a very small amount of ripple on it. Usually, a second capacitor at the load end of the inductor will remove almost all of that ripple, **Fig. 11**, so that your circuits work without that loud and annoying hum or buzz. A few super-sensitive circuits require a voltage that has almost zero ripple on it, and special filters have been developed for this purpose. You will not need to worry about that type of circuit for your Novice exam, however.

Enough of this expounding on theory and the like. How about a couple of questions to see if you got anything out of what I just told you.

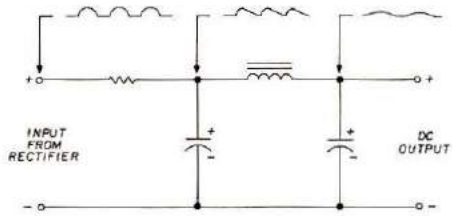


Fig. 11. By combining the effects of capacitance and inductance, the pulsating dc from a rectifier can be turned into almost pure dc for use in electronic circuits. The resistor at the input to the circuit is to prevent excessively heavy surges of electron flow when the circuit is first turned on. This is only a very small part of the uses for capacitors and inductors; they fit into almost every facet of electronics, including transmitters, receivers, oscillators, microwave devices, and even antenna circuits.

The unit of capacitance is the

(a) Joule
(b) Watt
(c) Farad
(d) Ohm

If you answered (c), you are right. Oh, yes, by some strange coincidence, the letter **C** is used in calculations involving capacitance. Another question:

A choke with a value of 0.001 henry is the same as

(a) 1 millihenry
(b) 1 microhenry
(c) 10 picohenrys
(d) 100 picohenrys

In case you've mislaid the issue of *Horizons* that had the prefix equivalents table in it, I'll remind you that milli is equivalent to 10^{-3}, therefore 1 millihenry is 0.001 henry, which makes (a) the correct answer.

I have spent quite a bit of time on the function of capacitors and inductors because they are so very important in electronics, and an early understanding of what they do will make life so much easier for you. In the next of the series I'll tell you about some of the components used in receivers, transmitters, power supplies, and the like; no deep theory, just gadgets. **HRH**

ME-3 microminiature tone encoder

Compatible with all sub-audible tone systems such as: Private Line, Channel Guard, Quiet Channel, etc.

- Powered by 6-16vdc, unregulated
- Microminiature in size to fit inside all mobile units and most portable units
- Field replaceable, plug-in, frequency determining elements
- Excellent frequency accuracy and temperature stability
- Output level adjustment potentiometer
- Low distortion sinewave output
- Available in all EIA tone frequencies, 67.0 Hz-203.5 Hz
- Complete immunity to RF
- Reverse polarity protection built-in

$29.95 each

Wired and tested, complete with K-1 element

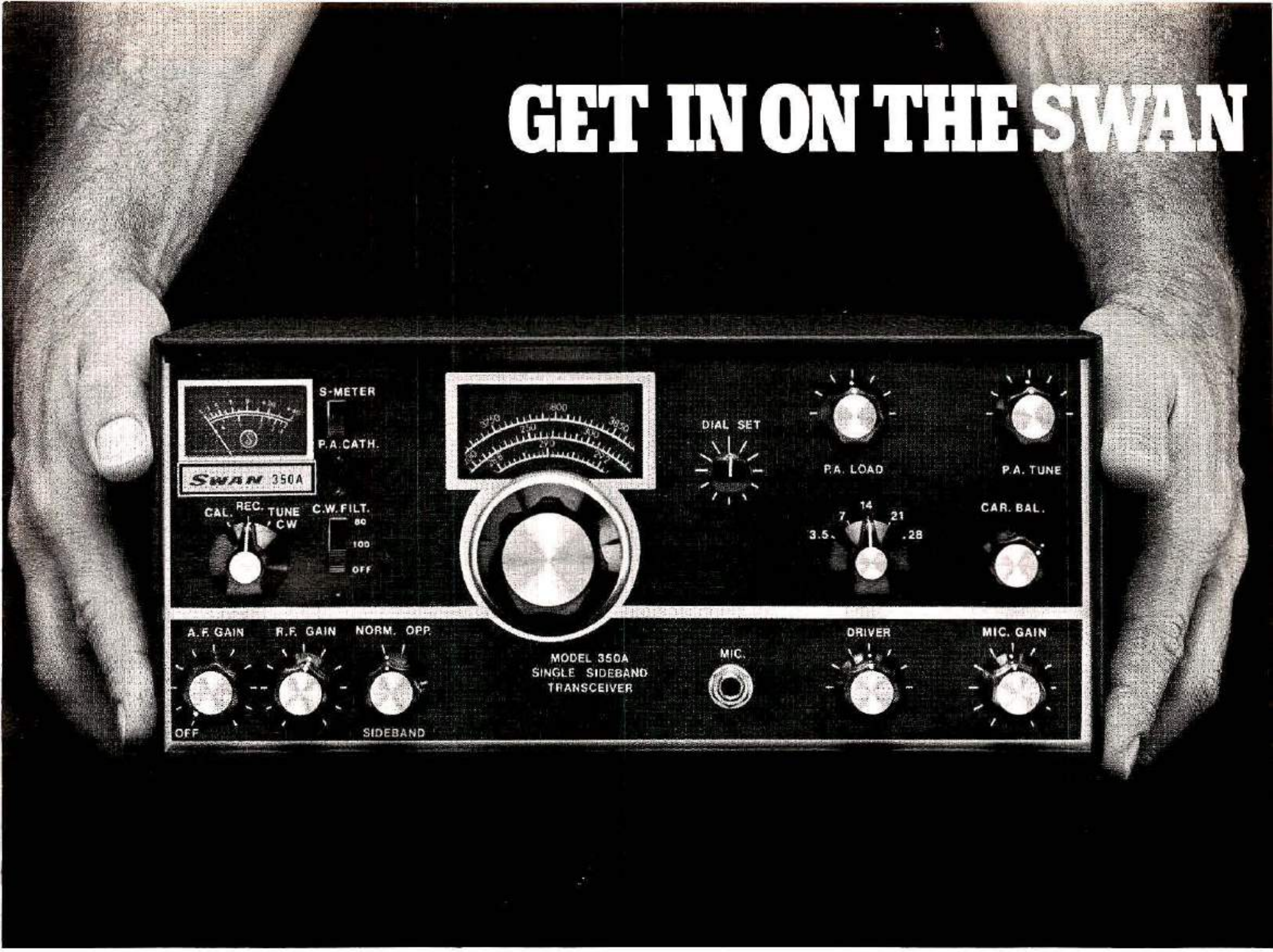
communications specialists

P. O. BOX 153
BREA, CALIFORNIA 92621
(714) 998-3021

K-1 FIELD REPLACEABLE, PLUG-IN, FREQUENCY DETERMINING ELEMENTS

$3.00 each

More details? Ad Check page 86.



Swan puts top-line transceivers into your grasp. At down-to-earth prices—even a novice can afford to become a world power. You start with more watts per buck; boost your rig's performance anytime. Swan makes it easy to add on capabilities.

Swan 350A. $599.95 with built-in AC power supply

- ☐ 300 watts P.E.P. Input SSB
- ☐ 200 watts DC Input on CW
- ☐ 80 through 10 meters, USB, LSB, CW
- ☐ 5.5 Mhz, 2.7 KHz bandwidth crystal filter
- ☐ Oscillators are solid state and IC regulated for stability
- ☐ CW sidetone monitor with adjustable pitch and volume
- ☐ CW audio filter 80 and 100 Hz selectable
- ☐ Crystal Calibrator (350A only)
- ☐ Built-in 117 VAC power supply and speaker. (220 VAC power supply available on special request)

Accessories

- ☐ VX-2 Vox
- ☐ 14A DC Converter
- ☐ 1200X linear amplifier

Swan 350D. $699.95 with built-in AC power supply
Same basic features as 350A except added feature of:

- ☐ 6 digit LED frequency display with readout to 100 Hz

WORLDWIDE POWER GRAB!

Swan transceivers are compatible with an extensive line of proven accessories, available at your Swan dealer or factory direct. Including linear amplifiers that can stretch your power grab, to the legal limits around the globe.

Swan 750CW. $679.95 (PSU-3 AC Power Supply $173.95)

- ☐ 700 watts P.E.P. Input on SSB
- ☐ 400 watts DC Input on CW
- ☐ CW audio filter selectable 80 or 100 Hz
- ☐ CW sidetone monitor with adjustable pitch and volume control
- ☐ 80 through 10 meters, USB, LSB, CW
- ☐ Selectable 25 or 100 KHz crystal calibrator
- ☐ Standard 5.5 Mhz, 2.7 Hz bandwidth crystal filter or optional accessory 16 pole filter available with 140 dB ultimate rejection

Accessories

- ☐ VX-2 Vox
- ☐ MK-II Linear amplifier
- ☐ DD-76 Digital Dial
- ☐ SS-16B 16 pole filter

☐ Please rush full specs for Swan Transceiver:

_____ 350A
_____ 350D
_____ 750CW

☐ Send application forms for Swan Revolving Credit Card, useful for financing Swan equipment purchases through dealers or factory.

Name____________________

Address____________________

City__________ State__________ Zip______

Swan ELECTRONICS
a subsidiary of Cubic Corporation

305 Airport Road, Oceanside, CA 92054

Swan's continuing commitment to product improvement may affect specifications and prices without notice.

Where to tune in, and what to listen for

BY TONY CURTIS, K3RXK

Sorcery, a sleek, fast, sailing sloop, was racing the wind across the northern reaches of the Pacific Ocean. Japan was far behind and California a smooth cruise ahead. The 62-foot (19-meter) vessel seemed a strong cradle, protecting the human crew it carried over the high seas. But wind and weather were stronger.

As *Sorcery* ran with the wind 1200 miles (1900km) north of the Hawaiian Islands, seas heightened. A violent storm blew up and rolled the sloop. The mast snapped; sails were dumped into the ocean, life rafts were washed away, and all power was lost. Lives of the crew might have been lost without fast action by a skilled amateur radio operator.

Mable Walters of Poway, California, operator of amateur radio station W6YLT, rigged a wire antenna above the debris-littered deck of the yacht. She hooked the boat's battery to her ham gear and fired up the transmitter on the 20-meter amateur band to call Mayday.*

Fred Boggs, operator of W7SRU at Port Townsend, Washington, and Hal Berry, KL7HAY, of Homer, Alaska, were chatting when they heard Mabel's call. Fred maintained contact with her while Hal called the Coast Guard. Amateur radio stations at Kodiak and Ketchikan, Alaska; Widbey Island, Washington; and San Francisco helped keep Mable in touch as a cutter and plane, equipped with ham radio gear, searched the ocean for *Sorcery*.

Even a nearby merchant ship, alerted by the Coast Guard, put its transmitter on the air in the 20-meter ham band to help. The merchantman was the first ship on the scene after the wreck was spotted.

Mabel's husband, Glenn, W6MUY, talked with her by radio. During the 24 hours of the *Sorcery* emergency, amateur radio supplied all contact with the yacht. Such service to the public is not unusual in ham radio. Everyday, amateurs help stranded motorists, search for downed aircraft, provide weather bulletins, or send countless messages to American servicemen around the world from families back home.

The *Sorcery* disaster is only one episode in the never-

*From French *M'Aider* (help me); international radiotelephone distress signal.

ending stories of life and its drama, which can be heard in the infinite radio spectrum. Eavesdropping on the ham bands is fun and thrilling, but amateur radio covers only a portion of the giant radio dial we call the spectrum.

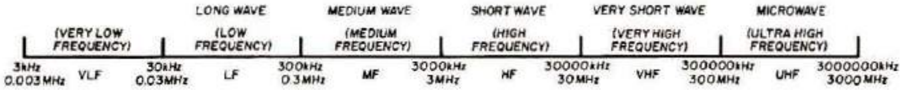


Fig. 1. The radio spectrum has been divided into convenient segments, each with its arbitrary tag of identification. Some of the terms are left over from when the spectrum was defined in wavelengths.

The radio spectrum

The spectrum is easy to understand. It's like a giant radio dial full of stations and things to be heard. Tuning the imaginary dial from one end to another, many different and unusual signals can be heard. In the Pacific Ocean, Japanese fishermen easily relocate whales they have killed by listening for radio beacons they attach to the carcasses. The beacons send signals at a frequency of 1645 kHz in the radio spectrum. Press agencies around the world transmit news to ships at sea on 6376 kHz while, overhead, Russian aircraft enroute to Cuba talk to Havana on 6748 kHz.

Our giant radio dial, the spectrum, is marked off in steps called frequency. Each frequency is labeled with the name Hertz. The spectrum theoretically extends from zero hertz at one end to the highest number of hertz you can imagine toward infinity at the other end. For practical purposes, let's confine our giant radio dial between 3000 hertz on the low-frequency end and three billion hertz on the high-frequency end (see **Table 1**).

To make things easier to talk about, we use *kilo* for thousand and *mega* for million. The low end of our arbitrarily confined radio spectrum, then, is 3 kilohertz or 3 kHz. The upper end is 3000 megahertz or 3000 MHz.

A sleek British submarine cruises quietly through the murky depths of the South Atlantic. Commands are received, even under water, by means of high-powered signals from navy radio station GBR at Rugby, England. GBR transmits at a frequency of 16 kHz in the radio spectrum.

Passengers aboard international airliners make telephone calls back home with transmitters on a frequency of 8201 kHz which is the same as 8.201 MHz. The Firestone Rubber Company at Akron, Ohio, calls its African rubber plantation in Liberia on 7775 kHz.

Music you enjoy from a-m broadcast radios is transmitted near the low end of the spectrum in the band of frequencies between 535 and 1605 kHz. Fm broadcast stations transmit on frequencies between 88-108 MHz. Consider a car salesman, tapping his fingers in time with music from station WGTO in Cypress Gardens, Florida. His radio receiver is tuned to a frequency of 540000 hertz; which is 540 kHz. At the same time, a housewife on Yuba City, California, is listening to her favorite local disc jockey on station KUBA. Her radio is tuned to 1600 kHz or 1.6 MHz. A continuous-entertainment broadcaster that many old-timers remember is Pittsburgh's KDKA which transmits on a frequency of 1020 kHz.

