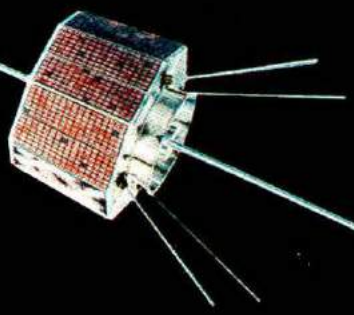
MARCH 1977/$1.00

HAM RADIO HORIZONS

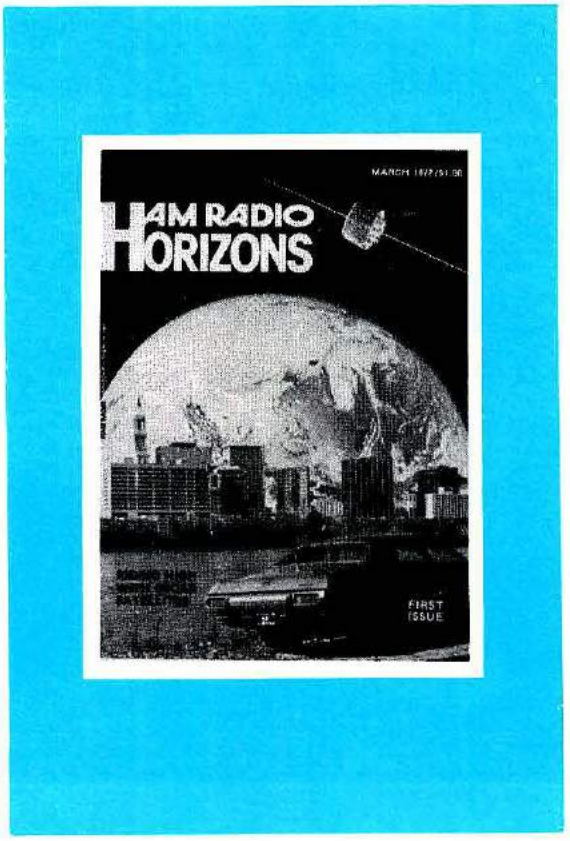


A New Era in Amateur Radio Arrives

SEE PAGE 37

RIDING HIGH WITH OSCAR SATELLITES

FIRST ISSUE



Here it is! The most exciting publishing event in the history of Amateur Radio.

Look over the enclosed copy of Ham Radio HORIZONS very carefully. You will see a fresh vibrant new magazine completely unmatched by anything else in it's field.

Ham Radio HORIZONS is specifically dedicated to the thousands of newcomers and would-be Hams, but it's so loaded with the flavor and the fun of Amateur Radio that everyone new and old is going to find it to be fascinating reading.

We've come up with a magazine that will talk clearly to the youngest reader and will interest other family members yet will be a super FUN experience for the most experienced Amateur.

You will see that we've tried to cover almost every facet of Amateur Radio from DX'ing to learning the code, from Oscar satellites to setting up your first station. It's all there, written and edited in the clearest, most easy-to-read form ever. This is all an awfully big order, but I think that you're going to agree that Ham Radio HORIZONS does a great job of it.

To make it even more enticing we are offering a special introductory discount subscription price to what will quickly become Amateur Radio's most popular monthly magazine. Don't miss a single issue (the early ones will quickly be collector's items). Send in your order today.

73,

Skip Tenney

Skip Tenney, W1NLB
Publisher

P.S.

If you've already subscribed don't worry. We've sent this offer to nearly everyone. Your actual subscription will start with next month's issue.

MARCH 1977/$1.00

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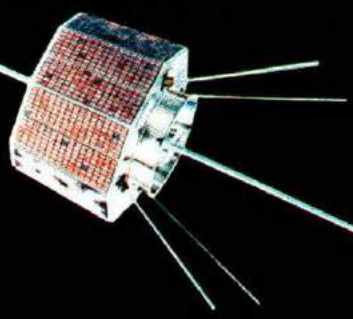
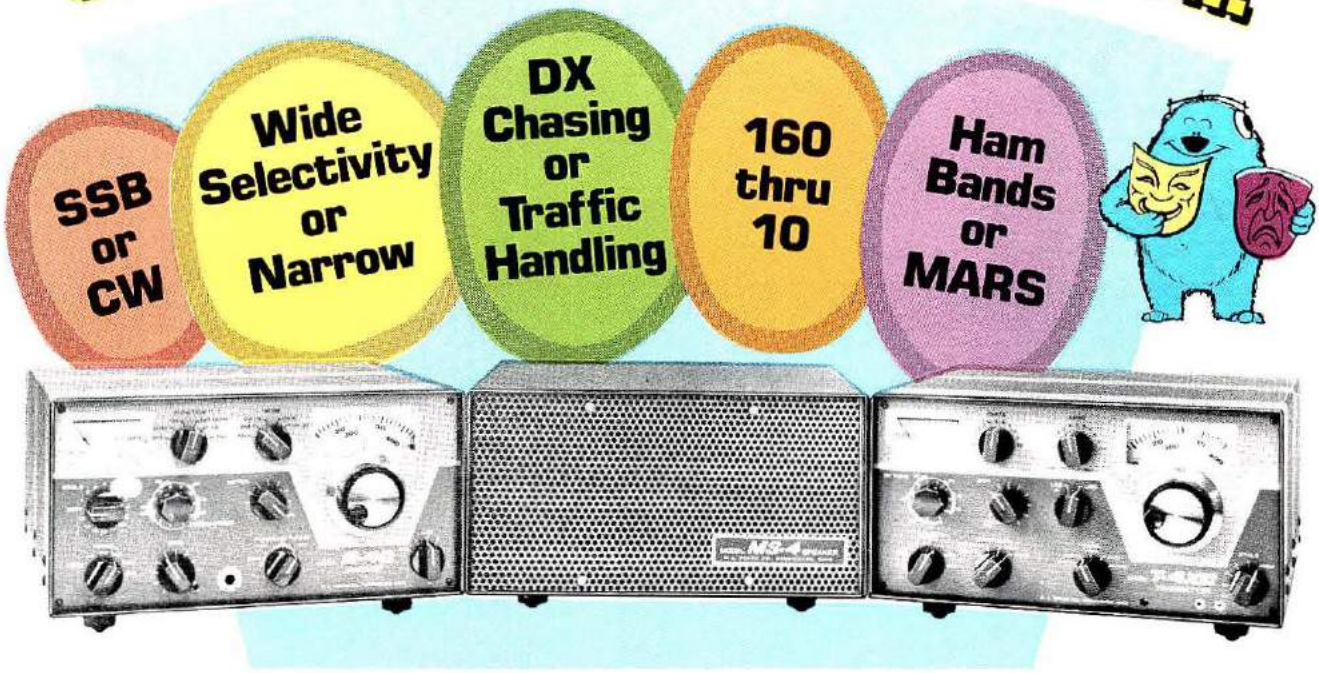


RIDING HIGH WITH OSCAR SATELLITES

FIRST ISSUE

The station of many faces...



Drake C-Line

Both the R-4C and T-4XC cover extra 500 kHz ranges throughout the hf spectrum. Additional crystals, which are front panel selectable, provide new bands as they are needed such as those discussed for 10, 18, and 24 MHz.

The excellent performance of the system makes weak signal DXing on 160 meters a pleasure.

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• Linear Amplifier • Desk Top or Hand Held Ceramic Microphones • Noise Blanker

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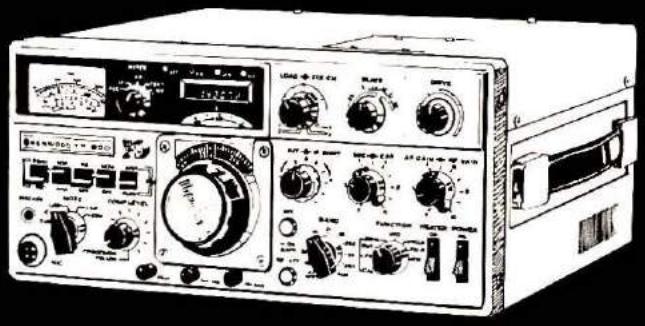

KENWOOD TR-7400A 2m FM transceiver

Has provisions for CTCS, encode and decode • Can achieve tone burst operation with added TBM's • Front switch selects squelch system you desire • High power 25 watts RF output • Solid-state final stage • LED digital frequency indicator display • PLL provides 800 discrete channels at 10 kHz intervals • Final protection circuit • Excellent output signal, 2nd & 3rd harmonics better than - 60 dB • PLL unlock protection circuit • Repeater offset circuit • Low power position, 5 watts • 2-pole, 10.7 MHz monolithic crystal filter • MOSFET

LIST PRICE **399.95**

KENWOOD TS-820 transceiver

The TS-820 covers 10 thru 160 meters • Has 200 watts P.E.P. • Integral IF shift • RF speech processor • Completely solid-state, except for driver and final stages • Heater switch • Vox circuit • Noise blanker • PLL circuitry • Full metering • DRS dial • Built-in 25 kHz calibrator • CW sidetone and semi-breakin • Rear panel terminals for linear amplifier • IF OUT, RTTY, and XVTR • Phone patch IN and OUT terminals • Digital readout unit (DG-1, list, 170.00) is optional • Other options: VFO-820, DS-1A, DC-DC converter, TV-502, 2 meter transverter.

LIST PRICE **830.00**

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• 10W output • 6 channels supplied: 94/94, 34/94, 52/52, 16/76, 22/82, 28/88 • Complete w/hand mike • Slide-out bracket • PS-5 power supply available for fixed base operation.

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• Frequency range: 144 to 148 MHz • Built-in SSB, FM, AM and CW • High stability FET VFO • 44 channels, w/11 crystals (optional) • Heterodyne switching circuitry • Noise blanker • Amplified-type AGC circuit • S-meter, RIT • Squelch circuit • RF circuitry, w/dual gate type 3SK35 MOSFET

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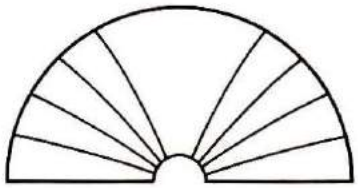

HORIZONS

OSCAR Satellites

The first free-access communications satellite was built by hams. With numbers 6 and 7 still in orbit, amateur signals from all over the world may be heard as the spacecraft comes over your horizon. Author Curtis gives you a taste of the thrill of being a part of the space age and provides some tips that will help you hear the Orbiting Satellite Carrying Amateur Radio.

CB To Ham

For the CB or SWL enthusiast who would like to travel onward and upward, here are a few words about the many attractions of becoming a ham, and then some pointers on taking that first step. You'll be reading more on this subject in the future issues.

The Golden Years

Amateurs, CBers, SWLs of today have become so accustomed to the marvels that abound in this electronic age that they do not realize how short a time has passed since things were quite different. Fortunately there are people who can tell about the glamour (and the troubles) of the earlier days. W6SAI provides some interesting reading for the nostalgia buffs, and somewhat indirectly shows today's hobbyists that they never had it so good.

Audio Oscillator

A variable-frequency audio oscillator can be a very handy gadget to have around, and can be used to test many types of equipment. Here W1KLK tells what is inside the magic IC, what it does, and how to build a neat piece of test gear for your shop or shack.

An Evening Of DX

One of the most avidly persued facets of the Amateur Radio hobby is the contacting of distant stations (DX). Here veteran DXer W9KNI invites you to sit in with him through an evening in his ham shack — an evening that encompasses both the thrill of "catching" a new one and the companionship of a chat with an old, but far away, acquaintance.

Single Sideband

Single-sideband — ssb — is a mode of transmission that many hams have been using for many years. More recently the term has been showing up in the literature describing features of new CB rigs. CBers are not alone in being unsure what it is all about and how it will help reduce interference; most of the newer hams who have worked with Morse code will likely face the same bewilderment as they advance. This first of a series of articles covering ssb theory should begin to shed some light on the inner workings.

On A Budget

One of the first things you'll have to face when you get your Amateur ticket is the equipment you'll need to get on the air. What do you need in terms of a receiver, or a transmitter? It's all explained here. And it doesn't take an arm and a leg to get started, either — you can put an operational Amateur station together on a very modest budget.

DX Propagation

Everything under the sun is influenced by the sun, and this is particularly true of the mechanism that permits radio waves to travel from place to place. Just how this influence works is not obvious to most of us, so an explanation of how things happen will lead to better understanding of what happens on the various ham bands.

Confidentially, it just may be that our forecaster is explaining the various fudge factors in order to soften the blows he'll receive when he goofs in the propagation predictions.

Early-Bird Subscribers

This special introductory issue of *Ham Radio Horizons* does not count toward your subscription; it has been sent to every licensed U.S. Amateur to acquaint them with a great new publication. If you sent us an advance subscription, it will begin with the April, 1977, issue of *Horizons*.

The first complete small computer under $1,000

Twenty-five years ago a computer so powerful cost you a cool million.

Today, for less than 0.1% of the cost, you can have your own personal computer with even greater power—one that fits in a package no larger than a typewriter.

It's the Sol-20 Terminal Computer. There's nothing like it anywhere.

A powerful computer at your disposal is quite simply, fantastic!

Use your computer to run your ham station. Do your taxes and books with it. Control your inventory. Curb your energy bill by letting your computer regulate energy usage. Use it to study science and engineering. Use it to help you invent.

And after hours, take your computer home to play (and create) sophisticated games. Computers may indeed be the ultimate hobby because you never outgrow them. Uses for computer intelligence are literally unlimited.

You can find a basic computer kit for about $600. Though by the time you purchase the other components needed to make it run—keyboard, additional memory, software and I/O interfaces—you're up around $1,500. Phew!