CB radios operate in a band of frequencies around 27 MHz on our giant radio dial. For instance, channel 1 is 26.965 MHz, channel 23 is 27.255 MHz, and channel 40 is 27.410 MHz.

Table 1. SWL and amateur bands in the radio spectrum where international shortwave radio broadcasts and amateur two-way radio communications can be heard.

International Broadcasting to SWLs (Band)	(MHz)	U.S. Amateur Radio Bands (Band)	(MHz)
120-meter	2.3-2.5	160-meter	1.8-2.0
90-meter	3.2-3.4	80-meter	3.5-4.0
75-meter	3.9-4.0	40-meter	7.0-7.3
60-meter	4.75-5.06	20-meter	14.0-14.35
49-meter	5.95-6.2	15-meter	21.0-21.45
41-meter	7.1-7.3	10-meter	28.0-29.7
31-meter	9.5-9.725	6-meter	50-54
25-meter	11.7-11.975	2-meter	144-148
19-meter	15.1-15.45	1¼-meter	220-225
16-meter	17.7-17.9	70-cm	420-450
13-meter	21.45-21.75	uhf	1215-1300
11-meter	25.6-26.1	uhf	2300-2450
Citizens Band (CB)			
11-meter	26.965-27.410 (channels 1-40)		

Frequency and wavelength

Frequency bands sometimes are referred to as being at certain *wavelengths* measured in meters. Any specific frequency can be converted to wavelength, in meters, by dividing 300 by the number of megahertz. For instance, to find the wavelength corresponding to a frequency of 30 MHz, divide 300 by 30. The answer is 10 meters. Hams have a band of frequencies from 28.0 to 29.7 MHz, immediately below the frequency of 30 MHz, which they refer to casually as the *ten-meter band*. The CB radio portion of the spectrum is known to many hams as *11 meters*.

Signals from the OSCAR amateur-radio satellites (*Ham Radio Horizons* March, 1977) can be heard with a simple shortwave receiver tuned to the area around 29.5 MHz in the ten-meter ham band. By the way, "shortwave" is an old-time name for a chunk of the radio spectrum extending from 3 to 30 MHz.

Shortwave listening on the vhf and uhf bands requires a receiver that is designed especially for the job. This Panasonic Tech-1100 covers both the high and low public service bands, as well as part of the uhf spectrum. It also receives the standard broadcast band and the fm broadcast band to provide you with music or news. It can be operated portable, from batteries, or it can be plugged into standard ac power.

Radiomen refer to the usable part of the radio spectrum from 3 kHz to 300 kHz as *long wave* and the part from 300 kHz to 3000 kHz (3 MHz) as *medium wave*. The spectrum from 30-300 MHz is *very high frequency* (vhf) and from 300-3000 MHz is ultra high frequency (uhf). Above 3000 MHz are microwaves, X-rays and even infrared, ultraviolet, and visible light.

Receivers

Active hams and shortwave listeners (SWLs) often have receivers capable of tuning several of these areas of the radio spectrum between 3 kHz and 3000 MHz. I have tuned the signals described here using a medium-priced receiver, model *QR-666* from Trio-Kenwood Communications Inc., 1111 West Walnut, Compton, California 90220. The *QR-666* tunes from 150 kHz to 30 MHz.

Vhf, amateur, and police signals are tuned easily on an inexpensive ($100 range) Panasonic model *RF-888* receiver which can be found in many radio and electronic supply stores. Other Panasonic models tune different vhf and uhf bands.

Ham bands

The amateur radio bands of frequencies include the 160-meter band at 1.8 - 2.0 MHz; 80 meters at 3.5 - 4.0 MHz; 40 meters at 7.0 - 7.3 MHz; 20 meters at 14.0 - 14.35 MHz; 15 meters at 21.0 - 21.45 MHz; 10 meters at 28.0 - 29.7 MHz; 6 meters at 50 - 54 MHz; 2 meters at 144 - 148 MHz; 1¼ meters at 220 - 225 MHz; 70 centimeters at 420 - 450 MHz; and uhf at 1215 - 1300 MHz and 2300 - 2450 MHz.

A group of amateur radio operators, calling themselves the Early Bird Transcontinental Net, can be heard getting together every day at 6 AM on 3940 kHz to send messages and report weather conditions across the United States.

The Flying Sams, a group of California, Arizona, and Mexico hams properly titled the Flying Samaritan Mexico Net, gather every midnight at 3860 kHz, standing by to help in case of aeronautical or other emergency.

Campers and trailer travelers get together every day in the 75-, 40-, and 20-meter ham bands as the Recreational Vehicle Service Net to discuss common problems and interests. The Hurricane Watch Net, on the other hand, convenes at 14.325 MHz in the 20-meter amateur band on a 24-hour-a-day basis only when hurricanes threaten.

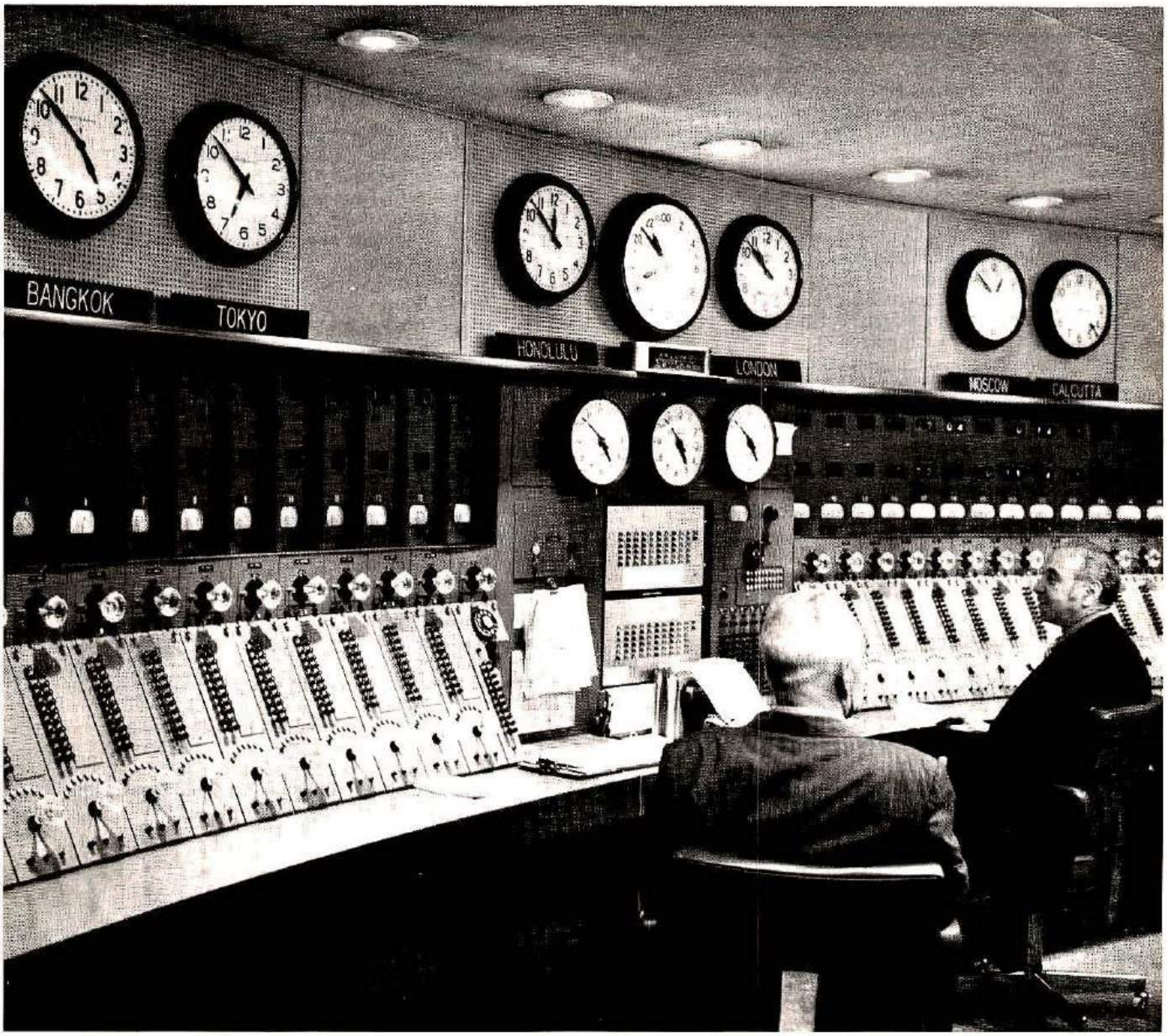
Hams transmit pictures around the world to each other on the shortwave bands using a technique known as slow-scan TV. See November 1977 *Ham Radio Horizons*, page 12.

Slow-scan pictures are similar to those one-frame-at-a-time snapshots received from the Viking Lander on Mars. Other amateurs send full-motion pictures, called fast-scan TV, like those you see of Archie Bunker or Walter Cronkite on your local television station broadcasts. Fast-scan TV transmissions are made in the 420- to 450-MHz ham band in the uhf portion of the spectrum.

Chart of the spectrum

The chart of the radio spectrum which accompanies this article shows where you would tune to hear different

For you long-wave Listeners, here is the Kenwood R-300, a replacement for the QR-666. Its coverage starts at 170 kHz to 410 kHz, then picks up again at 525 kHz to 30 MHz. It features both a main-tuning and a band-spread dial, in the style of many old-time shortwave receivers. It will receive ssb, so you can understand that funny sounding stuff in the amateur and communications bands.



The Master Control Console for the Voice of America short-wave broadcasting stations. This equipment can feed program material to all of the VOA transmitters at the same time. Technicians are on duty at all times (*photo courtesy Voice of America*).

kinds of radio signals. The stations listed are by no means the only ones you can hear. There are thousands and thousands of transmitters on the air, each putting out signals on specific frequencies. The chart shows a representative sampling of the types of transmissions and dial locations for those stations heard on the airwaves.

For example, the familiar broadcast band where local disc jockeys in the United States play music, accommodates many more than the handful of stations listed on our chart. The CIA radio transmissions listed on our chart are only the visible tip of the iceberg. CIA station KKN50, for instance, has been spotted on shortwave at 6.924, 7.470, 10.470, 11.095, 12.111, 13.646, 17.390, 18.252, and 26.760 MHz, transmitting International Morse code from high-powered transmitters. No doubt the CIA has other, unreported, transmitters on the air.

The United States is like other host governments in permitting foreign ambassadors to send radio messages home from transmitters in embassies. The Czechoslovakian Embassy in Washington, D. C., transmits to Prague on 14.649 MHz. The Polish Embassy transmits to Warsaw on 15.804 MHz. These signals are CW, a designation used by radiomen for the dots and dashes of International Morse code.

Frequency lists

To eavesdrop on such unusual stations, or almost any other signals you might care to hear, keep in touch with other hobby listeners via *Ham Radio Horizons* and SWL clubs for

The radio spectrum is full of stations that are interesting to listen in on. Here is a frequency chart showing just a few of the short-wave signals that you may be able to hear. Atmospheric conditions and time of day will determine what parts of the world will be available on your radio dial.

12.0 Omega B, Trinidad, Navigation Beacon
12.2 Omega C, Hawaii, Navigation Beacon
12.5 Omega D, New York, Navigation Beacon
16.0 GBR, Rugby, England (time and weather) British Navy
16.5 USSR Navy
17.0 French Navy
17.8 NAA, Cutler, Maine (time and weather) US Military
18.0 NBA, Canal zone, (time and weather) US Military
18.6 NCK, Jim Creek, Washington US Military
19.6 British Navy and USSR Navy
19.8 NPM, Hawaii (time and weather) US Military
20.0 WWVL, Colorado (time signals)
21.4 NSS, Annapolis, Maryland, US Military
44.0 VIX, Sydney, Australia (time)
50.0 OMA, Prague, Czechoslovakia, (time)
60.0 WWVB, Colorado (time)
77.5 DCF77, Germany (time)
88.0 NSS, Annapolis, Maryland (time, weather, ice patrol)
91.15 FTA91, France (time)
96.05 HBB, Berne, Switzerland (time)
100.0 RES, Moscow (time)
114.95 NPG, San Francisco (time and weather)
121.95 NSS, Annapolis, Maryland (time and weather)
131.05 NPM, Hawaii (time and weather)
133.5 CFH, Nova Scotia (ice patrol and weather)
147.5 WCC, Massachusetts, 10 PM EST News
147.85 NBA, Canal Zone
160-190 Experimenter's Band
185.0 NSS, Annapolis, Maryland, (time, weather, ice patrol)
195.0 LOL, Buenos Aires, Argentina (time)
200-400 Aeronautical Beacons, many with local weather
286-320 Marine Radio beacons
416-518 "AMVER" Automatic Merchant ship Location
417.50 New Zealand (time)
428, 440, 448, 450, 457, 466, 472, 482, 486 US Coast Guard
430 Australia (time)
434 Calcutta, India (time)
435 Rio de Janeiro, Brazil (time)
458 Shanghi, China (time)
472, 476 Australia (time)
484 Capetown, South Africa (time)
485 Peru (time)
500 Emergency alarm signals and beacons from ships
540 WGTO, Cypress Gardens Florida
660 WNBC, New York City
670 WMAQ, Chicago
700 WLW, Cincinnati
750 Sapporo, Japan
780 ZBVI, British Virgin Islands
800 PJB, Dutch West Indies
835 Nanchang, China
930 Radio Antilles, Montserrat
1020 KDKA, Pittsburgh (Also ZCO, Tonga)
1034 CSB-2, Lisbon, Portugal
1295 PJD-2, St. Maarten
1450 WMAJ, State College, Pennsylvania
1475 Asiatic USSR
1530 WCKY, Cincinnati
1600 KUBA, Yuba City, California
1645 Whale-carcass Beacons in Pacific Ocean
1800-2000 Ham 160-meter band (also Loran Navigation)
2182 Emergency alarm signals from ships and aircraft
2374 Civil Air Patrol, USA
2300-2500 120-meter international shortwave broadcast
2500 WWV Colorado (time)
2558 Hurricane warnings from Nassau, Bahamas
2593, 2840 Interpol
2666-2706 US Coast Guard
2889, 2980 Volmet international airplane weather
2868-2987 Airliners worldwide radio communications
3001 International airlines weather
3.046, 3.151 Canada Air Force
3.2-3.4 90 meter shortwave broadcast band
3.330 CHU, Canada (time)
3.593 Interpol
3.5-4.0 US 80 meter ham band
3.9-4.0 75 meter international sw broadcast band
4.025 Pentagon, station AIR
4.072, 4.091, 4.101 Passenger phone calls from airliners
4.247, 4.310, 4.343, 4.367 News agency press
4.235-4.409 Automatic merchant ships position location
4.400 Civil Air Patrol
4.495 US Military
4.721 US Air Force
4.732 British Navy at Gibraltar
4.750-5.060 60 meter international sw broadcast
5.0 WWV, Colorado, (time)
5.104, 5.208, 5305.5 Interpol
5.373, 5.484 International Airline Flight Safety
5.703 US Military
5.870 Station NSS, Annapolis, Maryland
6.012 Radio AFAN, USA McMurdo Base, Antartica
6.070 CFRX, Toronto
6.428 NPG, San Francisco (time)
6.351-6.505 Automatic merchant ships location reports
6.376, 6.418, 6.488, 6.495 News Agency press
6.715 US Air Force
6.748 USSR Air Force to Cuba
6.753 US Military
6.761 USA Strategic Air Command
6.792, 6.705 Interpol
6.748 Aeroflot USSR Airline in Flight
6.924 CIA
6.945 Health Epidemic Bulletins from Switzerland
7.0-7.3 US Ham 40 meter Band
7.080 Station W1AW On-Air code practice
7.1-7.3 41 meter international sw radio broadcast band
7.335 CHU, Canada (time)
7.470 CIA
7.500 VGN, Australia (time)
7.532, 7.832, 7.906 Interpol
7.775 Firestone Rubber Co. private radio link
8.038, 8.045 Interpol
8.201, 8.204, 8.220, 8.239 Airline passenger phone calls
8.364 Emergency radio beacons from ships and life boats
8.514, 8.618 News Agency Press Transmissions to ships
8.465-8.776 Automatic merchant ship location reports
8.613 China Military
8.964 US Military
9.040 Romanian Embassy, Washington
9.041 Hungarian Embassy, Washington
9.200 Interpol
9.267 USSR — Cuba Military contacts
9.277 NPG, San Francisco (time)
9.425 NSS, Annapolis, Maryland (time)
9.490 Lhasa, Tibet, Broadcasting station
9.5-9.725 31 meter international sw radio broadcasting
9.805 Radio Cairo
9.940 VNJ, Australian station at Casey Base, Antarctica
10.0 WWV, Colorado (time)
10.049 International airline flight safety
10.390 Interpol (also police network in Spain)
10.410, 10.950 NASA
10.470, 11.095 CIA
10.996 USSR time signals
11.179, 11.243 US Military
11.312 Aeroflot USSR Airlines
11.7-11.975 25 meter international sw broadcast band
11.720 Canadian Broadcasting Corp (CBC)
11.995 CIA
12.0 VNG Australia (time signals)
12.111, 12.022 CIA
12.422 US Coast Guard
12.800, 12.826, 12.997, 13.024, 13.078 News agency press