Now, the good news. The new Sol-20 in kit form gives you an entire working system for $995.

Those of you who are already into personal computers will recognize what an incredible advance this is in computer packaging. This is the only small computer that offers all of the following as *standard* features:

8080 microprocessor—1024 character video display circuitry—control PROM memory—1024 words of static low-power RAM—1024 words of preprogrammed interface capable of controlling two recorders at 1200 baud—both parallel and serial standardized interface connectors—a complete power supply including fan—a beautiful case with solid walnut sides—software which includes a preprogrammed PROM personality module and a cassette with BASIC-5 language plus two sophisticated computer video games—the ability to work with all S-100 bus, including Altair, Imsai and Processor Technology products.

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MARCH, 1977
Volume 1, Number 1

HAM RADIO HORIZONS

CONTENTS

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

The Cover

Personal communications can extend to greater distance than ever before thanks to the help of OSCAR satellites. Foreground and skyline photograph by Carl Dane, W1FXK; Earth photograph courtesy NASA; artist's rendition of Oscar 7 courtesy of Radio Amateur Satellite Corporation (AMSAT)
The story begins on page 18

Welcome to the exciting world of Amateur Radio, and to *Ham Radio Horizons*, your magic carpet to this fascinating new land of adventure and education. Through the pages of *Ham Radio Horizons* you'll be traveling throughout the world to those many exotic DX locations you'd like to know more about. We'll be showing you how to find these DX stations and how to put a good share of them into your logbook. You're even going to be invited into outer space as we give you the low down on listening and communicating with the Amateur Radio communications satellites that are constantly orbiting the Earth.

Our editors are going to work their very hardest to see that you get your license. Then you will get help in putting your first station on the air. We'll then follow through to see that you get the most in performance, fun, and satisfaction from this exciting experience. We'll be helping you to step right on through to the higher-class Amateur licenses, and then will be introducing you to more advanced forms of communications such as slow-scan television, radio Teletype and vhf-fm. Amateur Radio is just chock full of extremely interesting and very fulfilling public service opportunities. Locally there are civil defense and emergency organizations that can use your talents. Special public events are always in need of good communications and Amateur Radio has set an enviable record in giving them a hand. On a much wider scale there are always message-handling opportunities which become particularly important in time of disasters and other emergencies. *Ham Radio Horizons* will be examining all of the requirements and will do our best to help find a place for you in one or more of these fascinating activities.

1977 is a perfect time, both for you and *Ham Radio Horizons*, to get started in Amateur Radio. We are currently experiencing a growth spurt unlike any we've seen for many, many years. Virtually everyone active in the hobby has become dedicated to helping to recruit and train newcomers and to seeing that they move along as rapidly as possible. The Federal Cummunications Commission is doing their part with new expanded Novice and Technician operating privileges, and with regulations designed to make it more convenient and quicker than ever before to get your first "ticket."

Ham Radio Horizons has been specifically edited to meet the requirements of this exciting new era. It will be distributed and promoted just as widely as possible to help expose a very large number of new people to the many fascinations of Amateur Radio. For the first time you'll be seeing ads for an Amateur Radio magazine appearing well outside of traditional Amateur channels. We'll be telling the readers of CB magazines, youth-oriented magazines, and many other special-interest publications about Amateur Radio and *Ham Radio Horizons*. This is very important because we'll really be selling the idea of Amateur Radio — not just an Amateur magazine.

Here, for the first time, is an Amateur Radio magazine that can truly present itself to a non-Amateur and offer something that he or she will really enjoy and understand. No longer will potential Amateurs have to sift through many pages of magazines that are largely over their heads to find a few paragraphs which pertain to them. Beginners, this is *your* magazine.

Old timers, I hope you'll also be keeping your eye on us. We're going to have so much fun with this new project that we think you'll enjoy us, too. There'll be fiction and humor that will entertain everyone no matter what their age or experience. You're going to find simple projects that will fit well into any station, and the basic reviews of theory that we'll have will be worthwhile reading for everyone.

We're going to be right out there doing our part for Amateur Radio, and with the experienced and dedicated staff we've put together for this new project I can promise that we'll do it very well. As we have already done before with our sister publication, *ham radio*, we're dedicated to making Amateur Radio a significantly better place by our presence. Keep your eyes on us and I'm sure you'll agree.

Skip Tenney, W1NLB
Publisher

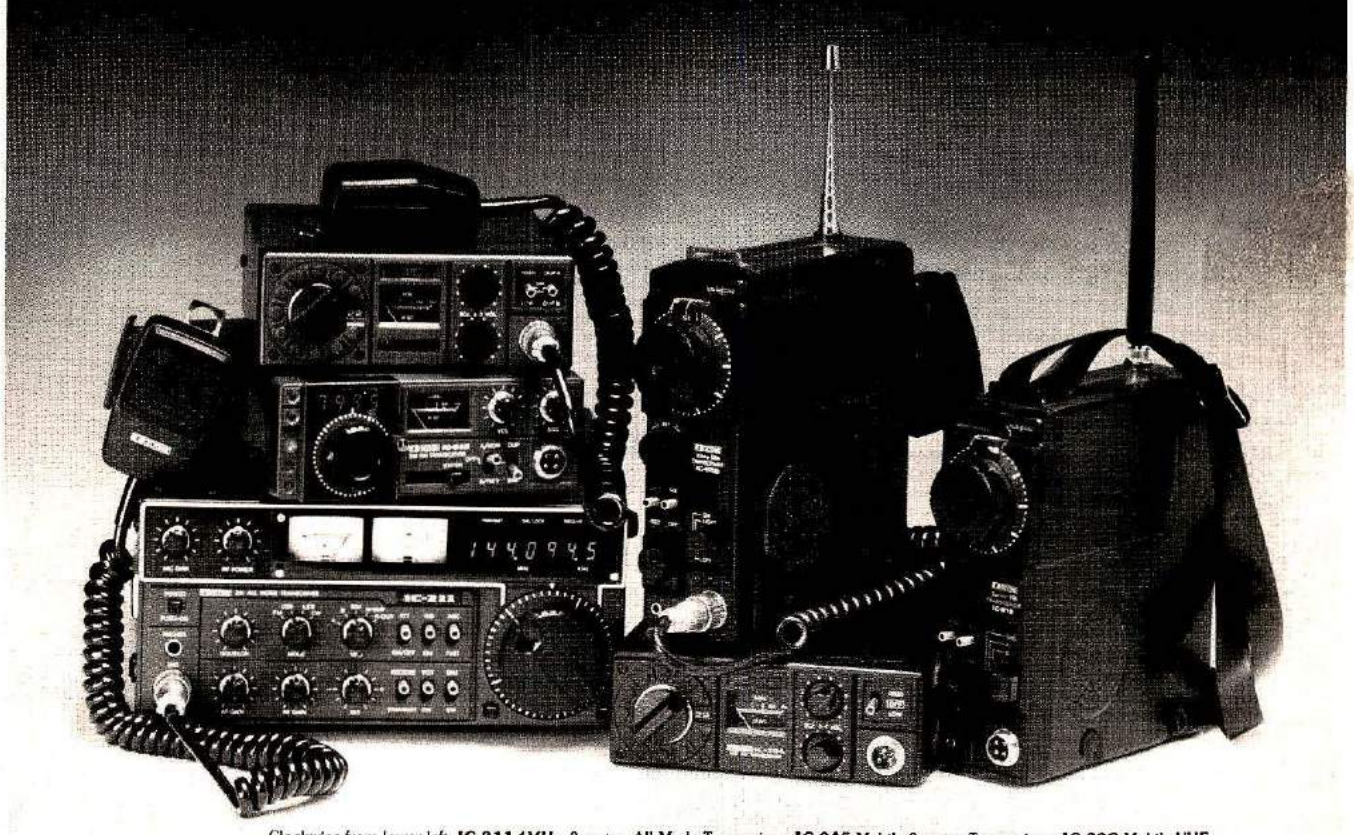
ICOM wants you to

Begin with the Best

As you develop your skills, increase your participation in Ham Radio activities, and add hardware for ever-increasing flexibility of operations, you'll come to know ICOM. Just ask any old Ham. ICOM is the quality name in VHF/UHF Amateur Radio equipment because it is simply the best. ICOM is the line you'll want to move up to for unequaled quality and features.

But you needn't wait until you can trade in a truck load of equipment to reach up to ICOM. You can begin building your Amateur Radio operations with reasonably priced ICOM units that have flexible add-on features when you purchase your very first voice transceiver. And when you are installing ICOM's top-of-the-line fixed station unit, the ICOM equipment you began with will probably still be an important integral part of your active hardware.

Don't delay in moving up to ICOM: begin with the best.



Clockwise from lower left: **IC-211** 4MHz, 2 meter, All Mode Transceiver; **IC-245** Mobile 2 meter Transceiver; **IC-22S** Mobile VHF FM Transceiver; **IC-502** Portable 50 MHz SSB Transceiver; **IC-215** Portable 2 meter FM Tranceiver; **IC-30A** Mobile UHF FM Transceiver.

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More details? Ad Check page 86.

THE VIEW FROM HERE

Throughout the early history of Amateur Radio, all Amateurs shared one thing in common: an interest in radio *technology*. Indeed, there was a time when most Amateurs were radio engineers. But those were simpler times, when there was little if any commercial equipment on the market, and Amateurs *had* to build their own receivers and transmitters. Today, it's a whole new ball game and the emphasis has shifted to person-to-person radio communications. I think most Amateurs still have a basic interest in the technical aspects of radio, but only to the extent that they can improve the *operation* of their station. Quite simply, they want to have the technical "smarts" to intelligently select the equipment for their station, but they don't want to be bogged down with details.

And, frankly speaking, to most hams there's a lot more to Amateur Radio than building your own equipment or experimenting with new devices. There will always be an important place for these Amateur activities — perhaps an essential one — but for the ham whose primary interest is in personal communications, there's a whole lot more: working through Oscar, relaying traffic and phone patches, chasing DX, working vhf-fm, slow-scan TV, or simply rag chewing with your buddy half-way around the world — the list could go on and on. If you're in this group, I think you'll find that *Ham Radio Horizons* is right up your alley. Our staff will be doing its best to keep you up to date on the latest happenings in Amateur Radio in easy-to-read, easy-to-understand terms.

If you want to get the most out of your station (and who doesn't?), we'll show you how. Want to broaden your horizons to satellite communications or slow-scan television? We'll show you the way. Buying a new receiver or transmitter? We'll tell you what to look for and how to get the most value for your dollar. Interested in becoming an amateur but don't know where to start? We'll try to point you in the right direction. Thinking about moving up the ladder to a higher class license? We'll help you along the way, step by step.

Ham Radio Horizons will do its best to give you the low down on all aspects of our hobby, and we will not stand still. We will always be looking for ways to improve because Amateur Radio is a dynamic hobby, always on the move — as the equipment, techniques, and challenges of Amateur Radio change, so will we. We'll constantly try to make *Ham Radio Horizons* more useful to you as well as more interesting and stimulating. I can promise you that we will never become complacent — we'll always try to make *Ham Radio Horizons* better.

Jim Fisk, W1DTY
Editor-in-Chief

DenTron amateur radio products have always been strikingly individual. This is the result, not of a compulsion to be different, but of a dedication to excellence in American craftsmanship. This dedication now extends to one of the worlds finest high performance Military amateur amplifiers.

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Compare the MLA-2500. It has the lowest profile of any high performance amplifier in the world. It's modular construction makes it unique, and at $799.50 it is an unprecedented value.

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The linear amplifier beyond compromise.

Amplifier in actual operation.

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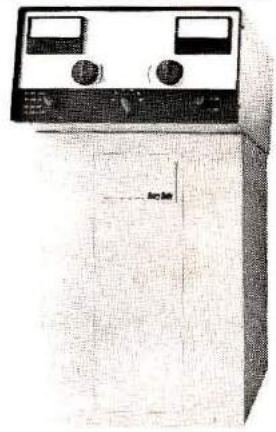
The 2K-4

LINEAR AMPLIFIER



The 2K-4 linear amplifier offers engineering, construction and features second to none, and at a price that makes it the best amplifier value ever offered to the amateur. Constructed with a ruggedness guaranteed to provide a long life of reliable service, its heavy duty components allow it to loaf along even at full legal power. If you want to put that strong clear signal on the air that you've probably heard from other 2K users, now is the time. Move up to the 2K-4. $995.

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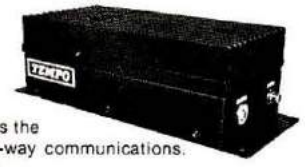
TEMPO/FMH.....$199.00

TEMPO/FMH-5 (5-watt).....$279.00



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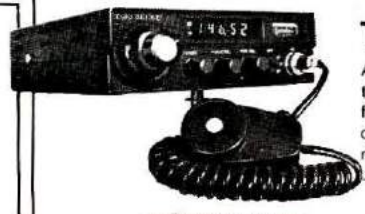

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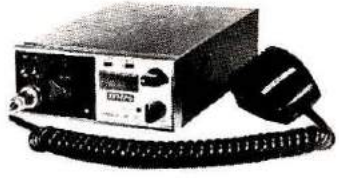

TEMPO CL146A

VHF/FM mobile transceiver for 2 meter amateur band, 144 to 148 MHz coverage. Compact, ruggedly built and completely solid state. One Channel supplied. . .2 of your choice free...$239.00

TEMPO 6N2

Power amplifier for 6 and 2 meter operation. Small, reliable and inexpensive. One full KW of power for SSB operation. Features two Eimac 8874 grounded grid triodes, built-in solid state power supply, built-in antenna relay...$895.00.

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The TEMPO 'ONE'

The Tempo 'ONE' SSB transceiver represents the culminating achievement of many years of experience in the amateur radio field. Modern design, superb performance, sturdy construction, outstanding reliability . . . at a surprisingly low price makes the Tempo 'ONE' the best buy in transceivers today...$399.00.

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NEWSLINE

WORLD ADMINISTRATIVE RADIO CONFERENCE proposals in FCC's Third Notice of Inquiry don't provide the new hoped-for Amateur hf bands, but they significantly expand existing frequency allocations, and provide two new bands at opposite ends of the spectrum. The New 1750-Meter (160 to 190 kHz) and 3/8-meter (902 to 938 MHz) bands offer excellent opportunities for experimentation and communication. Other proposed allocations include expansion and slight re-arrangement of existing Amateur bands. Final result will depend on agreements reached at WARC 79 where all nations have a voice in how the "pie" will be sliced.

GLADE VALLEY SCHOOL combines a North Carolina vacation with a very effective two-week Amateur licensing or license upgrading program. The 1977 session runs from July 30 to August 12. Write to C.L. Peters, Box 1461, North Myrtle Beach, South Carolina 29582.

NOVICE LICENSE TURNAROUND time can be sharply reduced, according to several sources, by printing "AMATEUR RADIO NOVICE APPLICATION" in large letters on the envelope used to apply for the exam, and then returning the completed exam in the envelope it came in to FCC, Box 1020, Gettysburg, Pennsylvania 17325. Mark envelope "COMPLETED AMATEUR RADIO NOVICE EXAM ENCLOSED."

WEATHER REPORT FROM MARS published in the Malden (Massachusetts) News was based on data gathered during Viking's first day on the planet. Light winds from the east in the afternoon changed to light winds from the southwest after midnight. The maximum wind velocity during this period was 15 miles per hour. The temperature ranged from minus 122 degrees to minus 22 degrees Fahrenheit.

"NESSIE" STILL MISSING. The scientific expedition to Loch Ness during the summer and early fall of 1976 could neither confirm nor deny the existence of the famed Loch Ness Monster, but they did find submerged ruins that rival the famous Stonehenge structure. Question: how were they built, when, and by whom?

EARTH IS OLDER THAN WE THOUGHT. New measuring methods make scientists believe the earth is now 20 billion years old, and not 14 billion years as formerly believed. Not long ago it was considered to be only 4 billion years old. Live and learn.

NEW RADIO TELESCOPE having a 300-GHz bandwidth is nearly ready near the Amherst campus of the University of Massachusetts. The surface accuracy of the 45-foot diameter dish is one tenth of a millimeter, the pointing accuracy is less than 2 arc-seconds, and its 115-GHz resolution is 40 arc-seconds. This would be equivalent to standing in Boston and being able to see a man with outstretched arms standing on top of the Empire State building!

1977 ARRL NATIONAL CONVENTION will be held June 3-5 in Toronto. For additional information, write Box 1011, Station C, Scarborough, Ontario, Canada N1H 2Z4.

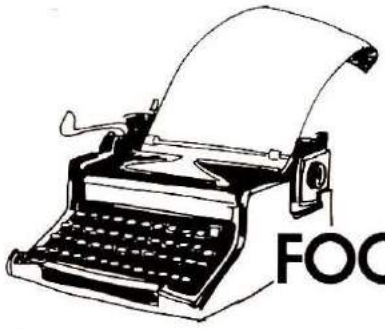
THE ROCHESTER (NEW YORK) HAMFEST will run three days this year — May 20, 21, and 22. A card to "Hamfest," Box 1388, Rochester, New York 14603 will put you on their mailing list.

LF BAND ENTHUSIASTS can join the "Long Wave Club" and receive its monthly bulletin Lowdown, covering happenings at frequencies from 540 kHz down. Send 12 legal-size SASEs to H. John Clements, 9010 Tobias #258, Panorama City, California 91402.

HOBBY ELECTRONICS FAIR is planned for May 18-22 in Philadelphia. Amateur Radio is included with other electronics hobbies in the planned exhibits, workshops and clinics. Write Industrial and Scientific Conference Management, 222 West Adams, Chicago, Illinois 60606 for details.

PORTABLE AND MOBILE Amateur Radio operators have not needed to identify their stations as such since last November 26. However, it is necessary to have a permanent mailing address where the FCC can reach you. If you are contest-oriented, you'll probably have to sign portable or mobile anyway, to meet contest rules.

"RADIO — HAM OR CB — THEY'RE NOT THE SAME THING" is a new booklet published to help straighten out the all-too-common confusion of the communications media. Copies are available from the ARRL for any Amateur working with newspaper, radio or TV people. Write to The American Radio Relay League, Newington, Connecticut 06111.



FOCUS & COMMENT

The staff here at *ham radio* and *Ham Radio Horizons* consists of people with very diverse backgrounds, to put it mildly. We often have a lunchtime gab fest, and the subjects threshed about are even more diverse. We had been discussing the various aspects of large ships, and someone related a story about a merchant ship that was laden with rice, and, after a leak allowed the cargo to get wet and expand, it simply burst apart at the seams and sank.

The story may or may not be true, but nontheless, it could happen. Later, in a reflective mood, I thought about how comparative this is to a situation we have in the world of people today. By people, I am speaking of those who have had a taste of communications and decided that they like it; the millions of CBers. If you give it a moment's thought, the pressure is logical and inevitable. There are just too many people to fit into that small cargo ship at 27 MHz. They have been splashed with the fluid of communications and are beginning to swell. The pressure that is being created has attracted the attention of both government and industry, with the result that ways are being sought to relieve the strain. The outcome of this pressure-relief exercise will have a lot to do with the future of Amateur Radio, in more ways than one.

Historically, civilizations (organisms, companies, individuals) that have survived under pressures have done so by finding better ways in which to exist or grow. Those who became complacent, disinterested, or out-of-touch, have atrophied and died. There is no logical reason to expect any different outcome for the Amateur Radio Service, no matter how emotional the arguments to the contrary.

Some people have applied the term "elite club" to the Amateur Radio Service. I am not so sure that the average Amateur feels all that elite; more than likely he is simply interested in doing his thing, be it repeaters, DXing, rag-chewing, traffic-handling, or designing and building equipment. Regardless of what *we* know about ourselves and our hobby, if the world around us sees us in this unfavorable light, we are in trouble. The trend must be reversed.

Some very forceful reminders of the consequences of this trend can be found in many of the Amateur magazines and journals: Towns that pass ordinances against antennas; lawsuits that entail great expense to defend a hobby that is far less destructive to the environment than many hobbies are. No matter how righteous you are, or how well you can present your case, it is often an all-out effort to get enough help to successfully defend your hobby.

The obvious way out, and perhaps in the long run the less painful way, is to become more numerous and more vocal. We need great numbers of Amateurs doing their thing, and at the same time telling the whole world that what they are doing is good, worthwhile, and deserves a place in that world equally as much as does bike-riding, raising horses, racing, sail-boating, or any other hobby.

The question of where we are to get those numbers brings us right back to my previous point — there are a lot of people who have tried the communications adventure on 27 MHz. Many dislike it and will never be back; many like it as it is and are content to put up with the way things are; but many, many, more are looking for a better way to go. That is where you and I fit into the picture — we can show them the way, and we can do so without losing the pride in accomplishment that makes the Amateur Service one of the most trouble-free parts of the radio spectrum. To use a blunt analogy: If they are going to ride the elevator with you, then you may as well teach them how to get aboard without stepping on your toes.

Finding room for these new Amateurs is where the advancing-technology-to-stay-alive bit comes into the plan of things. Sure, it will become more crowded — for a while. But given the number of excellent engineers among the Amateur ranks, and with the larger potential market for new devices, it's a sure bet that new ways to communicate, new equipment for unused bands, and perhaps even new bands, will be forthcoming. The Amateur Radio Service must become large enough, and sophisticated enough, to apply pressure in a positive manner for its own good.

We at *Horizons* are here to foster orderly growth along with pride in achievement. To those of you who would like to help, an enthusiastic "Welcome Aboard."

Tom McMullen, W1SL
Managing Editor

Hy-Gain verticals stand alone.

Hy-Gain multi-band vertical amateur antennas are entirely self-supporting. They require no towers or guys and go up in just a few square feet yet they offer remarkable performance. Their omnidirectional pattern means no rotator is required. Hy-Gain verticals go up easily with just a few hand tools and their cost is surprisingly low.

See your Hy-Gain dealer for the antennas that give you the performance you want, take minimum space and have your kind of price. Hy-Gain verticals.

18HT 6-80 meters.
The only vertical antenna on the market offering multi-band performance without traps. The Hy-Gain 18HT utilizes a unique stub decoupling system to maximize efficiency, frequency stability and band isolation. It also offers a 50 ohm input impedance for all bands.

The 18HT features automatic band switching, ¼ wavelength performance on 40 and 80 meters, 1¾ wavelength on 10 and 15 meters. Maximum legal power rating on all bands. It is entirely self-supporting and requires no guys. Heavy duty, slotted, taper swaged, aircraft quality aluminum with full circumference compression clamps is used for radiators. The 24' tower is all rugged, hot-dip galvanized steel and all hardware is iridited for corrosion resistance. Special hinged base for easy raising and lowering. **Order No. 182**

18AVT/WB 10-80 meters.
The Hy-Gain 18AVT/WB gives you true wide-band performance in limited space. And now we've made it even better. The 18AVT/WB now has an improved 80 meter coil and an over-size corona ball on the whip to eliminate wasteful and noise corona discharge.

This antenna is rated in excess of maximum legal power 10-40 meters and up to 1 KW PEP on 80 meters. Entirely self-supporting, requires no guys. All tubing is slotted, taper swaged, aircraft quality aluminum with full circumference compression clamps.

The 18AVT/WB has automatic band switching and utilizes three air dielectric Hy-Q traps for exceedingly stable performance and true ¼ wave resonance on all bands. May be roof mounted with Hy-Gain 14RMQ kit. Recessed SO-239 connector prevents moisture deterioration. 12" heavy duty mast support bracket. **Order No. 386**

14AVQ/WB 10-40 meters.
The Hy-Gain 14AVQ/WB uses the same trap design as the famous Hy-Gain Thunderbird beams. 3 separate air dielectric Hy-Q traps with oversize coils for superb stability and ¼ wave resonance on all bands. Automatic band switching.

An extremely low angle of radiation is utilized for superior DX performance. Taper swaged, slotted aircraft quality aluminum tubing. Entirely self-supporting, no guys required. Recessed SO-239 connector prevents moisture damage. 12" heavy duty mast support bracket. Roof mount with Hy-Gain 14RMQ kit. **Order No. 385**

12AVQ 10, 15 and 20 meters.
The 12AVQ also uses Thunderbird design air dielectric traps for extremely Hy-Q performance. This is the way to go for inexpensive tri-band performance in limited space. Entirely self-supporting, requires no guys.

For superior DX transmission, the 12AVQ uses a very low radiation angle. Has automatic band switching. Aircraft quality, slotted taper swaged aluminum tubing. Recessed SO-239 connector prevents moisture damage. Heavy duty 12" mast bracket. Roof mount with Hy-Gain 12RMQ kit. **Order No. 384**

18V 10-80 meters.
High performance air dielectric traps, high quality construction and low cost make the 18V an exceptional value. Easily tuned to any 10-80 meter band by adjusting feed point at the base inductor.

All aircraft quality, slotted, taper swaged aluminum with full circumference compression clamps. Self-supporting, requires no guys. 12" heavy duty mast bracket. Roof mount with Hy-Gain 14RMQ kit. Easily portable. **Order No. 193**

HY-GAIN VERTICAL ANTENNA SPECIFICATION COMPARISON

	18HT	18AVT/WB	14AVQ/WB	12AVQ	18V
Electrical					
Max. power input	1 KW AM 2 KW PEP	1 KW AM 2 KW PEP (1 KW PEP on 80)	1 KW AM	1 KW AM	250 watts AM 500 watts PEP
VSWR	2:1 or less	2:1 or less	2:1 or less	2:1 or less	2:1 or less
Impedance	50 ohms	50 ohms	50 ohms	50 ohms	50 ohms
Mechanical					
Height	50'	25'	18'	13'6"	18'
Shipping Weight	96.7 lbs.	10.7 lbs.	8.2 lbs.	7 lbs.	4.6 lbs.
Mast Diameter	None required	1⅝"	1⅝"	1⅝"	1⅝"

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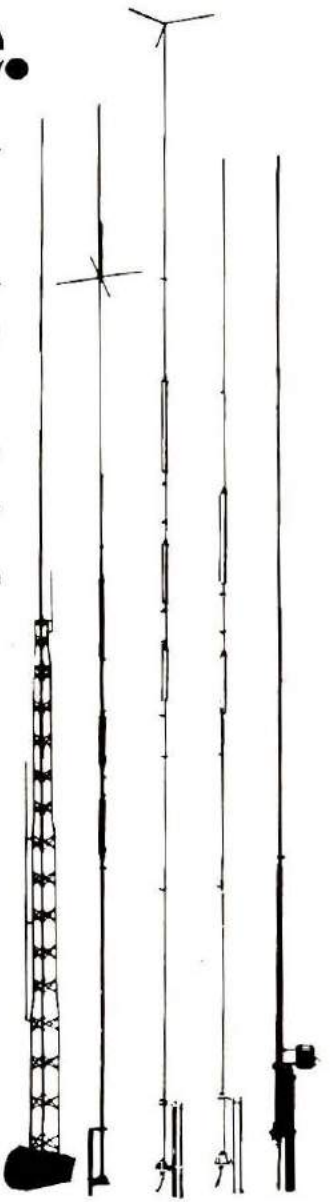


HRH INTERVIEWS

JOHN JOHNSTON, K3BNS
Chief, FCC Amateur and Citizens Division

To Radio Amateurs, the FCC's Amateur and Citizens Division *is* the Federal Communications Commission. That's the part we deal with, so that's the part that counts. The Amateur and Citizens Division is, in turn, ably led by its highly visible Division Chief, John Johnston, K3BNS.