13.002-13.123 Maritime Coast stations
13.056-13.092 Automatic merchant ships location reports
13.201, 13.870 US Military
13.222 International airline weather forecasts
13.520, 13.820 Interpol
13.580, 13.905 NASA
13.715 CIA
14.313 International maritime mobile radio network
14.0-14.350 Ham 20 meter band
14.308 Recreational-vehicle owners' on-the-air roundtable
14.649 Czechoslovakian embassy, Washington
14.817 Interpol
14.995 US Military
15.0 WWV, Colorado (time)
15.008 USSR space satellites
15.034 USSR Military
15.060 Radio Peking
15.1-15.450 19 meter international sw broadcast band
15.160, 15.235 Voice of America
15.492, 15.450 CIA
15.502, 15.578, 15.592, 15.684 Interpol
15.804 Polish and Czechoslovakian embassies, Washington
15.870 NASA
16.065 Romanian Embassy, Washington; also USSR Navy
16.180 NSS, Annapolis, Maryland
16.491-16.526 Passenger Telephone calls from airliners
16.566 US Coast Guard
16.973-16.997 Maritime coast stations
16.988 US Military
17.021, 17.117 News Agency press transmissions to ships
17.002-17.300 Automatic merchant ships location reports
17.7-17.9 16 meter international sw radio broadcasting
17.936 USSR Military
18.267 News agency press transmissions to ships
18.008 USSR space satellites
18.380 Interpol
18.335 NASA
18.525, 18.972 CIA
19.150 USSR Space Satellites
19.130, 19.360, 19.405 Interpol
19.944 USSR space satellites
20.0 WWV, Colorado (time)
20.008 USSR Space Satellites
20.365 CIA
20.575 NPM Hawaii (time)
20.990 NASA
21.0-21.450 15 meter ham band
21.390 W1AW ham bulletins
21.450-21.750 13 meter international sw broadcasting
21.785, 21.807 Interpol
22.099, 22.106 US Coast Guard
22.485 Press agency news transmissions to ships
22.593, 22.764 US Military
22.695 Weather forecasts, California
23.442, 23.862, 23.975, 23.982 CIA
23.650 NSS, Annapolis, Maryland (weather forecasts)
24.070, 24.110 Interpol
25.0 WWV, Colorado (time)
25.6-26.1 11 meter international sw broadcast band
26.620 Civil Air Patrol
26.760 CIA
26.965-27.410 CB channels 1-40
26.995-27.195 Model Airplane radio control
28-29.7 Ham 10 meter band
29.4-29.550 OSCAR ham satellite downlink
30-50 VHF-Low Police band
50-54 Ham 6 meter band, Radio Control Models
54-72 TV Broadcast Channels 2-4
73-74.6 Radio Astronomy, Model Radio control
76-88 TV Channels 5-6
88-108 Broadcast FM stations
110 Amateur Radio Astronomers
108-136 Airplane Navigation and two-way radio
121.5 Emergency alarm signals and beacons
121.75 USSR space satellites
136-144 Space research (signals to earth)
145.924-145.975 OSCAR Ham satellite
144-148 Ham 2 meter band
150.0 US "Transit" navigation satellite
156.8 Emergency calls from yachts, boats, and aircraft
150-173.0 VHF-High band for police, marine radio
162.4, 162.55 National weather service forecasts
166.0, 183.54, 192.0 USSR space satellites
174-216 TV channels 7-13
220.0-225.0 Ham 1¼ meter band
230-260.0 USA space Booster Rocket telemetry
243.0 Emergency alarm signals from aircraft, liferafts
259.7 USSR space satellites
381.8, 383.9 US Coast Guard
401-403 Weather satellite (earth to space transmissions)
420-450 70 cm ham band
460-470 Weather satellite (space to earth)
450-512 UHF public service band, police, fire, etc.
470-512 TV Channels 14-20
512-890 TV Channels 21-83
860-912 Future UHF-high public service band police, fire, etc.
922.75 Beacons from USSR deep-space probes
925.24, 926.06 USSR space satellites
1215-1300 Ham band
1670-1710 Weather satellite and space research
2200-2300 Space research "S" band
2300-2450 Ham band

---

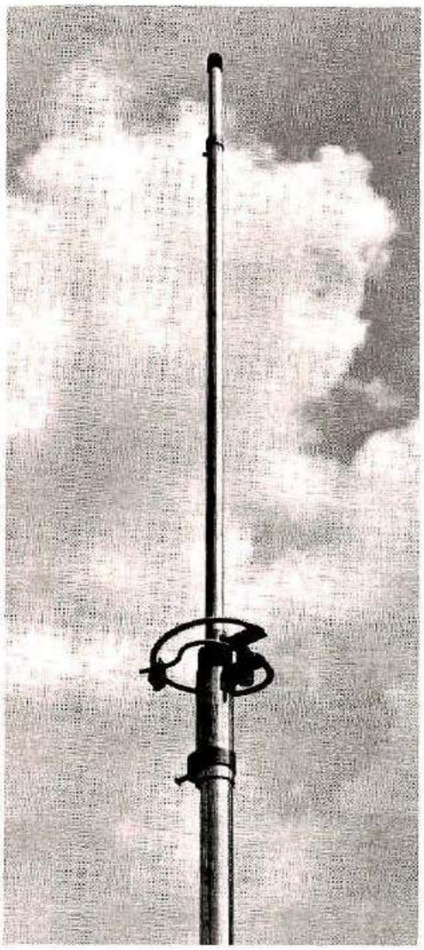
information. Find your stations by listening intently as you tune across the whole dial of your receiver. Stop and listen carefully to anything that sounds unusual.

Thousands of interesting radio transmissions are made in plain language for you to hear. Many other are in different languages. Some are in special codes such as CW or radioteletype. You can hear the dots and dashes of code with a receiver which has a BFO or CW switch position. Radioteletype can be copied on equipment that sells for under $200, including $150 for an electronic gadget to convert signals from your shortwave set and drive a used *Teletype* machine.

Slow-scan TV and facsimile (FAX) can be seen with a converter which takes sound from your receiver and changes it to pictures on a monitor. The same gear, with a special receiver, will permit you to receive weather-satellite photos of Earth.

"Underground" radio

Non-amateur stations sometimes take cover in the amateur radio bands, hoping their signals will be masked by hundreds of legitimate users of these frequencies. For example, there is a radioteletype station beaming signals out of mainland China on a number of frequencies inside the 20-meter ham band. The China station sometimes pops up with very loud signals on ham radio sets in North America. It begins transmissions with an apparently meaningless series of letters and numbers in CW, and then switches to radioteletype. The transmitter is high-powered and moves around the dial from 14.0 to 14.2 MHz. Bob Gutshall,



A random length of wire will suffice for the usual short-wave receiving equipment, but most of the scanners and monitors for vhf require an antenna that works well at the upper end of the spectrum. The Ringo Ranger, by Cushcraft, provides some gain for improved signal reception, and can be obtained for different portions of the Public Service Bands.

W3BTX, Altoona, Pennsylvania, and other hams who like to chat with friends around the globe, listens for the mysterious Chinese station as an indicator that the 20-meter amateur band is open for communication all the way to the Far East.

Roy Goshorn, operator of station W3TEF in Bellwood, Pennsylvania, tunes the lower end of the 80-meter amateur band around 3.55 MHz for signals from the Russian fishing fleet on the high seas. Roy says the ship-to-ship voice transmissions, usually in Russian but sometimes in Czech, are heard best early in the morning along the coasts. He reports that signals are strongest when the fleet is closest to shore.

Ferreting out secrets of the radio waves and eavesdropping on the snoops is very popular today. Hundreds of thousands, if not millions, of Americans are listening to police and fire calls on scanners and other police-radio receivers. Scanners are receivers tuned to several police and other public-service frequencies.* The set listens to each frequency in sequence and stops at one frequency when a signal appears there. Scanners let you listen to only those frequencies where local police action is likely to take place in your town.

More equipment — for vhf and uhf

I use the same scanner for police calls and monitoring the local two-meter ham band. I set my scanner to the two-meter frequencies used by local amateurs and, when someone comes on the air for a chat, my scanner lets me hear the conversation. I use the *Realistic PRO-14* scanner available at Radio Shack stores and the *Bearcat BC-101* programmable scanner, each with a Cushcraft *Ringo Ranger* two-meter antenna on the roof of my house. I hear all police, fire, ambulance and ham chatter for many miles around with that set-up.

You also can hear foresters, highway crews, garbage trucks, press crews, and remote radio-station broadcast pickups on scanners and other receivers capable of listening in the vhf and uhf portions of the spectrum. These public service bands are called *vhf low* for frequencies of 30 - 50 MHz; *vhf high* for 150 - 173 MHz; and *uhf* for 450 - 512 MHz. Note that there is a ham band just below (10 meters) and immediately above (6 meters) the 30 - 50 MHz range, plus the amateur 2-meter band just below 150 MHz, and the 70-centimeter ham band just below the uhf police band. Most scanners will tune far enough out of their intended coverage area to let you hear hams.

You will be able to hear vhf and uhf signals not more than 15-30 miles away, especially in hilly or mountainous terrain, compared with shortwave signals which skip around the globe, beyond line-of-sight distances. Shortwave signals bounce between the ionized layer in our upper atmosphere and the surface of the Earth, skipping from point-to-point around the world. Vhf and uhf signals usually do not skip, so you must be within line of sight of a transmitter to get the signals.

**Listening* is okay, but making use of the information you hear is illegal under the law, unless you are a member of the police or fire agency authorized to use those frequencies.

A recent addition to the list of short-wave receivers is the Drake SSR-1. It is all solid-state, light weight, and provides continuous coverage of the frequencies between 500 kHz and 30 MHz.

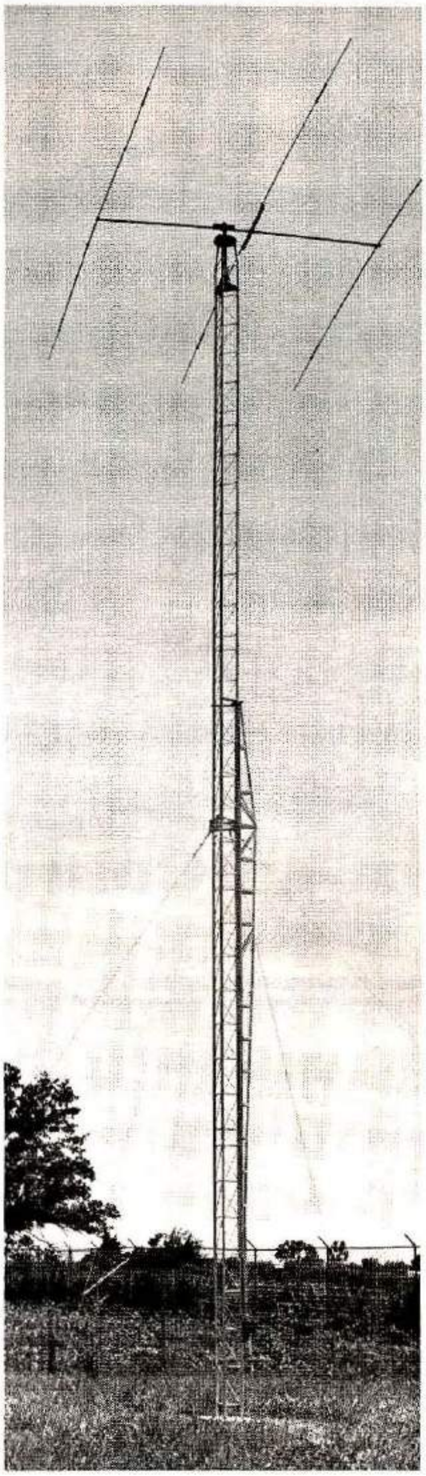
Other two-way radio stations transmitting in the vhf and uhf public-service bands are operated by businessmen, motion-picture film crews, oil-pipeline workers, heavy-construction workers, farmers, home fuel deliverymen, water companies, power linemen, tow trucks, railroad trains, buses, taxis, shipyards, yacht clubs, marinas, hospitals, doctors, Civil Air Patrol airplane searchers, rescue squads, school buses, and mobile telephones.

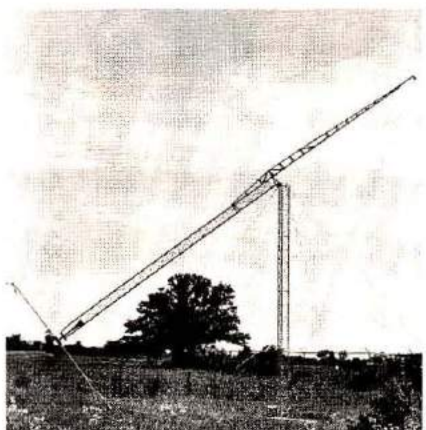
Not all such services will be available to you in your home area, but many will be there for you to overheard. Remember, you can listen all you want to any band. But Federal Laws, with stiff penalties, say you can *not* repeat to anyone, under any conditions, the content of signals you hear on the air. And you can't use information you overhear for your own personal gain. Nevertheless, you sure can have fun listening. **HRH**

Publications

Publications listing many of the frequencies where you can hear secretive stations include: *Confidential Frequency List* by Robert B. Grove, published by Gilfer Associates, Inc. for $5.45; the annual *World Radio TV Handbook*, published in Denmark is a popular guide to the international broadcasting stations and their frequencies for $10.95. Both are available from Ham Radio's Communications Bookstore, Greenville, New Hampshire 03048.

Police Call Directory, listing fire and police emergency communications frequencies for your area is available at a Radio Shack store near you. *Net Directory* for the current year, a listing of hundreds of scheduled amateur radio on-the-air meetings, is available as a service to members of the American Radio Relay League, 225 Main Street, Newington, Connecticut 06111.





CALL TOLL FREE

1-800-228-4097

ETO ALPHA 76
reg. $1195 only $1050

ETO ALPHA 374
List $1595 only $1395

WILSON MARK II
Slim line only $199 ppd.

BEARCAT 210 SCANNER
list $350 only $279

ICOM 22s
list $299 only $249

HY-GAIN SPECIALS

TH6DXX 6 element super Thunderbird reg $249.95 Now $209.95
TH3-MK3 3 element tri-band reg $199.95 Now $169.95
TH3JR 3 element tri-band reg $144.50 Now $129.95
TH2MK3, 2 element tri-band reg $139.95 Now$124.95
18HT Hy-Tower, reg $279.95 Now $239.95
12AVQ 10-20m vertical reg $37.95 Now $33.95
14AVQ/WB 10-40m vertical reg $67.00 Now $57.00
18AVT/WB 10-80m vertical reg $97.00 Now $84.95

Call for similar savings on all these excellent lines

Kenwood
Yaesu
Drake
Hy-Gain
ICOM
Ten-Tec
Dentron
Swan
Tempo
Wilson
Midland
Bearcat
CDE Rotors
ETO Alpha

master charge THE INTERBANK CARD

Communications Center

The Radio Store

443 N. 48th, Lincoln, Nebraska 68504 In Nebraska Call (402) 466-8402

BANKAMERICARD

THE BIG SIGNAL®

UNADILLA "W2AU" BALUN

$14.95

***UNADILLA ORIGINATED!**

World Famous Among Hams, Armed Forces, Communications Industry. Why?

- Each BALUN 2KW PEP tested
- Lightning Arrester
- 600# Pull – No Insulator Needed
- Only 7 oz. and 6" x 1¾" diameter
- Reduces TVI
- Improves F/B ratios
- Weatherproof
- Complete Instructions
- Antenna Length Table

DEALERS WANTED—NOW OVER 200 WORLD-WIDE

THE OLD RELIABLE™

REYCO "W2VS" ANTENNA COILS

$21.95 pair

***FREQUENCY-MATCHED PAIRS!**

Turns Your Antenna Into A Multi-Band! Professionals Demand Reyco! Why?

- Precision Machined
- Frequency-Matched Pairs
- Only 6 oz. and 5½ x 1¾" diameter
- Rugged – Over 300# Pull
- Weatherized
- Models for 10, 15, 20, 40 Meters
- Complete Instructions
- Multi-Band Length/Tuning Data

AT YOUR HAM DEALER – If not, order direct (Add $1)
Need the name of your nearest dealer, technical help, literature? ROGER!

Call us TOLL-FREE and ask for Hugh Gunnison, WA2ZOT
NYS: 1-800-962-7965 OTHER STATES: 1-800-448-1666
TWX: 710-541-0493 CABLE: MICROFILCO

UNADILLA/REYCO DIVISION, Microwave Filter Company, Inc., 6743 Kinne Street, East Syracuse, New York 13057

More details? Ad Check page 86.

POST BOX

Dear Horizons:

First I want to thank you for publishing the first magazine I've seen that really is interested in the future ham.

I am a licensed CB operator, but I discovered ham radio when I was about 10 years old. My cousin, K5VVV, put me in front of his radio station and gave me some basic instructions on how to tune the receiver; I heard things and people I had never dreamed of. I was totally impressed! Since that time I have wanted to be a ham but never knew how or what I should do.

I'm now almost 30, but I plan to possess at least a Technician license before my next birthday. Your magazine promises to aid me in that goal. I hope that between your magazine and friends who are hams, I can get there.

As you can see I have entered my order for a one-year subscription. Thanks and my best wishes for success.

L. W. Crooks
Independence, Missouri

Dear Horizons:

I would like to receive your information on becoming a ham radio operator. Although my father is a ham, K2LB, I haven't really been interested. But in the magazine, *Ham Radio Horizons*, I found new words, with their definitions, the articles were interesting and easy to read. So please send the information.

Jim Herzog
Rochester, New York

Glad to oblige, Jim. Our information package is on its way. ***Editor***

Dear Horizons:

I have never written to any magazine before, but you deserve it. Unlike other magazines, when I get it I read it from cover to cover. I do not have my license yet, but I am working on it with a tape I bought from you. Enclosed is my form for renewal of my subscription.

K. G. Fuller
Prosser, Washington

Dear Horizons:

Ham Radio Horizons is a beautiful publication in all respects. I am a charter subscriber and intend to save every issue (using your special binders).

I can think of only one way to make it perfect, and that is to issue an annual index. There is such a profusion of vital articles that retrieval could become a problem.

Please consider an annual index. It could be incorporated in the December issue, or sold at an extra charge. Whatever the cost, it would be worth it to me.

William T. Pace
South Charleston, West Virginia

Your letter arrived while we were in the process of preparing the annual index for the December 31, 1977 issue (also called the Wrap-Up issue). It will be in each December issue, William, so you'll have it at your fingertips at no extra charge. Thanks for writing to us. ***Editor***

Dear Horizons:

I read your article about electrical terms being like automobile terms. I decided that if my mother, WA4GUS, father, W4UZJ, brothers Chris (12 years old), WA4KWA, and Bobby (11 years old), WA4QLM, have Extra, Advanced, and General class licenses, I could also pass the General. I had a Novice license when I was 8 years old and take the code at 20 words per minute, but I always thought theory was hard. Your article was very easy to understand.

Now I have my General-class license! (I am 10 years old.)

Andrew Moffitt, WA4QLN
Lake Park, Florida

Dear Horizons:

You have a fine magazine. I'm sorry to be so late with my subscription. . . I know I will enjoy reading it every month. I am one of the few remaining really Old Timers . . . in 1923 I helped to build the transmitter for Don Mix (W1TS) to take to the Arctic, and helped monitor his signals in Chicago at the time.

I am back on the air now, after 54 years of being away from it. My General-class license came back to me in August, 1977, on my 74th birthday.

Fred Cassens, WB7SOT, (ex-9DB)
Phoenix, Arizona

Congratulations, Fred, on both the birthday and the General-class ticket. It's good to have someone with your experience around to cast a critical eye at what we are trying to do. ***Editor***

Dear Horizons:

I did not renew my *Horizons* subscription because of your article about CB in your latest issue. I subscribed to a ham radio magazine, not a CB magazine. I am extremely disappointed in you.

James L. Grubb, WB1AFL
Stoneham, Massachusetts

Dear Horizons:

I feel that it's only fair that you warn those hams who are adamant toward anything pertaining to CB that the odds are greatly in favor of Saint Peter being a CBer rather than a ham. Do unto others!

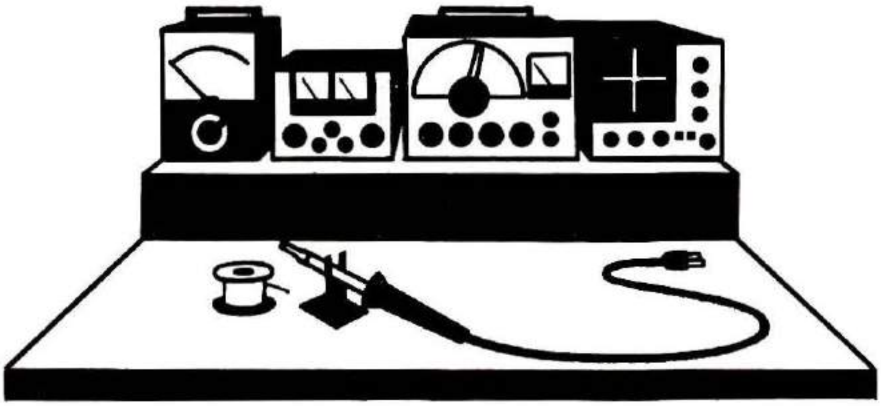
Rev. S. W. Paul, WA8QWN
Wintersville, Ohio

Dear Horizons:

I would like to drop a few lines to say how good your magazine is. Presently, I am working on my code and hope to obtain my General ticket in the near future.

Enclosed is my check for one year's subscription and for a copy of the August issue. I was very impressed with "Going Sailing With Amateur Radio." After all, sailing is another hobby that goes hand in hand with Amateur radio.

Louis Silva
Sausalito, California



BENCHMARKS

Simplified Transistor Testing

Here is a fast and simple method for separating usable transistors from defective ones. Only an inexpensive ohmmeter is needed, and there are no confusing polarities or "rules of thumb" to remember.

Set the ohmmeter to the X100 range, touch the probes to the base and emitter leads and note the reading. Reverse the probes and take a second reading. If the transistor is good, there will be a wide difference between the two readings. If the readings are very similar, the device is defective. Make the same evaluation between the base and collector leads. End of test. Of course, to determine the *quality* of transistor performance, a more elaborate tester is required.

The theory of this test is equally simple. Both bipolar and junction field-effect-transistor junctions exhibit the properties of two diodes, in addition to their ultimate role of controlling current flow. A transistor becomes inoperative if either junction is not functional. Thus, the simple test of forward and reverse currents through transistor junctions will reveal defective devices. Before testing very-low-voltage bipolar or jfet devices, take one precaution: use another meter to confirm that the battery voltage at the ohmmeter probes does not exceed the ratings of the transistor under test.

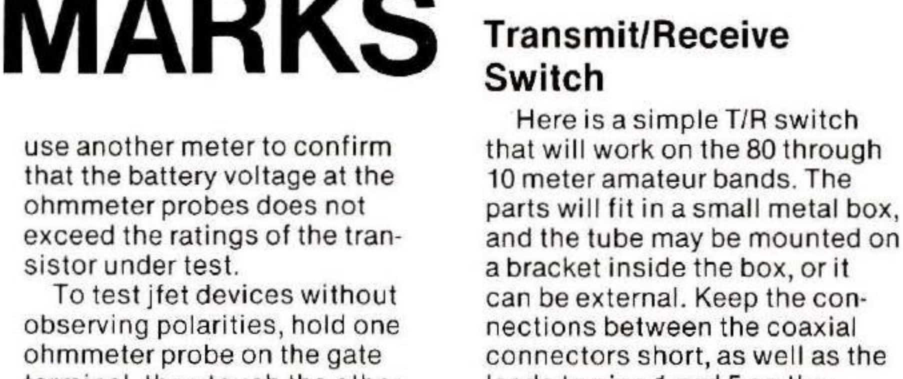
To test jfet devices without observing polarities, hold one ohmmeter probe on the gate terminal, then touch the other probe to the other two terminals in turn, and note the readings. Next, reverse the probes, hold one probe on the gate terminal, and again take readings at the other terminals. One set of readings will range between 10 and 100 ohms, and the other pair of readings will be almost infinite, through a usable jfet.

If unmarked transistors are to be identified as to type (pnp, npn, jfet), label the ohmmeter probes with the polarity of the voltage appearing there, which you must determine with another meter.

Gene Brizendine, W4ATE

Transmit/Receive Switch

Here is a simple T/R switch that will work on the 80 through 10 meter amateur bands. The parts will fit in a small metal box, and the tube may be mounted on a bracket inside the box, or it can be external. Keep the connections between the coaxial connectors short, as well as the leads to pins 1 and 5 on the tube. It will work with 100 to 200 volts of plate supply, which can be taken from your receiver or



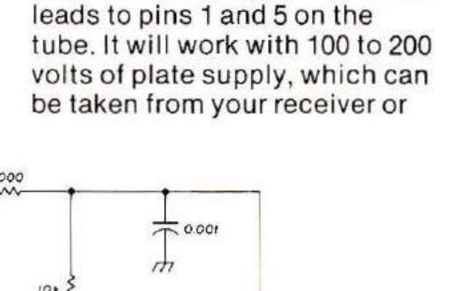


Fig. 1. The schematic diagram of the simple T/R switch is shown at **A**, and a companion power supply at **B**. All resistors are 1/2-watt, and all capacitors are disk ceramic with a 1000-volt rating. The connection between J2 and J3 should be as short as practical, as should the leads to pins 1 and 5. The coaxial connectors can be of whatever style is compatible with your transmitter and receiver. This circuit is not recommended for transmitters of above 500 watts output.

transmitter. Alternatively, you can build the simple power supply shown, using one of the inexpensive transformers available from many dealers or surplus stores.