In this inaugural issue of *Ham Radio Horizons* it is only fitting that the FCC be included, and, we thought, what better way could there be of doing that than an in-depth discussion with the FCC's most important Amateur (to us), K3BNS? Several phone discussions later we — *Ham Radio Horizons* publisher Skip Tenney, W1NLB, and *Ham Radio Horizons* Contributing Editor (and *HR Report* Editor) Joe Schroeder, W9JUV — found ourselves sitting with John in his fifth-floor office in the Commission's Washington headquarters building.

We had decided beforehand on a "Question and Answer" format for our discussion, with the expectation that both the questions and their answers could lead us into some pretty meaty areas. We weren't disappointed. In fact, what we'd envisioned as a nice one-time article for Volume I, Number 1, has expanded itself into a very informative series we'll be running. Here, then, is the first part of a very informative day's conversation with John Johnston.

John . . . how did you get to be Chief, Amateur and Citizens Division, FCC?

Ham Radio Horizons: John, before getting into the nitty gritty of the Amateur Radio Service and the FCC, let's talk about you for a moment. How did you get to be Chief, Amateur and Citizens Division, FCC?

John: Well, I started out in Amateur Radio in 1954 when I was licensed as KN2HHR. Oddly enough, it was my wife who really pushed me into it. I'd gotten interested in radio 'way back in 9th grade but — after the placement tests I took in the Navy showed I had *zero* aptitude for CW I never did anything about it until after we were married. She had a reason, of course — her dad is W8RE, and she wanted an inexpensive way to talk home on Sundays. She got it — I don't know how inexpensively — and we still do talk to him on 75 meters most Sundays.

I joined the FCC in 1972 as Chief of the Rules and Legal Branch of the Amateur and Citizens Division. Then I was away from Amateur and Citizens for a year but returned in September, 1975, as Chief of the Division.

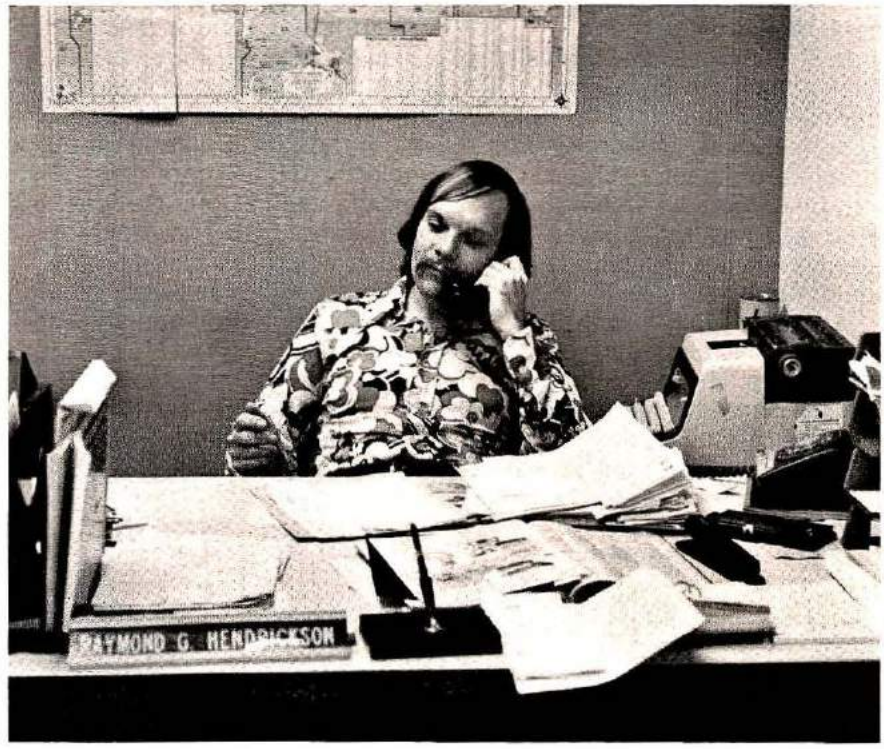
Prior to joining the FCC I worked in the electronics industry where I was with GE, RCA, and Sperry Gyroscope. By the way, I got my first exposure to CB at Sperry where we used the old Stewart Warner Porta-Phones on 465-MHz Class B — remember them? As a result I've also had a CB license for some time.

HRH: Speaking of CB, a lot of people don't see the distinction between Amateur Radio and CB. How do you explain the difference?

John: At first glance they're similar because they are the only two-way radio services that are made available to anyone who wants them without that person having to demonstrate a specific need. The difference is that CB is intended to be a short-range, affordable, strictly domestic, two-way communications service available to essentially everyone.

Amateur and Citizens is by far the largest division in the Bureau . . .

Ham radio, on the other hand, is intended to fulfill the objectives of Part 97.1 of the Rules. Amateur Radio appeals to the technically minded while also providing long-range communications. As such it is recognized internationally and is the subject of many treaties — for example, those



Typical pose of an FCC staffer, telephone to ear. Gary Hendrickson, W3DTN, is one of the more active Amateurs in the Amateur and Citizens Division.

97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.

(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur radio service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international good will.

permitting Amateur operators to handle third-party traffic.

HRH: Since Amateur and Citizens plays such an important role in our Amateur Radio lives, I think our readers would like to know a little more about your Division. How many people do you have, and how is the Division set up?

John: First of all, we're a part of the Safety and Special Services Bureau, which administers 40 or 50 different communications services. By administer, I mean we handle rules, regulations, prosecution of enforcement actions, and we issue licenses. Amateur and Citizens is by far the largest Division in the Bureau with about 120 people, including both Gettysburg and Washington.

Some of the other Divisions of Safety and Special Services include Aviation and Marine, Industrial and Public Safety Rules, Industrial and Public Safety Facilities, and Legal Advisory and Enforcement.

Amateur and Citizens has three branches. Gettysburg is called the Facilities Branch and is the largest with about 90 people. It's headed by Anna Deatrick. Facilities branch processes and issues all licenses for us plus those for Aviation and Marine and Restricted Radiotelephone Permits. Processing includes checking for correctness and doing any needed followup, then authorizing the application for grant after which the application goes to the computer and the license-printing machine. They also compile all the license records used in the field offices by monitoring stations.

In Washington we have two branches: Rules and Legal is headed by Joe Johnson (W3GGO) and his branch reviews all the petitions we receive, prepares drafts of

Notices of Proposed Rule Makings and Report and Orders, and does any analysis involved in putting a case together for presentation to the commissioners. His group also will present cases to the commissioners as well as interpret rules and answer questions from individuals concerning the rules.

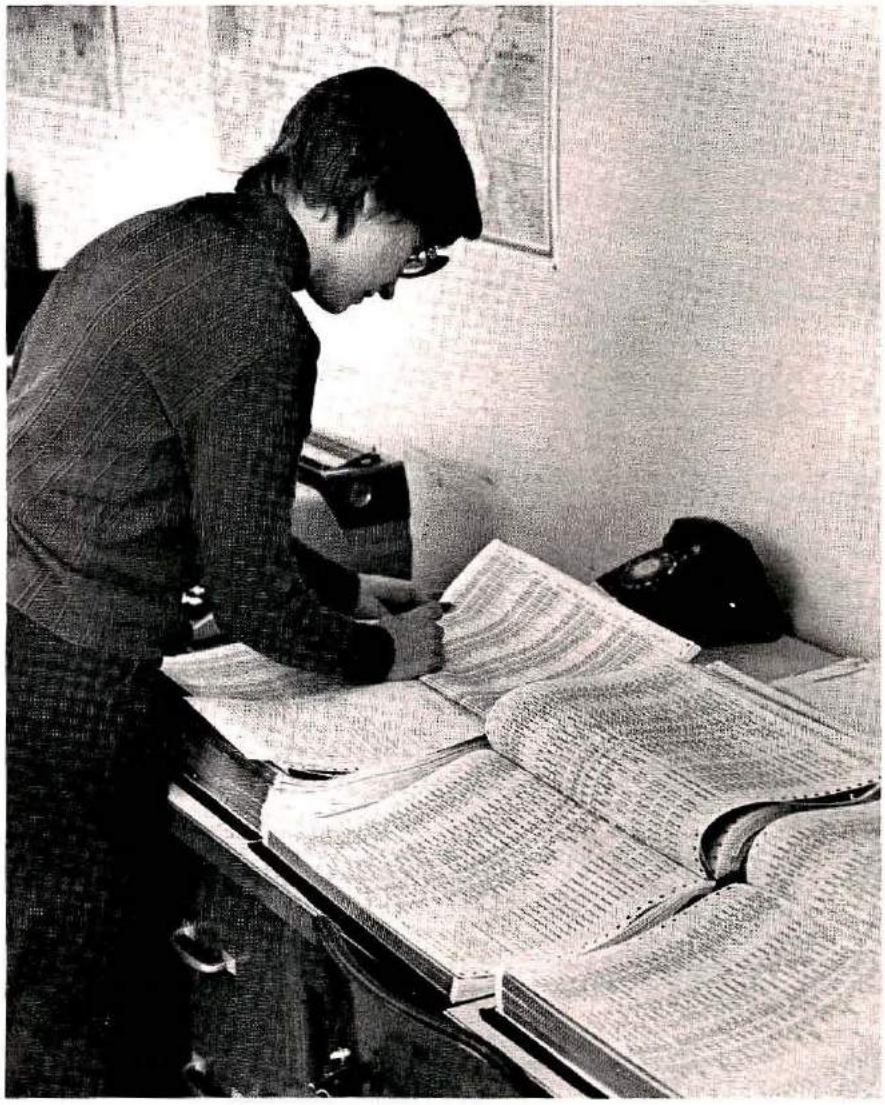
Our other branch is the Operations Branch and is under Joel Morris. He has a PhD in business administration as well as some other degrees. His group's job is systems engineering — making the licensing system flow, for example. That's something new, you know. We've always had systems here and they've sort of grown like Topsy so that's why they weren't too efficient. Now we actually have people looking at what we're trying to accomplish and what's the best way of doing it. That's why we were able to dig ourselves out of the hole that we were in. Everybody was saying, this fall, "Boy, this sure beats last year," but last September we were receiving and processing 50 per cent fewer applications than we've been doing this September. The difference is that now we're not doing a lot of things that we used to do that simply didn't contribute to the end result.

Now we actually have people looking at what we are trying to accomplish and what is the best way of doing it.

Public information is the other thing the Operations Branch is working hard on. In the past we tried to meet the public with a "one-on-one" approach by answering every letter and the like, but now we just don't have the resources to do that. But we don't want to drop communications so we're back looking for a way to answer such inquiries as, "What does this rule mean?" or, "Can I do this?" To do so, we're trying to upgrade all our bulletins, issue more news releases and Public Notices, attend more CB and Amateur affairs where we can present our story and meet with people, and have question-and-answer sessions.

We're in the midst of rewriting the CB rules to make them more readable. We're using tape-recorded messages to answer as many calls as we can. We're also trying to get as much info as we can to the media because — particularly in the CB field — they are thirsting for knowledge and if we don't provide it they make up things! That makes it worse than ever, of course! On the 40-channel expansion, for example, we've spent more time denying or correcting false stories than we did working on the expansion. So, information is another major concern of that group.

Another major area is what



If you've ever wondered what the FCC uses to check your license status here it is. These books that Gail Dinwiddie is checking show not only your call, name and address — all cross references — but also your expiration date, and full rundown of all additional licenses you may hold. Changes too late to be on the computer printout books are updated weekly on microfiche.

we call "Public Reference" — the followup that's necessary when someone's license "falls through the crack." That's unfortunately still a major problem. Ideally we should get that part of the system fixed so it simply doesn't happen and we've got a couple of things going on that. One's a contract for a new design data system — one problem is that the present system has simply evolved while no quality control system has evolved with it. As a result, the only real check we have on how well we're doing is by how many people are complaining that it isn't! — via call-ins and write-ins.

"Getting rid of WN was a big factor in rewriting the computer program for Amateur licensing."

We know we're doing better now, for example, because CB call-ins have dropped drastically in the last couple of weeks. That's because our systems people were able to figure out from the type of inquiries we were getting where the problem was in the computer program and how it could be corrected. In this case they found that since the first of the year about 145,000 CB licenses in various zip-code blocks had simply not been received by applicants! We went back to the computer, had those missing blocks reprinted and mailed, and the phones stopped ringing!

Now we're seeing the call-in volume from Amateurs growing as the number of Amateurs being licensed or upgrading grows. That's one reason why we had to drop the WN prefix, by the way. The computer program for Amateur is a very old one and it's simply not able to cope with current growth, and getting rid of the WN was a big factor in our getting that part of the program changed.

There's always a basic problem, of course — money! But the thing we're now starting to do is to apply some of the techniques we developed in working our way out of the CB licensing landslide to processing licenses for Amateurs. Of course, Amateurs have been a lot more tolerant of our problems than the CBers have, because most of the Amateur's licensing problems have been renewals, and Amateurs felt — rightly — that once they've sent in that renewal they can keep right on operating no matter how slow we are.