Dennis Grindrod, WA1EHF

Phillips Screwdriver

Make a powerful combination screw driver, for removing Phillips-head screws in cramped quarters, by grinding one end of an Allen wrench so it fits the Phillips screw slot. The other end of the tool can still be used on conventional Allen-head set screws.

Harry J. Miller

15-Meter RFI

While working as a technician for the State of Wisconsin, I received RFI complaints from our radio dispatchers at least once a year.

The RFI was a keyed carrier that opened the squelch on a 42.220 MHz fm receiver. This receiver's antenna was about 1200 feet (365m) above average terrain and within 4 miles (6.5km) of a population center of 35,000 people. We had a number of other receivers on 42.220 MHz but these were in remote regions of the state and I rarely had RFI complaints on these.

Each time I had the RFI on this receiver it turned out to be a newly licensed Novice, operating on 21.110 MHz. Either they weren't using a lowpass filter, or they were using one with a cutoff frequency above 6 meters (50 MHz). In all cases, I recommended using a lowpass filter with a cutoff below 42 MHz, or staying clear of any 15-meter frequency whose second harmonic fell on the frequency of a station within 5 miles (8km) of them.

I never had a problem with the same amateur twice.

Duane J. Meyer, K9PVY

Watts Cookin'? –*It could be the final amplifier in your xmtr if you're not adjusting to peak performance with a . . .*

Drake Directional RF Wattmeter


Drake W-4


Drake WV-4

Here's why: • Quick, accurate adjustment of antenna resonance and impedance match • Easily adjusts matching network • Directional, through line, highly accurate • Continuous monitoring of antenna performance and either forward or reflected power • Indirectly measures radiated power (forward minus reflected) and VSWR using nomogram included • Removable coupler for remote operation.

Specifications		W-4	WV-4
Frequency Coverage		1.8-54 MHz	20-200 MHz
Power Capability (cont. duty)	Hi Range	2000 W	1000 W
	Lo Range	200 W	100 W
Accuracy of Reading		± (5% + 1% of full scale)	
Line Impedance		50 Ohm resistive	
VSWR Insertion		no more than 1.05:1	
Size		14.0 x 9.5 x 10.2 cm	
And the price is not too hot to handle . . .		$79.00	$89.00

R. L. DRAKE COMPANY DRAKE®

540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 • Telex: 288-017

Western Sales and Service Center, 2020 Western Street, Las Vegas, Nevada 89102 • 702/382-9470

THE WINNER

WHISTLER RADAR EYE

WHISTLER RADAR EYE

AN' NEW CHAMPEEN'

Whistler Multiband Radar Detector

retail $159.95-

Reprint from November 1977 NATSO Truckers News	Distance from Gun (miles)	All Automatic	Geiger Counter	X & K Bands	Retail cost
Whistler Multiband	2.5	Yes	Yes	Yes	159.95
Long Range Super Snooper	2.4	Yes	Yes	Yes	189.95
Whistler Radar Eye	2.1	Yes	Yes	X only	99.95
Super Snooper	1.4	No	No	Yes	149.95
Fuzzbuster II Multiband	1.3	No	No	Yes	129.95
Sentrion XK	.9	No	No	Yes	149.95

TECTOR COSTS $20 or $400. IF IT WORKS, IT'S WELL WORTH IT!!!
OUR SUGGESTIONS —
The best radar detector we can suggest is a Whistler Multiband. It is by far the best detector on the market, and the only way to fly! At $159.95, you've never had it so good. It's your license, and you are well aware that a speeding ticket is about a half day's work.
The easiest way to understand how a

Amateur net:

$134.95

Colo. residents add 3.5% tax.

Include call with order

CW electronics
303-893-5525

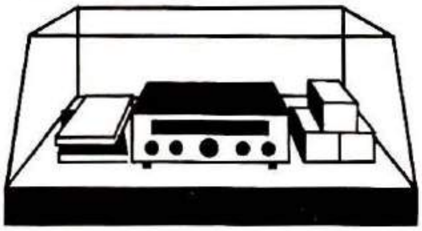
VISA · master charge

1401 Blake Street
Denver, Co. 80202

More details? Ad Check page 86.

More details? Ad Check page 86.

PRODUCT SHOWCASE



Kenwood TS-520S Transceiver

Trio-Kenwood has recently introduced the new TS-520S hf transceiver. It retains the field-proven characteristics of the popular TS-520, and incorporates many of the ideas, comments, and suggestions for improvement from amateurs worldwide.

The first major difference to be seen in the TS-520S is its full-band coverage, including 160 meters. Of course, transverters for 6 and 2 meters can also be used with the TS-520S. Provisions for attaching a digital display (model DG-5) have been included on the back panel. The DG-5 contains 6 digits which display your operating frequency while you transmit and receive.

Other new features of the TS-520S include an rf attenuator; new, improved speech processor; vernier tuning for final plate control; and a new monoscale analog dial. The TS-520S is completely self-contained with a built-in ac power supply. The addition of the DS-1A dc to dc converter (optional) permits mobile operation of the TS-520S. The transceiver also has two convenient RCA-type phono jacks on the rear panel, labeled *Phone Patch In* and *Phone Patch Out*, for quick, easy, hookup of almost any phone patch. For CW buffs, the CW-520 500-Hz filter can be easily installed and will provide improved selectivity on CW.

In addition to the DG-5 and CW-520, other accessories such as an external vfo (VFO-520S) and external speaker (SP-520) are also available to make a complete station which any amateur would be proud to own. These and other Kenwood Products are available from authorized Trio-Kenwood dealers throughout the United States. For a list of authorized dealers and more information on the TS-520S, write Trio-Kenwood Communications, Inc., 1111 West Walnut Street, Compton, California 90220; or use *ad check* on page 86.

DenTron Jr. Monitor

DenTron's newest tuner, called the *Jr. Monitor*, has power-handling capability of 300 watts, and can handle balanced, coaxial and random-wire-fed antennas. It also includes a relative-power-output meter and a mobile-mounting bracket. The *Jr. Monitor* measures a mere 5 1/2-inches wide by 2-3/4-inches high, by 6-inches deep (14x7x-15cm). This size makes it ideal for portable, mobile, or fixed operation. Designed to handle virtually any transceiver or receiver-transmitter combination, the *Jr. Monitor* is priced at $79.50 and is available at DenTron dealers throughout the United States and the world. For more information, write DenTron Radio Company, 2100 Enterprise Parkway, Twinsburg, Ohio 44087, or use *ad check* on page 86.

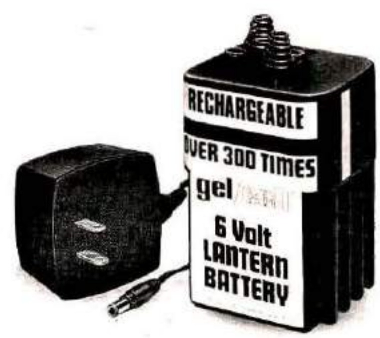
Heath Self-Instruction Microprocessor Course

Heath Company has introduced its ET-3400/EE-3401 microprocessor learning system. The EE-3401 self-instructional course employs Heath's individualized learning techniques to instruct the student in microprocessor operation, interfacing, and programming. The accompanying hardware and software experiments provide valuable hands-on experience via the ET-3400 microprocessor trainer.

Instructional materials in microprocessor operation and design, applications, machine-language programming, hardware, I/O interfacing, and much more, are all featured in the EE-3401 microprocessor course. The ET-3400 trainer features the popular 6800 microprocessor, 256 bytes of RAM (expandable to 512 bytes), a 1k ROM monitor, and 6-digit hexadecimal display and keyboard. Breadboarding sockets permit fast construction of experiments and special prototype circuits.

For further information on the EE-3401 microprocessor course and ET-3400 microprocessor trainer, mail-order priced at $89.95 and $189.95 respectively, write for a free catalog to Heath Company, Department 350-460, Benton Harbor, Michigan 49022, or use *ad check* on page 86.

Rechargeable Lantern Battery



Globe-Union, one of the world's largest manufacturers of automotive batteries, has announced the availability of a six-volt, rechargeable lantern battery. Globe is best known as the developer of the Sears *DieHard* battery. Globe calls the new power unit the *Gel/Cell Lantern Battery*, and says that, for the first time, it brings the reliability of their complete Gel/Cell industrial battery line to the consumer. According to Globe, it's totally rechargeable for 300 cycles or more, which means it provides more than 1800 hours of light, the equivalent of over 300 throwaway batteries. And the battery gives full power after each charge, unlike non-rechargeable batteries that lose irreplaceable power whether they are used or not.

The new *Gel/Cell Lantern Battery* features spring contacts and is encased in a tough polypropylene case proven effective in automotive applications. It also contains a self-resetting circuit breaker that protects the lantern battery from damage if the terminals are shorted. The battery operates much more efficiently than non-rechargeable batteries at low temperatures, providing approximately 50 per cent of its power at 0°F (−18°C).

For further information, contact Bob Scrima, Sales Manager-Special Products/Battery Division, Globe-Union, Inc., 900 E. Keefe Avenue, Milwaukee, Wisconsin 53201, phone (414) 228-2393, or use *ad check* on page 86.

New OSCAR Book

What's OSCAR? It's a series of communications satellites designed and built by amateur radio operators. The best thing about them is their accessibility — anyone with an inexpensive receiver and simple antenna can hear the tiny satellites as they pass overhead, and persons holding amateur radio licenses can transmit voice and Morse-code signals up to them as well.

OSCAR is an acronym for Orbiting Satellite Carrying Amateur Radio. A new book published by The American Radio Relay League provides everything the interested electronics and space buff needs to know to track, listen to, and transmit through the spacecraft. This new book *Getting to Know OSCAR — From the Ground Up* is a complete guide to the amateur satellites. Its 14 sections include an introduction to the exciting world of space communications, the equipment needed, a description of the brand-new OSCAR (and future ones now under construction), and a discussion of their many practical uses, such as relaying of medical data over long distances. Each copy also contains an attractive four-color tracking device that makes finding the satellites a simple task.

Every amateur radio operator, short-wave listener, electronics enthusiast, and technician now has access to all he will need to know to enter the space age via OSCAR. *Getting to Know OSCAR — From the Ground Up* is available for $3.00 postpaid at Ham Radio's Communications Bookstore, Greenville, New Hampshire 03048. Order AR-OSC.

Prototype High-Frequency Receiver

Ulrich Rohde, DJ2LR, has contributed many excellent articles on the subject of high-frequency receiver design, and a number of readers have asked if these design ideas have ever been incorporated into a receiver. The answer is yes — in a prototype built by DJ2LR's firm, Rohde & Schwarz. Although the receiver is a prototype and has never been placed in production (so is not available on the market), a list of its performance characteristics should spark the imagination of those amateurs who are still interested in building their own receivers.

The Rohde & Schwarz prototype is a frequency-synthesized, double-conversion communications receiver covering the range from 10 kHz to 32 MHz in steps of 100 Hz, selectable by thumbwheel switches. In addition, the receiver is fine-tunable ± 500 Hz from any preselected frequency set by the thumbwheel switches!

In operation, a signal is received by an *internal active antenna* or from either of the two external antenna input terminals and applied through switchable filters to a high-power, double-balanced mixer where it is converted to the first i-f at 41 MHz.

The first i-f signal is amplified by a push-pull, low-noise fet amplifier, passed through a

± 3.5 kHz bandwidth crystal filter, and delivered to another high-power, double-balanced mixer where it is converted to the second i-f at 455 kHz.

The output signal from the second i-f is fed into a low-noise, power fet and a diode circuit, and then through selectable mechanical filters. The signal is then demodulated by either the ssb/CW product detector or the a-m detector, depending upon the receive mode desired. Two independent agc circuits provide fast-attack, slow-decay characteristics (hang agc) for ssb/CW or medium response for a-m reception.

The audio amplifier has a built-in limiter and an active CW filter for improved reception. Audio output is through a built-in speaker, or may be taken from a rear panel connector. A rechargeable, built-in Ni-Cad battery power supply provides for five hours of continuous operation. An external power supply may be plugged in, if desired; requirements are 13.5 volts minimum, 24 volts maximum; nominal current drain is only 250 milliamperes.

Frequency stability is ± 1 ppm, internal, or an external frequency standard may be plugged in to provide laboratory-grade stability. Image i-f rejection is greater than 70 dB, independent of frequency setting, and adjacent-channel selectivity is high because of the mechanical filters in the second i-f, and the active audio filter (CW).

Reception modes are LSB, USB, CW, RTTY, and a-m. The noise figure is 10 dB; sensitivity is 0.3 μvolt for a 10 dB S/N ratio (ssb), and 1 μvolt (a-m).

This little receiver, barely a double handful, features an active antenna horizontally or vertically polarizable, meaning that no external antenna is required for most applications! It is designed for long-range monitoring, broadcast reception, public activities, press, military, coastal services, ships, time signals, and many other radio services.

More details? Ad Check page 86.

More details? Ad Check page 86.

HRH LOCATOR

TO HELP YOU FIND YOUR LOCAL AMATEUR RADIO DEALER

Alabama

LONG'S ELECTRONICS
2808 7TH AVENUE SOUTH
BIRMINGHAM, AL 35202
800-633-3410
Call Us Toll-Free
To Place Your Order.

Arizona

POWER COMMUNICATIONS
6012 N. 27 AVENUE
PHOENIX, AZ 85017
602-242-6030
Arizona's #1 "Ham" Store,
Kenwood, Drake, Icom & more.

California

C & A ELECTRONIC ENTERPRISES
2529 EAST CARSON STREET
P. O. BOX 5232
CARSON, CA 90745
213-834-5868
Not the biggest, but the best —
since 1962.

TOWER ELECTRONICS CORP.
24001 ALICIA PARKWAY
MISSION VIEJO, CA 92675
714-768-8900
Authorized Yaesu Sales & Service.
Mail Orders A Specialty.

Connecticut

ARCOMM ELECTRONICS
2865 MAIN STREET
BRIDGEPORT, CT 06606
203-335-9850
Featuring Ten-Tec and DenTron.

AUDIOTRONICS, INC.
18 ISAAC STREET
NORWALK, CT 06850
203-838-4877
The northeast's fastest growing ham department. Dedicated to service.
Kenwood dealer.

Florida

LAFAYETTE RADIO ELECTRONICS (Assoc. Store)
1811 N. HIGHWAY 17-92
MAITLAND, FL 32751
305-831-2271
The Electronics Emporium

Illinois

ERICKSON COMMUNICATIONS, INC.
5935 NORTH MILWAUKEE AVE.
CHICAGO, IL 60646
312-631-5181
Hours 9:30-9 Mon & Th. 9:30-5 Tu, Wed, Fri. 9-3 Sat.

SPECTRONICS, INC.
1009 GARFIELD STREET
OAK PARK, IL 60304
312-848-6777
Chicagoland's Amateur Radio leader.

Indiana

HOOSIER ELECTRONICS, INC.
P. O. BOX 2001
(43B Meadows Shopping Center)
TERRE HAUTE, IN 47802
812-238-1456
Communications Headquarters of the U.S.A.

Iowa

BOB SMITH ELECTRONICS
RFD #3, HIGHWAY 169 & 7
FORT DODGE, IA 50501
515-576-3886
For an EZ Deal on New or Used Equipment.

Kansas

ASSOCIATED RADIO
8012 CONSER, P. O. B. 4327
OVERLAND PARK, KS 66204
913-381-5901
Amateur Radio's top dealer.
Buy — Sell — Trade.

Maryland

THE COMM CENTER, INC.
LAUREL PLAZA - RTE. 198
LAUREL, MD 20810
301-792-0600
Drake, Hy-Gain, Mosley, Tempo, Ten-Tec, Wilson.

Massachusetts

TUFTS ELECTRONICS
209 MYSTIC AVENUE
MEDFORD, MA 02155
617-395-8280
New England's Friendliest Ham Store.

Michigan

RSE HAM SHACK
1207 W. 14 MILE
CLAWSON, MI 48017
313-435-5660
Complete Amateur Supplies.

Minnesota

PAL ELECTRONICS INC.
3452 FREMONT AVE. NO.
MINNEAPOLIS, MN 55412
612-521-4662
The Midwest's fastest growing ham dealer.

Nebraska

COMMUNICATIONS CENTER, INC.
443 N. 48 STREET
LINCOLN, NE 68503
402-466-8402
Call Toll Free for Low Prices! 800-228-4097

New Hampshire

EVANS RADIO, INC.
BOX 893, RT. 3A BOW JUNCTION
CONCORD, NH 03301
603-224-9961
Icom, DenTron & Yaesu dealer.
We service what we sell.

New Jersey

ATKINSON & SMITH, INC.
17 LEWIS STREET
EATONTOWN, NJ 07724
201-542-2447
Ham supplies since "55".

RADIOS UNLIMITED
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
New Jersey's newest, complete, Amateur Radio center.

New York

ADIRONDACK RADIO SUPPLY, INC.
185 WEST MAIN STREET
AMSTERDAM, NY 12010
518-842-8350
Yaesu and Kenwood dealer for the Northeast.

HRH LOCATOR
Continued

HAM-BONE RADIO
(Div. Stereo Repair Shop)
3206 ERIE BOULEVARD, EAST
SYRACUSE, NY 13214
315-446-2266
We Deal, We Trade,
We Discount, We Please!

HARRISON RADIO CORP.
20 SMITH STREET
FARMINGDALE, NY 11735
516-293-7990
"Ham Headquarters USA®"
since 1925.
Call toll free 800-645-9187.

Ohio

AMATEUR RADIO
SALES & SERVICE INC.
2187 E. LIVINGSTON AVE.
COLUMBUS, OH 43209
614-236-1625
Antennas for all services.

UNIVERSAL AMATEUR RADIO
1280 AIDA DRIVE
REYNOLDSBURG (Columbus)
OH 43068
614-866-HAMS
Drake, Yaesu, Ten-Tec, KDK, Wilson.
All Lines In Stock.

Pennsylvania

ARTCO ELECTRONICS
302 WYOMING AVENUE
KINGSTON, PA 18704
717-288-8585
The largest variety of semiconductors in Northeastern Pennsylvania

ELECTRONIC EXCHANGE
136 N. MAIN STREET
SOUDERTON, PA 18964
215-723-1200
Personal attention to Newcomer and Oldtimer.

Texas

HARDIN ELECTRONICS
5635 EAST ROSEDALE
FORT WORTH, TX 76112
817-461-9761
You Bet Fort Worth
Has A Ham Store!

More details? Ad Check page 86.

More details? Ad Check page 86.

HORIZONS ad·scan

RATES Regular classified is available at 50¢ per word. Display classified (1 inch deep x 2¼ inches wide) is $50, or at the 12x rate is $35. All Ad Scan payable in advance. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free regular classified ad (subject to our editing). Repeat insertions of hamfest ads pay the standard rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (not all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. *HORIZONS* cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of third preceding month.

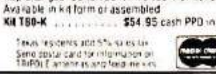
SEND MATERIAL TO: Ad Scan, Ham Radio Horizons, Greenville, N. H. 03048.

DIRECTORY OF STATESIDE QSL MANAGERS. Computerized cross-reference listing. Updated weekly. Most accurate and comprehensive source available. $1.00 with 24-cent business-size s.a.s.e. Gary Yarus, WS0MSZ, 921 N. Clay, St. Louis, Missouri 63122.

HAMS: Can you help a high school freshman get started? I need a Heathkit VF-1, HG-10 or HG-10B; Eico 722 or Johnson 122; and Hallicrafter HA-5. I don't have much money but will pay fair price for gear in good working condition. Larry Krainson, WB1DBY, 153 Brookwood Drive, Longmeadow, Massachusetts 01106.

STOLEN: Regency HR-2B, Registration Number 2200-363 engraved on the left front side. Rear terminal speaker strip is replaced by a mini-plug. Transceiver is bracketed to an AR-2 Regency amplifier. If seen, call Earl Carrier, K8LWP, collect, at 1-419-625-1817, or notify the Sandusky Police Department, Sandusky, Ohio 44870.

UR TRIPOLE MULTI-BAND



All-band antenna. Guaranteed. 80 to 6 Meters plus 160* 5 SWL Bands. Built-in balun. 2 KW PEP rating. No retuning, tap or trap changes. 80 to 120 ft inverted-V or horizontal. Available in kit form or assembled.
Kit T80-K .... $54.95 cash PPD in USA

Universal Radio Co. Dept. H3
Box 26041 El Paso, TX 79926
Telephone (915) 592-1910

Texas residents add 5% sales tax. Send postal card for information on TRIPOLE antennas and feed line kits.

27th DAYTON HAMVENTION at Hara Arena April 28, 29, 30, 1978. More room this year! Technical forums, exhibits and huge flea market. Program brochure mailed March 6th to those registered within past three years. For accommodations or advance flyer, write Hamvention, P.O. Box 44, Dayton, OH 45401 or call 513-854-4126.

SST T-1 RANDOM WIRE ANTENNA TUNER

All band operation (160-10 meters) with most any random length wire. 200 watt output power capability. Ideal for portable or home operation. Toroid inductor for small size 3 x 4-1/4 x 2-3/8. Built-in neon tune-up indicator. SO-239 coax connector. Guaranteed for 1 yr., 10 day trial. Compact — easy to use ... only $29.95 postpaid. (Add Sales Tax in Calif.) (213) 376-5887

SST ELECTRONICS, P.O. BOX 1, LAWNDALE, CA. 90260

STOLEN AMATEUR RADIO EQUIPMENT: Anyone desiring to list stolen amateur radio equipment please send information to Colorado Council of Amateur Radio Clubs, c/o Charles E. Meyers, W0RNT, 1120 Yosemite Drive, Colorado Springs, Colorado 80910. Include as much information as possible. FREE distribution will be made to all Amateur Radio magazines and Colorado Amateur Radio Clubs. Funds for postage and printing will be greatly appreciated.

SAVE $$$. Build your own: LINEAR AMPLIFIERS, 50-100 watt solid state. FREQUENCY COUNTER, 300 MHz, 7 digit, crystal accuracy, portable/mobile, memory! BASE ANTENNA, omnipolarized! Omnidirectional! VOX-COMPRESSOR AND MORE! Construction plans $3.00 each, 3 up/$2.50 each. Specify desired band. PANAXIS, Box 5516-AS3, Walnut Creek, CA 94596.

QSL's with class! Unbeatable quality, reasonable price. Samples, 25¢. QSL's Unlimited, Box 27553H, Atlanta, GA 30327.

"THE CADILLAC" of QSL's! — New! Samples: $1.00 (Refundable) — MAC'S SHACK, Box #1171-G, Garland, Texas 75040.

PHOTOGRAPHERS: I am a retired broadcast engineer who would like to meet active hams, on the air, who are interested in the historical processes of photography such as carbro, oil, bromoil, etc., for the purpose of exchanging data on the air with the hope of working together to preserve the knowledge of these beautiful processes for future generations of ham-photographers. I work all bands, 2 through 160 meters, am or ssb. For sked info please contact Tracy Diers, W2OQK, 58-14-84th Street, Elmhurst, N.Y. 11373.

GOVERNMENT SURPLUS Ham Band Gear. Send S.A.S.E. to Gordon, 10925 Morris Avenue South, Bloomington, Minnesota 55437.

TOROIDS 88 or 44 mH. Same day shipment. 5 for $3.50 postpaid. Gull Electronics, 12690 Rt. 30, N. Huntington, PA 15642.

MIDLAND AMATEUR RADIO CLUB will have a Swap Fest on Saturday and Sunday, March 18 and 19th. It will be held in the County Exhibit Building on Highway 80 just east of Midland, Texas. Pre-registration will be $3.50 per person, and $4.00 at the door. Please send registration fees to: Midland Amateur Radio Club, Box 4401, Midland, Texas 79701.

AWARD CERTIFICATES
Award for Public Service or Emergency Communications Award. Send 2.00 each, event, name and address. FREE Information. 49'er RADIO CLUB, Box 1400-HH, Downey, Calif. 90240.

CODE PRACTICE OSCILLATORS, hand keys, electronics keyers, other products. Free catalog. Globalman Products, Box 246, El Toro, CA 92630. 714-533-4400.

MOBILE IGNITION SHIELDING provides more range with no noise. Bonding strap sale less than 50¢ each. Literature. Estes Engineering, 930 Marine Drive, Port Angeles, Wash. 98362.

HAMFEST APRIL 1-2 by Mecklenburg Amateur Radio Society, Inc., W4BFB at new Civic Center in Charlotte, N.C. Plenty of parking, fun, and excitement. Come and enjoy with us!.

WEST COAST BULLETIN edited and transmitted by W6ZF, 9 PM PDT (8 PM PST) (0400 UTC) 3450 kHz, A-1, 22 WPM, FIRST AND THIRD MONDAYS each month. Ten to fifteen items of latest current events of interest to Amateurs, with final few minutes at 25 WPM to help build code speed.

ADVANCED MICROCOMPUTER INTERFACING AND PROGRAMMING WORKSHOP. On board the TSS Carnivale in the Carribean June 17-24, 1978. This five-day workshop will be based on a hands-on course using the popular 8080 and 8085 microprocessors. The use of programmable interface chips, data acquisition modules, programming techniques as well as future trends will be some of the topics covered. For more information contact Dr. Norris Bell, V.P.I. and S.U., Continuing Education Center, Blacksburg, Virginia 24061, (703) 951-6208.

ENGRAVED NAMETAGS 1½" x 2½" — $3.00. QTH added $0.50. Door plates, key tags available. Black, blue, red, walnut with white letters. Other colors available. Tag-it Co., Box 2062, Indianapolis, IN 46206.

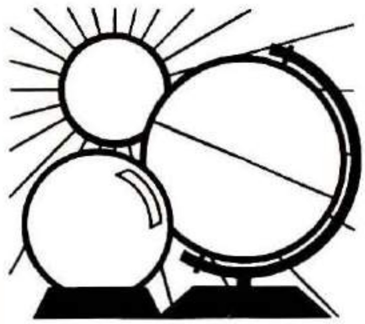
Free **solitrex** Literature
ELECTRONIC VOLTAGE REGULATORS FOR CAR ALTERNATORS
- Operating Range: −50°C to +85°C
- Full Warranty For 5 Years (£ 7.30)
- Available For Most Cars, Send $ 14.95 to

SOLID STATE DEVELOPMENT COMPANY
P.O.Box 108, Clarkson Postal Station,
Mississauga, Ontario, CANADA, L5J 3X9

FREE LICENSING CLASSES in Flushing, NY area. Send inquiries to FRATS (Flushing Radio Amateur Technical Society), 62026 Boelsen Crescent, Rego Park, NY 11374.

THE 4TH ANNUAL NORTHWESTERN PENNSYLVANIA Hamfest, May 6th, Crawford County Fairgrounds, Meadville, PA. Gates open at 8:00. $2 prize ticket required for admission — $1 to display. Children FREE. Hourly door prizes, refreshments, commercial displays welcome. Indoors if rain. Talk-in 04/64 and 52. Details CARS, P.O. Box 653, Meadville, PA. 16335.

17TH ANNUAL MICHIGAN CROSSROADS HAMFEST opening 8:00 AM, Saturday, March 4, 1978 at Marshall High School (Exit 110 from I-94 near I-69). Over $300 in door prizes. Check in 146.07/67 & 146.52 for lucky QSL card. Donation $1.50 advance, $2.00 at door. Table donations 50¢ each foot. Contact, Goodrich, K8UCQ, 110 Perrett, Marshall, MI 49068, 616-781-3554.