HRH: Just how important is the Amateur Radio Service to the FCC? In what kind of esteem are we held by those in the Commission?

John: Over the past 4 or 5 years I've been the one who's had to present cases concerning the Amateur rules to the other people in the Commission who would have to agree to changes. People in Enforcement, Field, Engineering, and the General Council, and of course there are a great many hams in practically all of those other groups. Many times I'll get the question, "Why do hams want to do this?" or, "What's this really for?" but then after another moment they'll say, "Though I don't really see why, I'm going to go along with it because the Amateurs have a good reputation and sure don't cause my people any trouble!" I think that's always been the case.

Amateur Radio is the oldest service — Marconi always considered himself a ham and Amateur Radio really did provide the first two-way radio communications — there were hams before there was anything else. Amateur Radio has always been an integral part of the Commission's activities, and one of its unusual roles to me that it's the one service which does not involve competing against commercial interests.

In other services there are usually always commercial interests that are always butting their heads together over something. In the Amateur Service those competitive values don't apply. We Amateurs might want the rules changed to make contesting easier, for example, but also want the change as one that benefits all the ham fraternity. What makes it hard for others in the Commission who aren't hams to understand us is that our values and concerns aren't at all like those of the other services with which they deal.

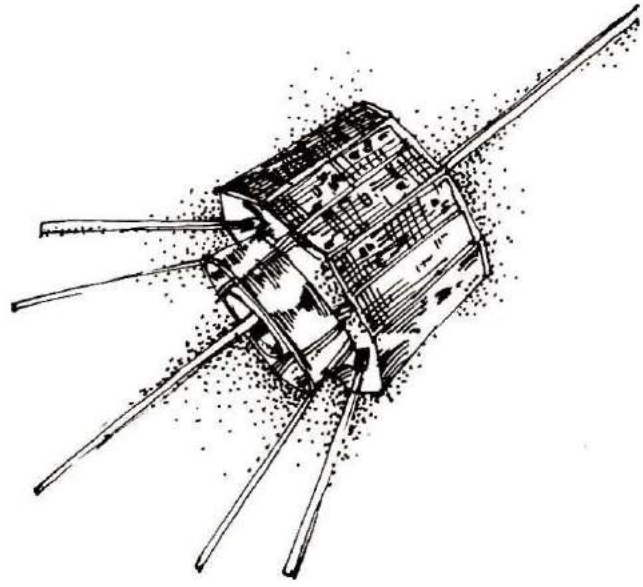
"In amateur radio it's the users who are pushing for and developing the innovations."

One other feeling about Amateur Radio that seems to exist within the Commission is a feeling that Amateur Radio is on the forefront of technology, more so than possibly any other service. And, in Amateur Radio, it's the users who are pushing for and developing the innovations.

HRH: In your opinion, where is Amateur Radio headed today? We've certainly got a revolution in numbers going . . .

John: Well, in the first place, there'll always be a role in the communications field for Amateur Radio. In 1979 (*the forthcoming World Administrative Radio Conference, where the radio-frequency spectrum will be reallocated between the various services.* ***Editor***) we may see a cutback or we may see an expansion. But either way, Amateur Radio is here to stay. As for Amateur Radio in this country, I see definite trends — some good and some bad . . .

Continued next month . . . Eat your hearts out, FCC watchers!



RIDING HIGH WITH OSCAR SATELLITES

BY ANTHONY R. CURTIS, K3RXK

Viking lander spacecraft peers at a rocky landscape and points a metal finger into the Martian sky. Pictures of red dust ride a radio beam out to our green planet where scientists flush with excitement as digital logic recreates the desolate vista. Bursting with the news from Mars, a researcher rushes down a corridor of the Jet Propulsion Laboratory in California and fires up amateur radio station N6V.

Signals from N6V stream up to a 65-pound communications satellite in Earth polar orbit and contact is established with ham station W3UN operated by Ed Clammer, 3000 miles away at Bethesda, Maryland. The fresh snapshots from Mars are transmitted through the 900-mile-high OSCAR satellite to Ed. When the satellite is high over the

north Atlantic, W3UN sends the pictures up to the bird where they are beamed down to Pat Gowen's station, G31OR, at Norwich, England. Man's first views of Mars are bounced around our globe by man's first system of privately built and maintained Earth satellites.

The seven satellites launched so far in the system have been called OSCAR for *O*rbital *S*atellite *C*arrying *A*mateur *R*adio. All have been designed by amateur radio operators and built in their garages, basements, and private workshops. OSCAR 1 was launched more than 15 years ago aboard a Thor-Agena rocket from Vandenberg, California, on December 12, 1961. It weighed 10 pounds, transmitted with one-tenth watt of power and beamed telemetry data about itself for three weeks to hams on Earth. OSCAR 2's data streamed down for 18 days.

OSCAR 3 lived only three weeks of 1965 but was the first active satellite. It used a one-watt transmitter to repeat signals heard from ham stations on Earth. A total of 100 different amateur radio stations in 16 countries used OSCAR 3, making it the first free-access communications satellite in history.

OSCAR 4 boasted three watts transmitter power and provided the first direct U.S. to U.S.S.R. contact via satellite. OSCAR 5 was built by students at Melbourne University in Australia. The batteries in its radio lasted 1½ months in 1970.

OSCARs all have been blasted into orbit as piggyback riders alongside government satellites. NASA uses ham-radio satellites to replace dead-weight ballast. This can be justified because the birds are put to educational use in schools around the world. The last two satellites in the OSCAR series still are in orbit and in daily use; more are about to be launched.

OSCAR 6, launched October 15, 1972, still is going strong. This active-repeater satellite weighs 40 pounds and can be turned on and off by ground command. It can receive messages, store them, and repeat them later following ground instructions.

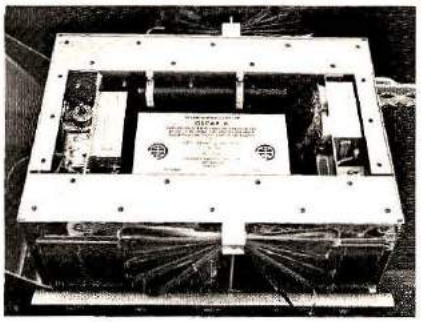
OSCAR 7, in orbit since November 15, 1974, has served many times to transmit medical data, weather bulletins and emergency communications as well as the usual ham chit-chat. It too can store and replay messages and be commanded on or off from Earth. It weighs 65 pounds and has a two-watt transmitter.

Emergency possibilities

Electrocardiogram impulses from a heart patient have been sent by George Dillon, W6ELT, from Santa Ana, California, via OSCAR 7 to Len Aberbach, K3ATA, at the National Institutes of Health, Washington, D.C. Fred Merry, W2GN, has transmitted EKG readings from a moving ambulance in New York to Washington, D.C.

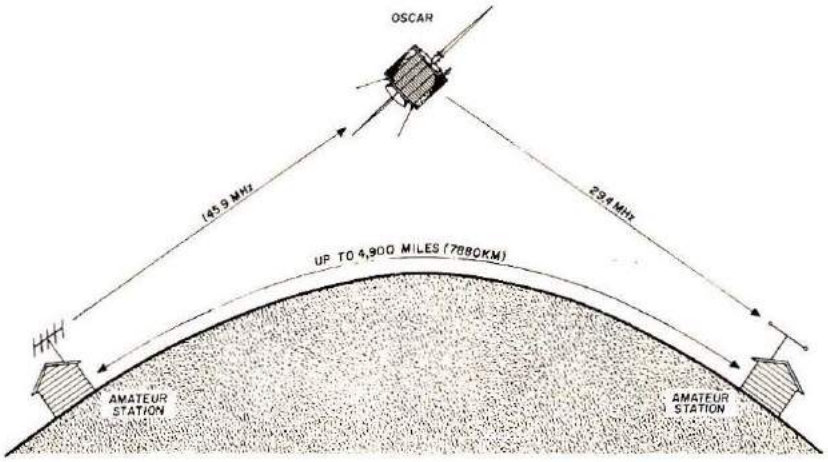
Miami hams maintain a weatherwatch with bulletins transmitted via OSCAR. A Coast Guard cutter crew on extended tour, far north in the Arctic Ocean, keeps in touch back home via OSCAR. And Doug Millar, WBØNST, of Rutland, North Dakota, took his OSCAR Earth station to New Orleans to permit youngsters attending a Lutheran Church rally to communicate through the satellites.

Hams use OSCAR 6 and 7 everyday, even as they are readying number eight to go up this year (1977). Other OSCARs, capable of even more exotic forms of communications controlled by tiny computers,



OSCAR 6 was dedicated to the memory of an AMSAT official, W3ZM. The ribbon "bow-tie" attachments on the front and rear of the housing are antennas. They are simply steel rules similar to the ones you might buy at a hardware store, folded up and secured by a pin. When the satellite is ejected from the launch vehicle the pins are pulled out and the rules unfold in frictionless space to form antennas. Solar power-collecting cells to recharge the batteries are located on the sides and cover of the satellite.

Whenever two ground stations can "see" the satellite they can use it to talk to each other. The distance between stations can vary from a few miles to several thousand miles. Future satellites will be placed in a higher orbit, which will increase the maximum separation between stations.



Satellite Operating Frequencies

Oscar 6	
Input (uplink) frequency	**Output (downlink) frequency**
145.9 to 146.0 MHz	29.45 to 29.55 MHz
	29.45 MHz beacon
Oscar 7	
145.85 to 145.95 MHz	29.4 to 29.5 MHz
432.125 to 432.175 MHz	145.975 to 145.925 MHz
	29.502 MHz beacon
	435.103 MHz beacon

Note: The uhf translator inverts the signals; USB on 432 MHz becomes LSB on 145 MHz. There is no signal inversion through the *vhf* translators of either Oscar 6 or Oscar 7.

are under construction and on ham drawing boards.

Amateur radio operators have great fun talking with each other through the satellites. Pat, G3IOR, has contacted hams in 80 countries via satellite. Dick Cotton, W8DX, Detroit, Michigan, has talked with hams in more than 50 countries on five continents. Bud Schultz, W6CG, Anaheim, California, has worked hams in all 50 states.

Suby, VU2UV, in southern India, has talked via OSCAR with amateurs in Finland, Rhodesia, Poland, Germany, Japan and the U.S.S.R. Vic Politi, W1NU, Fairfield, Connecticut, is an amateur bulletin station broadcasting news about OSCAR, through the satellites, to all hams.

Best of all, you can get in on the fun and excitement of the OSCAR satellites even before you get your ham license. Many shortwave listeners (SWLs) tune in on the ten-meter amateur band to hear the birds as they sail by overhead.

Organizations and uses

The international ham club which coordinates OSCAR activities is the Radio Amateur Satellite Corporation (AMSAT). Shortwave listeners and hams who send reports of hearing OSCAR satellites to AMSAT can receive QSL cards confirming the reception. Reports to AMSAT often include telemetry data received from OSCAR.

Boy Scouts can use signals from the satellites to earn Radio, Space-Exploration, Communications, Electronics, Signaling, Electricity, Engineering, and Emergency-Preparedness merit badges. Elementary and high-school students can learn math, physics, astronomy, electronics, communications, and space science from OSCAR. All you need is a simple shortwave receiver to tune 29.400-29.550 MHZ in the ten-meter ham band.

The American Radio Relay League (ARRL), 225 Main Street, Newington, Connecticut 06111, has a curriculum book available free to any school teacher for use in the classroom. The book explains in elementary language how to use a simple shortwave receiver to learn what keeps a satellite up, what governs its speed, and how to use OSCAR for class activities, even without an amateur radio operator's license.

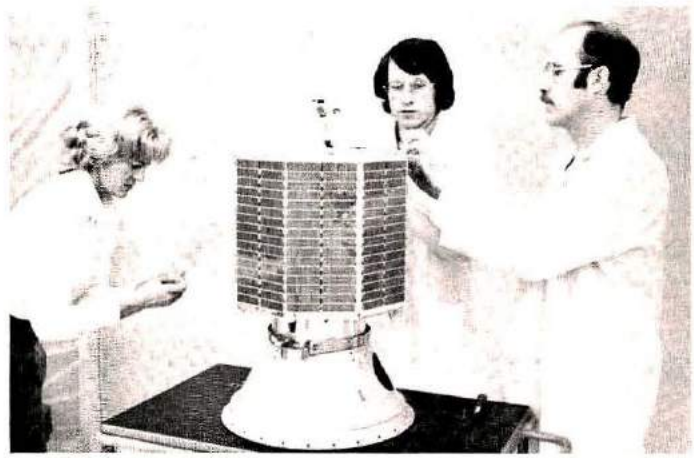
Hams transmit single-sideband (ssb) voice, International Morse code signals, slow-scan television, radioteletype, and other kinds of signals up to the OSCARs at frequencies of 145.850-146.00 MHz in the two-meter band. OSCAR hears those signals and repeats what it hears down to Earth in the ten-meter band.

Canadian hams have put OSCAR to use, locating downed aircraft. Using the satellite and a beacon radio transmitter aboard a simulated plane crash, amateur operators hundreds of miles away have been able to pinpoint the location of a downed aircraft within five miles, minutes after a crash. Other Canadian amateurs at Montreal chatted with friends across North America via OSCAR from a special station, CZ20, set up at the Olympics.