DX FORECASTER

March weather is traditionally unsettled, but radio propagation tends to be better than usual because of the equinox (March 21st) when Northern and Southern hemispheres enjoy days and nights of equal length. The most likely times for major disturbances during the month will be the week between March 4th and 11th, and a ten-day period between March 21st and 31st. Moon perigee occurs March 5th and 31st, and a lunar eclipse is scheduled for the 24th. The path of totality will take in extreme northwest North America, Australia, part of Antarctica, Asia, Africa, and Europe. During the periods of forecast disturbances keep your receivers tuned to WWV at eighteen minutes after the hour so that you can keep track of solar and geomagnetic upsets, which are likely to reach their peaks around the 5th and 27th. Unusual propagation and weather conditions are likely to accompany, or shortly follow, the disturbed periods.

Band-by-band propagation

Ten Meters will be remarkable for its activity, with many days of the month showing good ten-meter openings to Europe and Africa — occasionally to the Pacific.

Fifteen Meters may well turn out to be the best overall DX band this month, with openings to Europe and Africa in the forenoon, South America in the early afternoon, and the Pacific in the late afternoon or early evening. Very good short-to-medium skip will be a regular phenomenon.

Twenty Meters, as always, will be the favorite hunting ground for serious DXers, but the crowded conditions and high power levels will tend to drive newcomers to fifteen where DXing will be more relaxed — and modest equipment more effective.

Forty, Eighty, and One-Sixty will continue to bring very good to excellent DX during the evening and early-morning hours. Signals will tend to peak somewhat later than during the winter months, and the onset of spring will produce thunderstorm activity and higher noise levels. The chart can be used as an indicator of where and when to look for particular DX areas. Strong Central- and South-American signals will frequently mask weaker signals from rare spots. Dig deep for the "goodies."

Twilight-zone DXing is particularly good during the equinoctial period, so be alert for long-path signals as well as propagation along the north-south path of the line of advancing darkness. An hour before and after local dark will be particularly favorable for listening — and working DX!

VHF Opportunities will present themselves during the predicted periods of disturbance due to the active ionosphere and potentially higher usable frequencies. Tropospheric propagation along the edges of advancing cold fronts will be good this month, too. Be on the alert for auroral propagation around the 5th, 6th, and 7th and again on the 26th, 27th, and 28th of March.

MARCH

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	—	—	20	20	10	10	10	15*
0100	5:00	10	—	20	20	10	15	15	15*
0200	6:00	15*	—	—	20	15	15	15	15
0300	7:00	15	—	40	20	15	15	10	15
0400	8:00	20	40	40	20	15	15	20	20
0500	9:00	20	80	80	40	20	20	20	20
0600	10:00	20	40	—	40	20	20*	20	20
0700	11:00	—	40	—	40	—	20*	20	20
0800	12:00	—	40	—	40	—	40	20	20
0900	1:00	—	40	—	40	—	40	—	20
1000	2:00	—	40	—	—	40	40	—	—
1100	3:00	—	—	—	—	40	80*	40	80
1200	4:00	40	—	—	—	—	80*	40	40
1300	5:00	40	20	—	—	—	80*	40	40
1400	6:00	40	20	—	—	—	—	40	40
1500	7:00	20	15	40	—	—	—	—	40
1600	8:00	15	15	15	15	20	—	20	20
1700	9:00	15	15	15	15	20	—	20	20
1800	10:00	20	15*	15*	15	—	—	20	—
1900	11:00	20	20	15*	10	—	—	15	—
2000	12:00	—	20	15	10	—	—	15	15
2100	1:00	—	20	15	10	—	—	15	15
2200	2:00	—	—	20	15	—	10	10	15
2300	3:00	—	—	20	20	—	10	10	15

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	40	—	20	20	—	10	15	15	6:00
0100	6:00	40	40	—	20	—	10	15	15	7:00
0200	7:00	40	80*	—	20	20	10	—	15	8:00
0300	8:00	—	80*	40	40	20	20*	—	20	9:00
0400	9:00	—	80*	40	40	—	20	—	20	10:00
0500	10:00	—	80*	40	40	—	20	—	20	11:00
0600	11:00	40	80*	—	40	—	—	—	20	12:00
0700	12:00	40	40	—	40	—	—	—	20	1:00
0800	1:00	—	40	—	40	40	40	—	20	2:00
0900	2:00	—	—	—	40	40	80*	—	—	3:00
1000	3:00	20	—	—	40	40	80*	40	40	4:00
1100	4:00	20	—	—	40	—	40	40	40	5:00
1200	5:00	20	—	—	40	—	40	40	40	6:00
1300	6:00	20	—	—	20*	—	20	20	20	7:00
1400	7:00	15	15	—	20*	—	20	20	20	8:00
1500	8:00	15	15	—	15	—	20	20	20	9:00
1600	9:00	20*	15	15	15	—	—	20	—	10:00
1700	10:00	20	15	15	15	—	—	15	—	11:00
1800	11:00	—	20	15	10	—	—	15	—	12:00
1900	12:00	—	20	15	10	—	—	15*	—	1:00
2000	1:00	—	20	15	15*	—	15	10	15	2:00
2100	2:00	—	20	20*	15*	—	15	15*	15	3:00
2200	3:00	20	20	20*	15*	—	15	15	15	4:00
2300	4:00	20	—	20	20	—	15*	15	15*	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	40*	40	40	—	15	15	15	15
0100	8:00	40*	40	40	40	20	20	20	20
0200	9:00	40*	80	80	40	20	20	20	20
0300	10:00	—	80	80	40	80*	20	20	20*
0400	11:00	—	80	80	—	80*	20	—	—
0500	12:00	40	80	—	—	40	—	—	20
0600	1:00	40	80*	—	—	40	—	—	—
0700	2:00	40	40	—	—	40	40	40	—
0800	3:00	—	—	—	—	40	40	40	—
0900	4:00	—	20	—	—	—	40	40	—
1000	5:00	—	20	—	—	—	40	40	80*
1100	6:00	—	20	—	20	—	—	—	80*
1200	7:00	20	20	—	15	—	20	20	40*
1300	8:00	20	15	—	15	—	20	20	20
1400	9:00	20	15	—	15	15	20	20	20
1500	10:00	—	10	—	15	15	—	—	20
1600	11:00	—	10	15	15	15	—	—	—
1700	12:00	—	15*	15	15	15	15	—	—
1800	1:00	—	15	15	15	10	15	15	—
1900	2:00	20	15	20	15	10	15	15	—
2000	3:00	20	20	20	15	10	15	15	20
2100	4:00	15	20	20	20	10	15	15	15
2200	5:00	15	—	—	20	10	15	15	15
2300	6:00	20	—	—	20	15	15	15	15

HAM CALENDAR

March 1978

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
*All international events such as contests are shown on the GMT days on which they take place even though they may actually begin on the evening of the preceding day in North America.		 smile!	1	2	West Coast Computer Faire — San Jose Convention Center — San Jose, CA — Info: Jim Warren, Computer Faire — Box 1579, Palo Alto, CA 94302 — (415) 851-7075, 851-7664 — 3-5 3	ARRL DX Contest — Phone — 4-5 YL-OM Contest — CW — 4-5 4
Teays ARC Ham Fiesta — Pickaway County Fairgrounds — Circleville, OH — W8UCF Sterling-Rock Falls ARS Hamfest — Sterling High School Field House — 1608 4th Avenue — Sterling, IL — WA9PBS 5	FLORIDA HAM NEWS — SWAP NET By the Broward ARC — Ft. Lauderdale, FL — 146.31-91 at 7:30PM WEST COAST BULLETIN Edited & Transmitted by W6ZF 8PM PST 3540 kHz, A-1, 22 WPM 6	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) 7	8	9	Jefferson Barracks ARC — Hamfest/Auction — Electronics Hall, 5850 Elizabeth Avenue — St. Louis, MO 10	11
12	FLORIDA HAM NEWS — SWAP NET By the Broward ARC — Ft. Lauderdale, FL — 146.31-91 at 7:30PM 13	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) 14	15	16	17	ARRL DX Contest — CW — 18-19 ARRL South Carolina State Convention — Greenville, SC — 18-19 Knight Raiders VHF Club Auction/Fleamarket — St. Joseph's Church — East Rutherford, NJ 18
Toledo Mobile Radio Association Auction/Hamfest — Lucas County Rec Center — Toledo, OH Tri County ARC Hamfest — Activities Building on the Jefferson County Fairgrounds — Jefferson, WI — WA9VYL 19	FLORIDA HAM NEWS — SWAP NET By the Broward ARC — Ft. Lauderdale, FL — 146.31-91 at 7:30PM WEST COAST BULLETIN Edited & Transmitted by W6ZF 8PM PST 3540 kHz, A-1, 22 WPM 20	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) 21	22	23	24	ARRL Great Lakes Div. Convention — Muskegon, MI CQ WW WPX Contest — 25-26 BARTG Spring RTTY Contest — 25-27 — Info: HAM RADIO HORIZONS — Greenville, NH 03048 25
 See March 4, 6, 18, 20 26	FLORIDA HAM NEWS — SWAP NET By the Broward ARC — Ft. Lauderdale, FL — 146.31-91 at 7:30PM 27	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) 28	29	30	31	

TEMPO

VHF / ONE PLUS

MORE POWER / 25 OR 5 WATTS OUTPUT SELECTABLE

REMOTE TUNING / ON MICROPHONE

NEW LOWER PRICE / NOW ONLY $399.00

SIDEBAND OPERATION WITH SSB/ONE ADAPTER / MARS OPERATION CAPABILITY / 5 KHz NUMERICAL LED

The Tempo VHF / One Plus is a VHF / FM transceiver for dependable communication on the 2 meter amateur band • Full 2 meter coverage, 144 to 148 MHz for both transmit and receive • Full phase lock synthesized (PLL) • Automatic repeater split—selectable up or down • Two built-in programmable channels • All solid state • 800 selectable receive frequencies with simplex and +600 KHz transmit frequencies for each receive channel.

TEMPO FMH-2, FMH-5 & FMH-42 (UHF)

6 channel capability • selectable 1 or 2 - 1 or 5 Watts output • Solid-state • Battery level meter • Earphone jack • Built-in charging terminals and separate charging jack for Ni-cad batteries • Flex antenna • Carrying case standard • Excellent frequency stability allows use with booster amplifier for high power output over 100 Watts • 8 AA batteries or 10 AA Ni-cads*

*Not furnished.

FCC Type accepted models available.

TEMPO VHF & UHF AMPLIFIERS

VHF (135 to 175 MHz)

Drive Power	Output	Model No.	Price
2W	130W	130A02	$199
10W	130W	130A10	$179
30W	130W	130A30	$189
2W	80W	80A02	$169
10W	80W	80A10	$149
30W	80W	80A30	$159

UHF (400 to 512 MHz)

Drive Power	Output	Model No.	Price
2W	70W	70D02	$270
10W	70W	70D10	$250
30W	70W	70D30	$210
2W	40W	40D02	$180
10W	40W	40D10	$145
2W	10W	10D02	$125

FCC Type accepted models available.

TEMPO POCKET RECEIVERS

MS-2, 4 channel scanning receiver for VHF high band, smallest unit on the market. MR-2 same size as MS-2 but has manual selection of 12 channels. VHF high band. MR-3, miniature 2-channel VHF high band monitor or paging receiver. MR-3U, single channel on the 400 to 512 UHF band. All are low priced and dependable.

Sold at Tempo dealers throughout the U.S. and abroad. Please call or write for further information.

Prices subject to change without notice

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 — 213/477-6701
931 N. Euclid, Anaheim, Calif. 92801 — 714/772-9200
Butler, Missouri 64730 — 816/679-3127

Henry Radio

AD CHECK

. . . for literature, in a hurry ✓ we'll rush your name to the companies whose names you **check**.

Place your check mark in the space between name and number. **Example: HRH ___ 150.**

Amateur Elect. Supply ___ 659
Atlas ___ 198
Atronics ___ 382
CW Elect. ___ 533
Cohoon ___ 559
Colorado Silver ___ 630
Comm. Center ___ 534
Comm. Spec. ___ 330
Cont. Specialties ___ 348
Copy One ___ 651
Cushcraft ___ 035
DSI ___ 656
Dayton Hamvention *
DenTron ___ 259
Digital ___ 631
Drake ___ 039
E. T. O. *
Elect. Dist. ___ 044
Elect. Equip. Bank ___ 288
Erickson ___ 047
Gilfer ___ 207
Globe Union ___ 660
Gotham ___ 661
Hal ___ 057
"Ham" Buerger *
Ham Center ___ 491
H. R. C. B. ___ 150
H. R. Horizons ___ 150
Ham Outlet ___ 595
Heath ___ 060
Henry ___ 062
ICOM ___ 065
Int. Crystal ___ 066
Kantronics ___ 605
Kenwood *
Kester ___ 492
Larsen ___ 078
Long's ___ 468
MFJ ___ 082
Madison *
Microwave Filter ___ 637
Oak Hill Acad. A. R. S. ___ 213
Palomar ___ 093
Partridge ___ 439
RF Power Comp. ___ 542
RSE Ham Shack ___ 607
Callbook ___ 100
Constructor ___ 586
Radiola ___ 569
Rohde Schwarz ___ 306
Rohn ___ 410
Rusprint ___ 662
S-F Am. Radio Serv. ___ 640
Swan ___ 111
Western *
Whitehouse ___ 378
Wilson ___ 123

*Please contact this advertiser directly.
Limit 15 inquiries per request.

MARCH, 1978
Please use before April 30, 1978

Tear off and mail to
HAM RADIO HORIZONS — "Ad Check"
Greenville, N. H. 03048

NAME ______________________

CALL ______________________

STREET ______________________

CITY ______________________

STATE ____________ ZIP ____________

AD INDEX

Amateur Electronic Supply 73
Atlas Radio Company 79
Atronics 74
CW Electronic Sales Co. 68
Cohoon Amateur Supply 72
Colorado Silver Co. 67
Communications Center 62
Communications Specialists 51
Continental Specialties 23
Copy One 74
Cushcraft 4, 88
DSI Instruments 33
Dayton Hamvention 78
DenTron Radio Company 44, 45
Digital Electronics, Inc. 69
Drake Co., R.L. Cover II, 68
Ehrhorn Technological Operations 71
Electronic Distributors, Inc. 77
Electronic Equipment Bank 80
Erickson Communications 80
Gilfer Associates 72
Gotham 74
Hal Communications Corp. 75
"Ham" Buerger 67
Ham Radio Center 78
Ham Radio Horizons 87
Ham Radio Outlet 9
Heath Company Cover IV
Henry Radio Stores 85
ICOM 7
International Crystal 65
Kantronics 63
Trio-Kenwood Communications Inc. Cover III
Kester Solder 77
Larsen Antennas 29
Long's Electronics 1
MFJ Enterprises 3
Madison Electronic Supply 86, 87
Microwave Filter, Inc. 62
Oak Hill Academy Amateur Radio Session 87
Palomar Engineers 43, 50, 82
Partridge Electronics Ltd. 73
RF Power Components 72
RSE Hamshack 87
Radio Amateur Callbook 80
Radio & Electronics Constructor 87
Radiola 73
Unarco-Rohn 61
Rusprint 67
S-F Amateur Radio Services 80
Swan Electronics 52, 53
Western Electronics 77
G. R. Whitehouse & Co. 32
Wilson Electronics 10

Foreign Subscription Agents for Ham Radio HORIZONS

Ham Radio Austria
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Stereohouse
Brusselsesteenweg 416
B-9218 Gent
Belgium

Ham Radio Canada
Box 114, Goderich
Ontario, Canada N7A 3Y5

Ham Radio Europe
Box 444
S-194 04 Upplands Vasby
Sweden

Ham Radio France
Christiane Michel
F-89117 Parly
France

Ham Radio Germany
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Holland
MRL Ectronics
Postbus 88
NL-2204 Delft
Holland

Ham Radio Italy
STE, Via Maniago 15
I-201 34 Milano
Italy

Ham Radio Switzerland
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio UK
P.O. Box 63, Harrow
Middlesex HA3 6HS,
England

Holland Radio
143 Greenway
Greenside, Johannesburg
Republic of South Africa

HELP!

Anytime you have a question about your Ham Radio HORIZONS subscription, please include a mailing label to insure prompt service on your inquiry.

AFFIX LABEL HERE

CHANGE OF ADDRESS

If you're going to move, please let us know four to six weeks before doing so. Or, if there is anything wrong with your current mailing label, please let us know on this form also. Simply affix your present label here, and carefully print the updated information below.

PLEASE HELP US TO SERVE YOU BETTER

HAM RADIO HORIZONS Greenville, NH 03048

Name______________ Call__________

Address______________________

City_________________________

State ____________ Zip__________

AMATEUR PRODUCTS GALORE!

YAESU

FT-301D all solid-state transceiver; 160-10 meters; AM, CW, SSB, FSK; 200 watts PEP input on SSB, 200 watts DC input on CW, and 50 watts DC input on AM or FSK; features 100-Hz frequency stability, 6-digit LED frequency display; tailored audio response, 0.25 μ sensitivity, variable selectivity from 0.6 to 12 kHz, requires only 13.5-volts DC power source; matching AC supply and speaker available.*

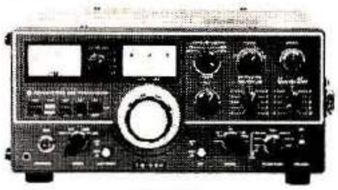
FT-301D TRANSCEIVER

ALL SOLID STATE

Famous YAESU quality, reliability, and versatility, and now all solid state! Conserves energy too.

*We will include FREE AC power supply with every purchase of a new FT-301D. You can't beat this offer, so order now.

KENWOOD



TS-520S
160-10M TRANSCEIVER

Ask around about Kenwood's TS-520. It's in constant use around the globe and has a record of reliability that is universally admired. USB, LSB, CW, operates AC, WWV receiver, RIT, VOX and noise blanker are some features that make the TS-520 a very welcome companion in your shack.

Also, come in and ask about the **NEW** Kenwood TS-820 that has all of the great features found in the TS-520 plus so many truly unique operating advantages that it is the Pacesetter of the industry.

KENWOOD

TR-7400A two-meter FM transceiver covers 144-148 MHz in 5-kHz steps, selectable simplex and 600-kHz offset; PLL circuitry with unlock protection; LED digital frequency display; CTCS encode-decode, plus tone-burst; MOSFET with helical resonators, plus 2-pole 10.7-kHz crystal IF filter for superior sensitivity and selectivity, and much more. Write today for details and price.

Call or visit with us today for assistance in selecting the Amateur product that is the most likely to meet your operating requirements.

RSE HAM SHACK

1207 W. 14 MILE, CLAWSON, MICHIGAN 48017
313-435-5660

RADIO & ELECTRONICS CONSTRUCTOR

Here is an interesting general electronics hobby magazine. It's loaded with lots of interesting simple circuits and ideas, not only about radio, but in all phases of electronics including test gear, audio, remote control and security electronics.

We are sure that you will find a number of worthwhile projects in this British magazine.

1 Year (12 issues) $12.00

Radio & Electronics Constructor
Greenville, NH 03048

Oak Hill Academy Amateur Radio Session

19th Year – July 29 thru August 11, 1978

We have moved our location just 15 miles from our previous site to the Oak Hill Academy, Mouth of Wilson, Virginia.

Our accommodations are now the finest one could hope for, suites in a beautiful Dorm with bath for each four students. Lovely spacious lobby and fine recreation room in the lower level of the dorm.

Oak Hill Academy in the Appalachian Mountains of Virginia offers an intensive two week Radio Session in code and theory starting at your level.

Expert instructors, some of whom have been on the staff for the past 18 years are the same. Only the location has been changed. Close association with fellow amateurs offers an opportunity for Saturation Learning that has been very successful since its conception. Novices upgrade to General, Techs to General & Advanced, and Advanced become Extras.

Golf privileges, canoeing on the New River & many other recreation activities are offered. Make your vacation a "Vacation with a Purpose" and upgrade your license at a beautiful school in the cool mountains of Virginia.

Formerly Glade Valley School Radio Session

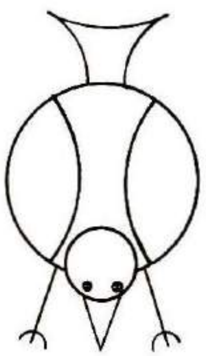
C. L. PETERS, K4DNJ, Director
Oak Hill Academy Amateur Radio Session
Mouth of Wilson, Virginia 24363

Name______________________ Call________

Address____________________________

City/State/Zip_______________________

WHAT DO THE BIRDS WATCH?



OTHER BIRDS, of Course!

Be a good egg . . . buy a BIRD!
. . . from your Bird distributor

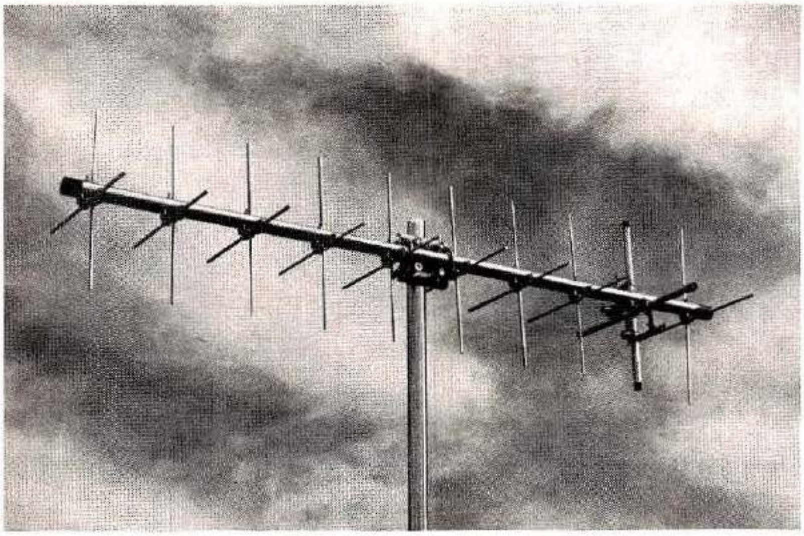
MODEL 43

$120

ALL ITEMS AND ELEMENTS ORDINARILY IN STOCK
Prepaid Shipment in Continental USA Only

MADISON ELECTRONICS SUPPLY, INC.
1508 McKINNEY HOUSTON, TEXAS 77002
713/658-0268 Nites 713/497-5683

2 METERS...

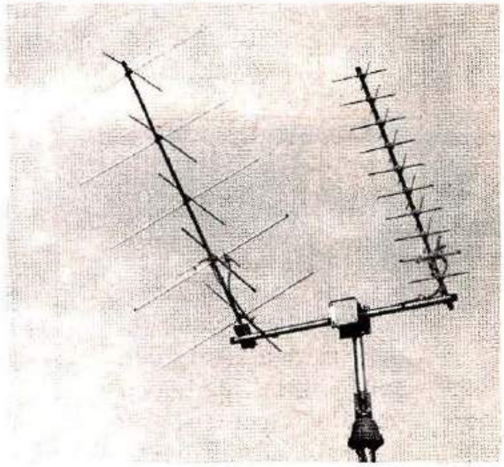


. . . *Alive* with activity at *both* ends of the band! Be a part of the total 2 Meter picture with the Cush Craft Twist Antenna. Actually two, easily assembled, 10 element yagis in one — the vertical elements are cut for the high end, the horizontal elements for the low end, and separate feed lines are used. The A147-20T is tailored to meet the demands of the operator who enjoys the best of both worlds — FM and SSB/CW.

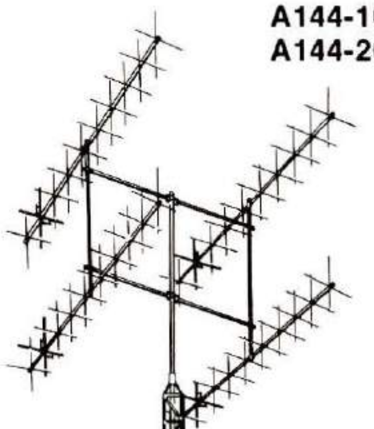
A147-20T $54.95

CQ OSCAR .... ..

. . . *Extend your horizon* — Explore the exciting new world of amateur satellite communications using low power with our multi-polarized Twist Antennas. All models include phasing harness for selectable linear or right/left circular polarization. Two of these Twists may be mounted on the A14T-MB mounting boom which is complete with a pre-drilled plate for a readily available mast-through rotator. *Face this challenging frontier—Become a Specialist!*



A144-10T $34.95
A144-20T $54.95
A432-20T $49.95
A14T-MB $15.95



PERFORMANCE ARRAYS . . .

Enjoy fade-free contacts on VHF/UHF with Twist Antennas and Arrays. Excellent for scatter and other long-haul techniques. Double your effective radiated power by stacking two Twists, or quadruple ERP by stacking four Twists. Arrays are easily assembled for your special communications requirement. Write for stacking and phasing harness details concerning amateur and commercial frequencies.

Dependable communications — *Now Yours!*

SPECIFICATIONS

Model	A147-20T	A144-10T	A144-20T	A432-20T
Center Freq. (MHz)	144.5/146.5	145.9	145.9	432
No. Elements	10/10	10	20	20
Weight (lbs.)	6	3.5	6	3.5
Wind Surf. Area (ft.²)	1.42	.74	1.42	.37
Mounting	Center	Rear	Center	Rear
Dimensions (Inches)	40x40x140	40x40x70	40x40x140	14x14x57

IN STOCK WITH DISTRIBUTORS WORLDWIDE

cushcraft

THE ANTENNA COMPANY

P.O. BOX 4680, MANCHESTER, N.H. 03108

More details? Ad Check page 86.

KENWOOD

...pacesetter in amateur radio

Kenwood offers this handsome pair for the amateur who appreciates the advantages of operating a receiver/transmitter combination. Discover the difference in performance, features and price of the 599D "Twins".

Kenwood developed the T-599D transmitter and R-599D receiver for the most discriminating amateur.

The R-599D is the most complete receiver ever offered. It is entirely solid state, superbly reliable and compact. It covers the full amateur band, 10 through 160 meters, CW, LSB, USB, AM and FM.

The T-599D is solid-state with the exception of only three tubes, has built-in power supply and full metering. It operates CW, LSB, USB and AM and, of course, is a perfect match to the R-599D receiver.

If you have never considered the advantages of operating a receiver/transmitter combination ... maybe you should.

Because of the larger number of controls and dual VFOs the combination offers flexibility impossible to duplicate with a transceiver.

Compare the specs and prices of the R/T-599D combination with any other brand of separates. Remember, the R-599D is all solid state (and includes four filters).

Your choice will obviously be the Kenwood.

R-599D/T-599D

Limited quantities available in the Spring!

TL-922

The Kenwood family is growing! The TL-922, a brand new linear amplifier, is now a reality.

Give yourself the "big signal" that commands attention on today's crowded bands. The TL-922 runs the full legal limit on the ham bands from 160-10 meters and is compatible with most amateur exciters. The TL-922 is a must in any Kenwood station.

Make yourself heard like you've never been heard before, with the Kenwood TL-922 linear amplifier.

TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220

The HEATHKIT SB-104A
The Head of the Class

Our top-of-the-line Heathkit SB-104A is the culmination of Heath's engineering excellence and expertise in Amateur Radio design. It's the transceiver the serious Radio Amateur aspires to – totally broadbanded, fully solid-state, true digital readout and much more – a truly superior performer that should be the "heart" of any first-class operating station.

That same engineering excellence goes into every piece of Heathkit Amateur Radio equipment – it's part of the reason Heath has been the start, and standby, of Amateur Radio hobbyists the world over. Heathkit equipment gives you superior performance, day-in, day-out reliability and more VALUE for your money. And because Heathkit Amateur equipment comes to you in easy-to-build kit form, you learn more about your hobby as you put the kits together, you SAVE money over comparable assembled units, and you can service the equipment and keep it in top operating condition.

So whether you intend to work the world on a couple of watts CW, or "go-the-limit" with state-of-the-art SSB, you'll find Heath is the place with quality good enough to measure up…to you!

For complete information on our entire line of quality Amateur Radio products use the postcard, found elsewhere in this magazine, and send for your FREE Heathkit Catalog, or write: Heath Company, Dept. 348-390, Benton Harbor, Michigan 49022.