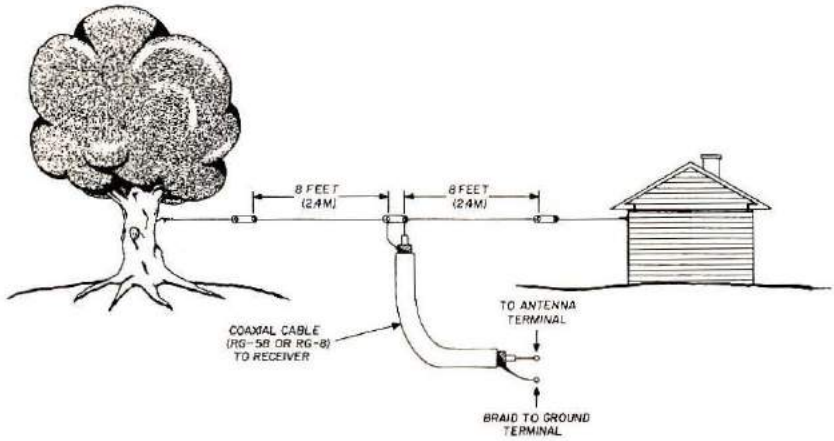
More than 500 Los Angeles high-school students and teachers took part in a live OSCAR radio contact last April. Another time, the governor of South Carolina visited a special bicentennial ham station, AA4SC, and chatted via OSCAR with YV5ZZ in Venezuela, VE3SAT in Ontario, W1NU in Connecticut, and K2OVS in New York.

Anyone can eavesdrop on

Final preparations on OSCAR 7 are being made by Marie Marr, technician, Jan King, W3GEY, and Dick Daniels, WA4DGU.



these conversations. OSCARs 6 and 7 circle the globe every two hours, passing over the whole face of the Earth in a day. You don't have to have your license to listen in, but I'll bet once you feel the fire of excitement in listening to OSCAR you'll want to get at least the Technician class license necessary to use the birds.



A simple dipole cut for the 10-meter (29-MHz) band will allow you to listen to both OSCAR 6 and 7. Antenna height above ground is not particularly critical, but a 15- to 20-foot minimum is a good starting place.

Equipment needed

To hear OSCAR signals through your receiver, you need only a simple antenna. Almost any outside antenna, cut for SWL or ham bands, can be hooked to your receiver to bring in the satellite. A very good antenna, cut especially to listen to OSCAR, would be a horizontal wire dipole. A dipole is constructed of two eight-foot lengths of wire of any size; a set of three insulators of plastic, ceramic, glass, or wood; and enough RG-58/U coaxial cable to serve as a lead-in wire from the center insulator of the dipole into your listening shack.

Antenna wire, insulators, and coax are available at electronics parts stores in many towns and from such national chains as Radio Shack. The insulators, which can be made easily from solid plastic, wood, or glass, prevent each eight-foot length of wire from touching the other. Tie an eight-foot length to each side of a center insulator and run the wire away from the center insulator in a straight line. Use an insulator at the far end of each eight-foot section of wire to prevent an electrical connection from the wire to antenna supports such as trees, poles, buildings or ropes.

You may subsitute RG-8/U for RG-58/U coax if you like. Both kinds will have a center conductor surrounded by white plastic insulation. Outside that white plastic insulation is a surrounding shield of copper braid. Outside the copper braid is a black rubbery-plastic covering to protect the coax from weather. Using the end of the coax cable outside at your antenna, connect the center conductor of the coax to one side of the antenna at one end of the center insulator. Connect the copper braid to the other eight-foot length of antenna wire at the other side of the center insulator. Inside your listening shack, attach the center conductor of the coax to a post or connector marked "antenna" on your receiver. Attach the shield braid of the coax to the post marked "ground" on your receiver. Your receiver will work even better if you run a heavy copper wire from that same "ground" post on your receiver to a four- to eight-foot metal rod driven in the ground outside your listening shack.

Ham Radio Horizons offers for sale a number of good, elementary books if you would like to learn more about how to make good antennas to hear the satellites and other ham bands or how your receiver works. They also have license manuals to help you get a ham ticket.

This array of equipment is empressive, but not all of it is required to work through the OSCAR spacecraft. Only two or three pieces of apparatus are being used by operator WA1JLD at WA1IOX, the club station at the Talcott Mountain Science Center, in Avon, Connecticut. Note the large, classroom size, OSCAR locator behind the operator. The Talcott Mountain facility was a leader in developing programs that would introduce amateur radio and satellites to students all across the country.

Oscar beacons

Most beginners first listen for the satellite's telemetry beacons. Both OSCARs have beacons which are radio signals transmitting strings of numbers in radiotelegraph code (CW). These beacons can be copied easily and deciphered to find out about temperatures inside and outside of the satellites as well as battery voltages and current drain from the batteries inside OSCAR satellites. The birds are powered by rechargeable nickel-cadmium (NiCad) batteries which take in new energy from the sun through solar cells on the satellite skins. OSCARs even have electronic alarm clocks inside

Although the OSCAR satellites are amateur projects, the spacecraft must meet the same exacting specifications as any commercial satellite. Here Perry Kline, K3JTE, and Jan King, W3GEY, prepare to submit OSCAR 7 to temperature and vacuum tests.

to remind control stations when internal housekeeping chores must be done. You can find out what time OSCAR thinks it is by copying the telemetry beacon.

Listen for the OSCAR 6 telemetry beacon at 29.450 MHz. OSCAR 7's beacon usually is stronger and can be copied at 29.502 MHz. Since the satellites are in orbit 900 miles high, you can be as far away as 2,450 miles and copy signals from OSCAR when it comes over your horizon. It need not be directly overhead but can be as far as 2,450 miles east, north, west, or south of your station. If the satellite is exactly half-way between two ham stations, they can be up to 4,900 miles apart and communicate.

Your receiver should be equipped with a bfo (beat-frequency-oscillator) or other means of making the dots and dashes of the International Morse radiotelegraph code sound like "dit " and "dah" tones when CW is being transmitted. You will use this feature to listen in on hams talking in single-sideband voice as well as CW.

Don't be discouraged if the voices or code you copy seem to fade in and out. The satellite is tumbling slowly in orbit and its signals are being affected by passing through the ionosphere. And you won't be able to hear both satellites at the same time as they are in slightly different orbits.

Hams all over the world work through the satellites, including stations in such exotic locales as Senegal, the Channel Islands, Sardinia, The Ivory Coast, and even Sable Island, a small rocky place off the east coast of Canada.

Dr. Peter Peham is a flying doctor working the northern slopes of Mount Kilimanjaro, Kenya. Pete got an old radiotelephone, a vacuum tube, some coaxial cable, and a bunch of empty aspirin tins. With the quartz crystal from his airplane radio, he built a transmitter right out there in the African bush and fired up to talk with hams via OSCAR. Using his call letters, 5Z4JJ, Pete made his initial satellite contact with 4W1ED more than 1000 land miles away in Yemen. Since then he has talked via OSCAR with hams in more than 18 countries on three continents.

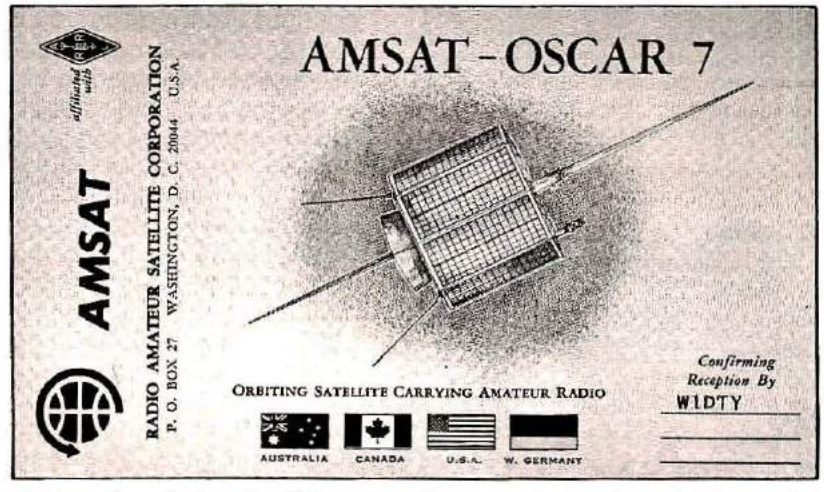
OSCAR excitement

I came down with a bad case of OSCAR fever a couple of years ago and haven't gotten it out of my system yet. In fact,

Some older receivers need a bit of help to hear 10-meter signals well. A preamplifier can be connected ahead of the receiver for better results. Some of the receiving preamplifiers that are sold for Citizens Band use might work well for this purpose. Instructions on how to build your own simple preamplifier can be found in *The Radio Amateur's Handbook*.

each contact through OSCAR adds fire. I strung my ten-meter dipole receiving antenna between two chimneys on my house and hooked the coax to my general coverage receiver (a Kenwood QR-666 which sells for under $300).

I tingled with excitement when I first fired up my own OSCAR Earth station. The ten-meter band was silent as the satellite crossed the equator and moved north toward the United States. Suddenly, as the satellite came over my horizon some 2,450 miles to the southwest, the band came alive with signals. There was the Morse-code telemetry beacon on 29.502 MHz. Morse code and ssb voice signals were everywhere between 29.400-29.500 MHz. OSCAR 7 was out over the Rocky Mountains,



QSL (confirmation) cards will be sent to listeners who send reports of receiving the beacon or telemetry information from OSCAR satellites. Write to Radio Amateur Satellite Corporation, P.O. Box 27, Washington, D.C. 20044, and tell them which satellite you heard, what frequency you listened to and what the information was that you copied. There is a different card for OSCAR 6.

Metric Equivalents. Rather than break up the flow of the story with many parenthetical statements, here are the metric equivalents of some measurements and dimensions used.

900 miles ≈ 1450 km	4 feet ≈ 1.2 meters
1000 miles ≈ 1600 km	8 feet ≈ 2.4 meters
1200 miles ≈ 1930 km	
2450 miles ≈ 3940 km	10 pounds ≈ 4.5 kg
3000 miles ≈ 4825 km	40 pounds ≈ 18 kg
4900 miles ≈ 7880 km	65 pounds ≈ 29 kg

streaking north at four miles per second.

I calculated I would be able to hear my own signal coming down near the frequency of 29.480 MHz so I tuned my receiver there and transmitted a long string of "dits," the letter "E" in Morse code. And there it was, my own dits coming back to me from high above the Rocky Mountains. Quickly, I sent a simple

CQ DE K3RXK

"Hey, I would like to talk to someone."

Immediately, Gordy, operator of ham station VE5XU who had been listening on my frequency, answered me, "K3RXK de VE5XU." I tingled with excitement.

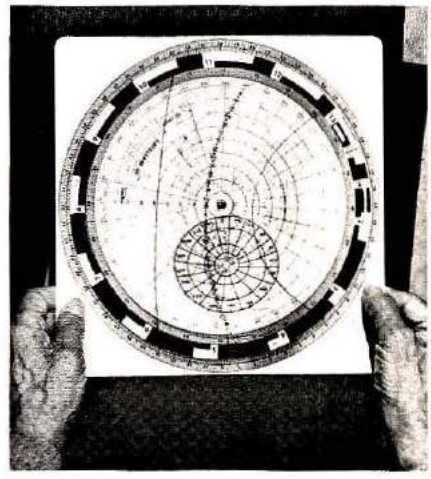
Here I was — a licensed ham for many years — using an orbiting satellite floating across the sky out west more than 1000 miles from my Pennsylvania home, contacting another fellow all the way up in Saskatchewan, Canada.

Gordy and I talked for about five minutes, exchanging signal information while the satellite raced northward. OSCAR 7 was in view of my Earth station only 20 minutes on that pass. I used that all up in listening for my signals, and talking to Gordy.

My first trans-Atlantic DX contact came on the third night. OSCAR 7 was over the North Atlantic when a station in England came back to my CQ.

My first use of OSCAR 6 came a bit later. The OSCARs are in similar orbits, one trailing the other. After a satellite crosses the equator, it passes over the United States from South to North. The Earth also is moving sideways under the satellite so OSCAR seems to move to the West on each pass. If the satellite comes up over the Southeastern United States one hour, it will come northward over the Rocky Mountains two hours later. And nearly two hours after that it will come North over the Pacific Coast. And so on around the Earth, daily covering the United States and the world.

If you have a scientific pocket calculator and want to add up the satellite's exact location once you hear it, OSCAR 6 takes 114.99449 minutes to get around the Earth once. It appears to move



Since OSCAR is continually moving, and the earth is rotating underneath, locating its position in the sky at any one time can be a problem. The *Satellabe*, pictured here, quickly provides the necessary orbital and antenna pointing information to communicate through the satellite. The *Satellabe* is available from *Ham Radio Horizons* for $7.95, postpaid.

The ease of OSCAR operation has been demonstrated by W2GN at many conventions and meetings throughout the eastern part of the country. A ground-plane antenna for 432 MHz allows Fred to operate through the uhf portion of the satellite.

west by 28.7486 degrees along the equator each rotation and it crosses the equator at an angle of 101.6015 degrees. OSCAR 7 has a period of 114.94478 minutes; an increment of 28.7362 degrees per revolution; and an inclination of 101.7010 degrees. For more information, write AMSAT at P.O. Box 27, Washington, D.C. 20044.

Hams work the satellite from most anywhere. Dick Long, WA4JID, of Plantation, Florida, has chatted from aboard his sailboat on an ocean cruise down through the Florida Keys. So, dust off your shortwave receiver. Hang out a wire antenna. Cock an ear toward OSCAR. You might hear Sable Island or the Hawaiian Islands, EKGs or hurricane bulletins, a ham in his car or in his boat. You might even hear my station, K3RXK, as I talk with new states and countries. If you do hear me, send a reception report. I'll be glad to return one of my QSL cards for your collection. We'll share the excitement together as we ride along on the ham radio satellites. **HRH**

THE NOT-SO-ROCKY ROAD FROM CB TO HAM

Now is the Time to Take Your First Step on the Journey to Amateur Radio Where You'll Find Fun and Companionship. Here's an Overview of the Super Highway to Ham

BY JAMES H. GRAY, W2EUQ

So you're a CBer and want to become a ham? Great! Welcome to the fraternity of amateur radio. The full name of our hobby is the Amateur Radio Service, with emphasis on *service*; to each other, to beginners and to the community. Just ask a ham for help, and he is more than happy to be of service to you and anyone else who needs it. Radio amateurs, traditionally and with great pride, form the backbone of non-commercial communication in the world.

All that's necessary for you to begin is to have the desire; there's a huge world of communication opportunities out there just waiting for you to take part.

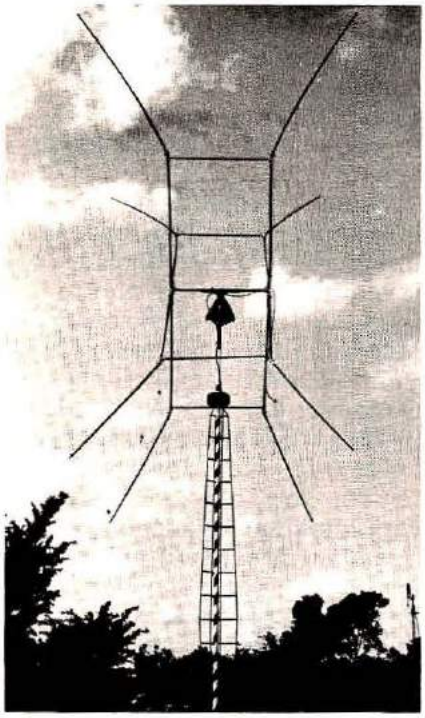
What can I do?

Rag chewing? You bet! And you are not limited to five minutes, either. Work DX? Sure; as much as you can rack up or have time for. In fact, DXing is encouraged and a whole branch of amateur radio operation is dedicated to working DX. Are you tired of being "rock-bound" or "channelized?" Then become a ham. Did you know that hams are legal "sliders?" Not only on one or two bands, but on all of them. In fact, if you don't use a vfo, you're old-fashioned!

Until recently, when seventeen new channels were granted to the Citizen's Radio Service, the CBer was restricted to just twenty-three channels. Now, even forty channels is limited in its ability to accommodate the communications burden, particularly when you consider that those channels are located in a small portion of the old eleven-meter amateur band, long a favorite of DXers among hams. On the other hand, amateurs are welcome to use many authorized bands ranging from our "top" band — 160 meters — lying just above the a-m broadcast band, to the ultra-high frequencies which are located above the TV channels. In between, we enjoy the use of the high-frequency bands: 80, 40, 20, 15, 10 and 6 meters — even 2 meters, which is technically a vhf band; all having different "personalities" and communications capabilities.

Learning is fun, too

Are you concerned about the



The beginning amateur can improve his signal by using a beam antenna. The cubical quad is a simple, inexpensive, and very effective beam that can be built from readily available materials.

"code," and do you worry about passing theory? Well, you can quit worrying, a five-year-old boy in Vincennes, Indiana did it last summer and is now on the air as WN9VPG — a Novice Class amateur. If he did it, you can too! Another thing: there's no age limit to becoming a ham, and — what's more — you are permitted to operate your amateur radio station in other countries under a program called reciprocal licensing, sponsored by our government and the governments of cooperating countries. Under this program, their hams can operate here, too.

Besides, you wanted to learn something about communications, didn't you? You've outgrown the "10-4 good buddy" routine and want to progress to a greater understanding of what it's all about, right? Okay, then ham radio is made for you.

Nuts, bolts and screws

How about equipment? Isn't it expensive? No more so than CB radios, really, when you consider what you get for your money. Most popular transmitters, receivers and transceivers are equipped to operate on five different amateur bands, 80 through 10 meters, at a price comparable to that of a good CB radio; and at higher power, too!

You fellows out there with Yaesu transceivers, for example, don't even have to buy any new gear; you can be ready to operate on the ham bands as soon as you're licensed. You might also think about getting on the air with good *used* equipment for much less than the price of a new CB radio; with the added advantage of a vfo, plus world-wide communications capability at power levels of several hundred watts.

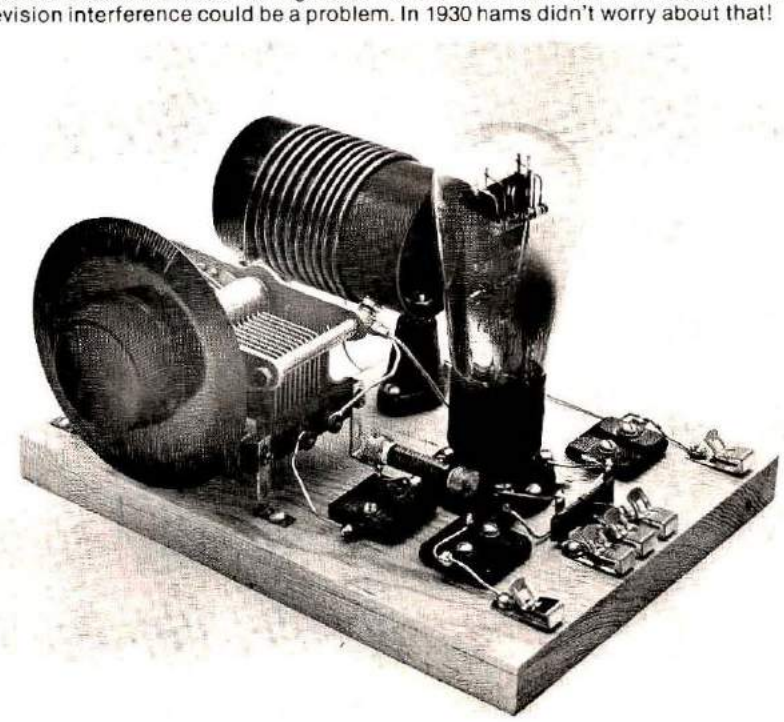
Sure, the ham rig can cost a cool Kilobuck or two, but it doesn't have to; it could cost as little as a couple of Centibucks — depending on what you can afford and how good a "wheeler and dealer"you are. Point is, you don't need the most expensive radio to get started, and you won't be taking a back seat, either. Some of the best signals around are put on the air by Novices running less than 100 watts and using "ancient" tube-type equipment.

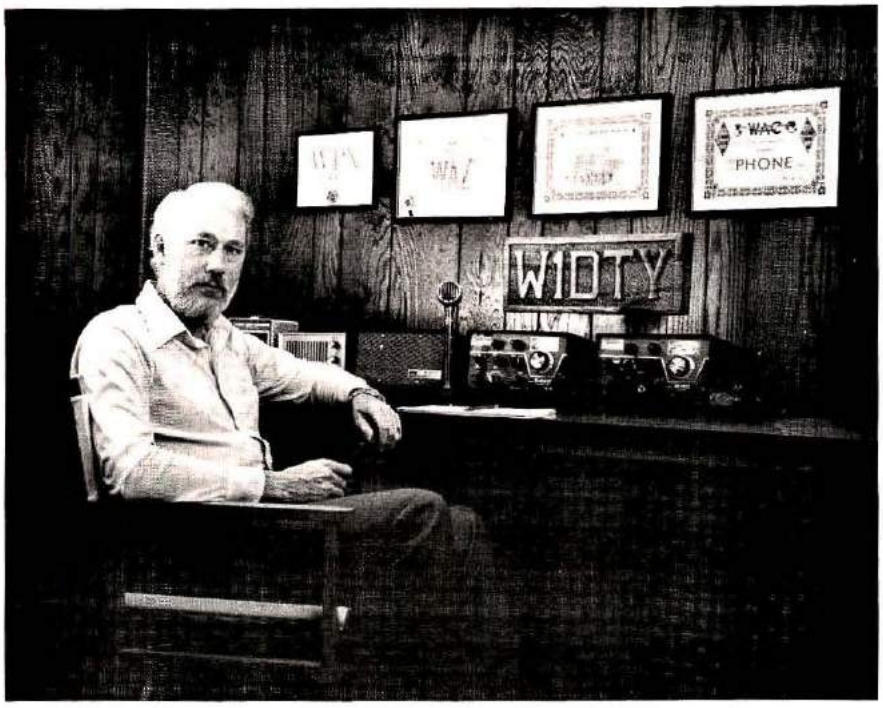
By the way, in case you hadn't heard, Novices can now run 250 watts of input power to the final amplifiers of their transmitters; more than enough to communicate with any country in the world under normal circumstances and conditions. Hams tend to do it with finesse, not force; but — when you need power, General and higher class licensees can *legally* run a kilowatt!

Begin at the beginning

Oh, I know: you don't have time for all that study and practice, right? *Wrong*! If you can spare 15 minutes a day to work on the code and another 15 minutes each day on the theory, you could have your

Single No. 45 tube transmitter, built by W6SAI from parts taken out of a defunct receiver and arranged in a Hartley circuit, cost little or nothing to build but gave a good account of itself on CW in 1976 — just as the original did in 1930. Note simple breadboard construction, direct wiring, hand-wound coil. However, with exposed circuits, television interference could be a problem. In 1930 hams didn't worry about that!





Modern amateur station of W1DTY is capable of worldwide communication and includes transmitter, receiver, electronic keyer, microphone, dummy load for tuning without placing signal on the air, and — of course — the operator.

Novice ticket (well, at least be ready for the exam) in a month; and be ready for the General Class license exam in three months.

Rules and regulations for the birds? Wrong again. Amateur radio operators represent the largest self-regulated and disciplined group in all of radio. Sure it's a hobby, and a darned good one, but the name of the game is responsibility. Just show "Uncle" that you can play the game fair and square, and he'll respond by giving you the freedom you want and need. Rules and regs are common-sense simple, and boil down to one underlying theme: respect and non-interference. Respect of the other ham's right to use a frequency on a non-exclusive basis — just like you have the same right; and the willingness to let him use it without interference if he's there first. If the frequency is busy, slide! That's legal, in ham radio.

What's in it for me?

You may wonder what you're going to get out of all this, and the answer is — fun; FUN, in capitals. Hamming is a way of doing your own thing, and there's more to do than you ever dreamed possible. Traffic nets for one thing; where you send, receive, and relay messages all over the United States, and many countries — free! Part of that word *service*, again.

There is experimentation and building; all perfectly legal and, in fact, encouraged because it is instructive and it's part of the tradition that has made ham radio what it is today. Build your own equipment? Certainly! It's done all the time by beginners and old timers alike. *Ham Radio Horizons* will tell you how to do just that, with minimum chances for mistakes or costly trouble. Even if you goof, so what? That's part of learning, too.

There's the opportunity for public service through Civil Defense, Red Cross, disaster and preparedness communications and many others.

You'll find education and training, the business of helping others like yourself get started on the right foot; and there's challenge. Reminds me of the time I was in Oklahoma City, and I asked a little old

For many hams, operating brings its awards and fun. Among the most sought-after awards is the WAS — Worked All States — certificate issued by ARRL, the American Radio Relay League. All that you need to do is submit proof that you have made a two-way contact with another ham in each of the fifty United States. QSL cards are the best proof available.

NEWS BULLETIN

"S-E-R-V-I-C-E is our MOST IMPORTANT PRODUCT"

DEAR OM:

If you're in the market for a new or used piece of HAM RADIO equipment, and in the process of "Shopping Around" for the "BEST DEAL" you can get — you no doubt realize that there are TWO IMPORTANT FACTORS to consider — the PRODUCT and the DEALER — or, in otherwords, WHAT you buy and WHERE or from whom you buy it! Furthermore, if you're truly a "Smart Shopper" — you probably take into account such variables as Price, Performance, Features, Quality, Resale-Value and SERVICE-ABILITY when making your comparison of the various makes & models available. And, if you're really ON TOP OF THINGS, you KNOW that there IS much-much MORE to a "GOOD DEAL" than just the "lowest price" — that, in the final analysis, the REPUTATION of the dealer standing behind YOU and your purchase is worth as much or MORE than the quality of the product itself.

Now, assuming that you AGREE WITH US up to this point, you're probably a little more than CURIOUS about our operation,and WHAT kind of a "DEAL" we've got to offer YOU!! To begin with, at BURGHARDT AMATUER CENTER in Watertown, South Dakota — of all places — our whole structure of business is built upon a foundation of FRIENDSHIP and PERSONAL S-E-R-V-I-C-E. We do not "PRETEND" to be "BigOperators" or "Wheeler-Dealers" as this would defeat our whole purpose in giving you the kind of FAST, DEPENDABLE SERVICE that you would expect — and you GET — from a company whose reputation as "AMERICA'S MOST RELIABLE AMATEUR RADIO DEALER" is on the line every day of the year. On the otherhand, we are BY NO MEANS a small nor inexperienced outfit just out to make a "fast buck" by selling one or two lines of HAM RADIO equipment, while the major portion of our enterprise may be devoted to other areas of communications — or entirely unrelated. Simply stated — "HAM RADIO IS OUR ONLY BUSINESS!!"

IN FACT, Stan Burghardt, WØIT, has been serving the nation as your DIRECT LINE to virtually EVERY MAJOR LINE of HAM RADIO gear since the fall of 1937 from our CENTRAL LOCATION here in the Midwest offering his customers both the LATEST and the BEST in amateur equipment. And, TODAY — with nearly 40-Years of S-E-R-V-I-C-E behind us — we still STOCK & SELL and GUARANTEE and SERVICE all of the familiar brand names that are a factor on the modern ham market — PLUS, we carry a COMPLETE LINE of operating aids and accessories to fill nearly every ham's needs. BUT, it's not so much WHAT we sell — rather HOW we sell it that's worth your consideration.

First of all, when it comes to FAST DELIVERY, HONEST DEALING and DEPENDABLE SERVICE — we don't just advertise it — WE GIVE IT!! We ALWAYS ship your order the same day it crosses our desk, and we WILL BE HONEST with YOU — right from the start! We ARE in this business to make a living — but NOT at YOUR expense. Our prices on new & used equipment are "down-to-earth" in the sense that they SQUARELY reflect the "REALISTIC" value of the merchandise WHEN you take into account the fact that we truly "SERVICE WHAT WE SELL" — and many that we don't!! OUR POLICY on the handling of defective merchandise is WELL-KNOWN to those who have dealt with us before — when we say "SERVICE with a smile" — we MEAN IT — and it's YOUR smile that we're after. It's always our aim to PLEASE because we KNOW (and YOU know) that THERE IS NO SUBSTITUTE for "GOOD" S-E-R-V-I-C-E!!

Furthermore, when you deal with us, you ALWAYS receive our prompt, PERSONAL attention and INDIVIDUAL concern. Each and every letter or phone call puts you in INSTANT TOUCH with a licensed ham who is READY, WILLING and ABLE to give your order or inquiry his UNDIVIDED ATTENTION — not put you on "HOLD!!" We approach every new transaction with a "fresh frame-of-mind" (we'll try "ANYTHING" once) and you'll always find us willing to COOPERATE with YOU to the limit. You won't catch us using any stereo-typed methods or responses in our conduct of business either, because we KNOW that THERE ARE NO SHORT-CUTS IN GIVING "GOOD" SERVICE!!

In conclusion, we realize that WATERTOWN may not exactly appeal to you as the "crossroads of the country" — but, it may well be (or become) YOUR "cornerstone of CONTENT-MENT!!" We most certainly are ON THE MAP — and WE WILL go a long-long way to take VERY GOOD CARE of YOU and make you feel "WELCOME." Above all else, your CONFIDENCE in us is our MOST IMPORTANT asset — just as S-E-R-V-I-C-E is our MOST IMPORTANT PRODUCT, and, in terms of "dollars 'n' cents" — these will never be discounted. All WE ASK for is the "OPPORTUNITY" to serve YOU — whatever YOUR NEEDS may be — and we look forward to hearing from you soon.

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More details? Ad Check page 86.

wizened-up bell hop at the hotel: "What's to do in Oklahoma City, Pop?" Quick as a flash he snapped back: "Anything you're *man* enough to do, Son!" And that pretty well sums it up: the challenge to get busy and do something with ham radio. The most important letter in fun is "u," spelled y-o-u!

You can participate in hamfests, in field-day exercises and in many different types of contests. Some hams are trying to contact all of the counties in the United States, others are trying to work all of the states in the U.S.A., while still others are well on their way to achieving contacts with every country in the world recognized in the "DX countries list." They call it certificate hunting, but we call it fun — all a part of the fine art of hamming. As you do these things, and many more, you'll be talking to other hams, improving your operating skills, and gaining knowledge; even better — understanding.

Have you heard about OSCAR? No, it's not a ham — it's a satellite. That's right, radio amateurs have their own satellites; not one, but *two*! The acronym stands for *O*rbital *S*atellite *C*arrying *A*mateur *R*adio. The first OSCAR, way back in December, 1961, was a small box-like package that went beeping around the globe sending code letters that translated to HI — HI, the ham's abbreviation for laughter. Each succeeding OSCAR, and we're up to seven of 'em at last count, has carried improved communications capability. The latest ones, OSCARs Six and Seven, regularly serve as repeaters; accepting signals from earth and rebroadcasting them on another, and usually lower, frequency.

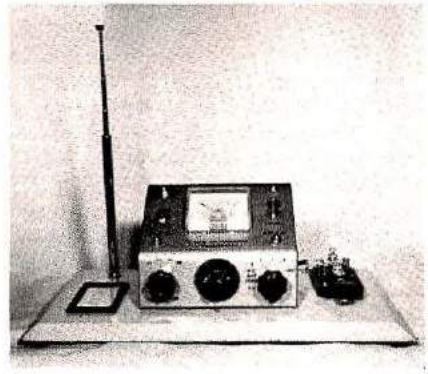
Hams all over the globe have communicated with each other via OSCAR, and still do it on a daily basis. OSCAR eight will be lofted some time before 1980, launched into an eccentric orbit that will permit amateurs to have several hours of access on each "pass," rather than the present few minutes available with OSCARs Six or Seven in their essentially circular orbits. Equipment needed is modest, and the antenna is probably the most important item you'll need. In future issues we'll offer simple and inexpensive equipment for you to assemble for the purpose of "accessing" OSCAR. Sound like fun? You bet it is, and represents just another of the many new, different, and interesting aspects of our amazing hobby.

Modes and means

There is mobile and fixed-station activity carried on by hams using a variety of modes: a-m, fm, ssb, CW, ATV and RTTY — even FAX, or facsimile. Now the field of amateur computers and calculators — microprocessors — attracts and ensnares the amateur experimenter. In short, there is more to do and more to be done than ever before, and all of it is waiting for you to take the first step.

How do you get started? That's easy, too. By reading this article, you've already begun your journey on the road

This little battery-powered receiver covers the Novice portions of 40 and 80 meters. Built from inexpensive parts,the receiver features a true superheterodyne circuit, with excellent sensitivity and selectivity. Could be a companion unit for the flea-power transmitter in the following photograph. Constructing and operating your own equipment is lots of fun.



This small four-band homemade QRP transmitter uses readily-available crystal oscillator circuits and features a built-in whip antenna with a tuning unit to radiate its one watt of power. Despite its size, this little rig can be used to send signals for hundreds of miles. A battery power supply and hand key mounted on base board complete this fine portable and emergency station.

On-the-air shot of W9NTP. Here, Don adjusts the slow-scan monitor of his amateur television station. The camera is at upper right. Station can be assembled at modest cost using some surplus and some homebuilt equipment. New equipment for ATV stations is also available from suppliers of amateur radio gear. Amateurs all around the world can communicate via slow-scan TV.

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Go along with the winners... assure yourself of amateur radio gear with professional performance.

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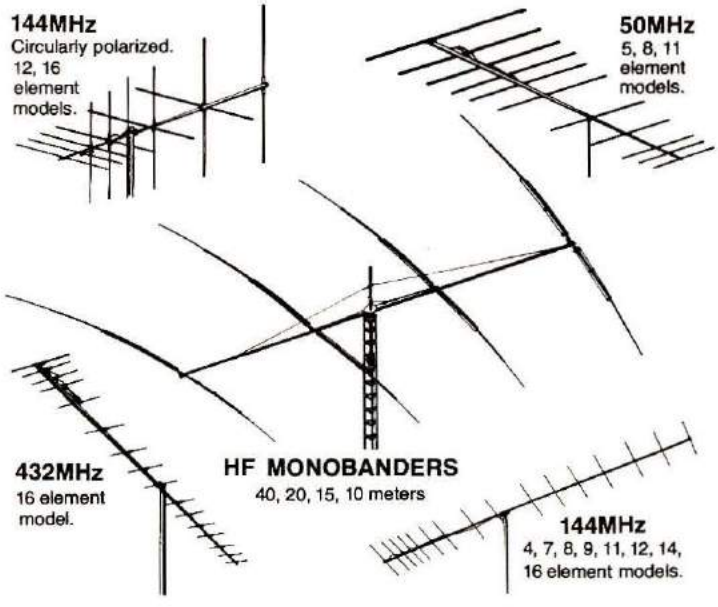
KLM antennas are bouncing signals off the moon... piling up contacts on a world-wide basis through OSCAR amateur radio satellites... are the choice of foremost DXers and high scoring contestors, HF, VHF and UHF. Exclusive designs with multiple driven elements give wide band coverage, low VSWR, efficient, non-critical operation. All antennas are strong... weather resistant. Professional performance... amateur pricing.



144MHz
Circularly polarized. 12, 16 element models.

50MHz
5, 8, 11 element models.

432MHz
16 element model.

HF MONOBANDERS
40, 20, 15, 10 meters

144MHz
4, 7, 8, 9, 11, 12, 14, 16 element models.

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- VXO ±7 kHz.
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- Standard 600 kHz splits plus 2, oddball splits.
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- Built-in VFO. 144-148 MHz. 1 kHz readout.
- 8 pole SSB filter plus 2, FM filters.
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- VOX (voice operated relay).
- Audio speech compressor.
- Noise blanker.
- RIT ±5 kHz.
- Power-out/"S" meter.
- FM center deviation meter.
- 10 watts output.
- 0.25 μV double conversion receiver.
- Built-in supply for 12VDC and 115VAC operation.

Multi-7 VHF, FM transceiver

A great "starter" unit with 23 crystal controlled channels and power output of 10 watts. Excellent, sensitive, selective double conversion receiver . . . RIT . . . Triple Band Pass filters . . . Metering . . . many other features. 13.8VDC operation (negative ground). Mic. w/coil cord/plug supplied.

Multi-11 VHF, FM transceiver

Another high performance unit for multi-faceted 2 meter operation. Features 23 crystal controlled channels (144-146 or 146-148 MHz) **plus** 4 channels which can be "scanned" continuously over any 4, selected frequencies within the range. Power out 10W, NBFM. Multi-conversion receiver and **two** RF stages. High sensitivity, outstanding selectivity. Features include multi-function metering, RIT. 13.8VDC (neg. gnd). Has mic./cord/plug.

Model "70" UHF, SSB/CW transceiver.

Covers 432-435 MHz, provides SSB with choice of USB and LSB plus CW. Frequency synthesized in 20 kHz steps with VXO providing continuous coverage within each step. Also has "auto watcher" that will scan any 20 kHz segment on receiver. A super performing, high quality UHF transceiver, ideal for "hill topping", UHF DX, OSCAR, etc. 10W power output. Triple conversion receiver with 0.5 μV sensitivity, RIT, Metering, other operating aids. 13.8VDC (negative ground). Supplied w/mic/cord/plug.

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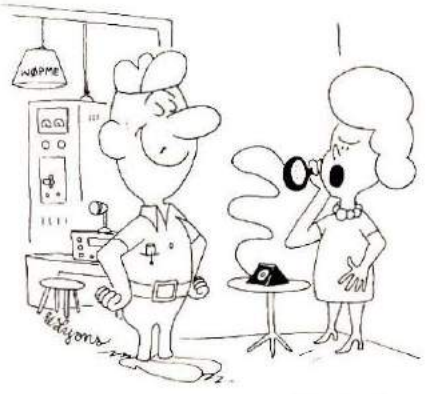
More details? Ad Check page 86.

Joe DelPrincipe is a junior at New York State University College at Fredonia, and an active radio amateur. He holds the amateur Extra Class license and is a member of the Navy's Military Affiliate Radio Service (MARS) teletype network. Joe's room is his communications center where he spends up to four hours a day relaying messages, primarily from servicemen to their families, through his station. Joe has been a ham since he was a senior in high school, and much of the equipment shown here has been built from kits from scratch or rebuilt by Joe in his spare time — including the "junk" teletype machines donated by the Navy. Joe exemplifies service to the public through his hobby — amateur radio.

to HAM. A next step might be to find a local amateur radio club in your town or city — or even an individual — a licensed ham in your neighborhood. Just show a sincere interest and a desire to learn more. Ask his help; he'll find your request irresistible.



"Mother, you can't expect him to fix a leaky faucet when he's just bounced a signal off the moon!" Many hams are active in EME, earth-moon-earth, communication. In fact, a recent *moon-bounce* expedition to Colombia, South America, set new records for distances and number of stations worked.

Service with a smile

Remember we've been talking about service? Well, part of the amateur's service to his hobby is getting others started and on the air. I'll admit that some "dyed-in-the wool" hams start out by being prejudiced against CBers, but I'll bet that you know more than one CBer who feels the same way about hams. Okay, that's bound to happen, and there's argument on both sides to support this attitude; but it isn't widespread, and I know lots of hams who are actively recruiting Citizen's Banders into the ranks of amateur radio. On the other side of the coin, many hams are avid CBers and will continue to be in order to take advantage of the very real benefits the band has to offer.

First, you'll have to learn to send and receive five words per minute of International Morse Code, and be able to pass a written test of 20 questions about simple electrical principles, FCC rules, and operating practices for amateur Novice Class stations. If you already know that an Ohm is a unit of electrical resistance, that QSL means confirmation of a contact, and that "blue" language is prohibited, you're already on your way to becoming a ham.

Who's on first?

To make it even easier for you to get started, perhaps joining with four or five others who want to become amateur radio operators, *Ham Radio Horizons* has an introductory package of learning materials that you can order and use — even alone, if necessary. The code lessons are on tape and the book includes a sample FCC-type theory examination. You don't even have to go to the nearest FCC office to take the examination; a licensed amateur can give you the test in your home or his, provided that he holds a General — or higher class — amateur license.

Feminine amateurs? Of course; many are on the air and taking part in those ham

Slow-scan amateur television pictures have excellent quality, as evidenced by this picture transmitted on 14 MHz by W4CCG, Manassas, Virginia and received by W8SH, East Lansing, Michigan. The television pictures you receive at home on your commercial set are called fast-scan, but can be sent or received in the slow-scan mode with an appropriate converter.

"I wish you'd learn to control your temper, Ralph. Remember, you were a CBer, too!"

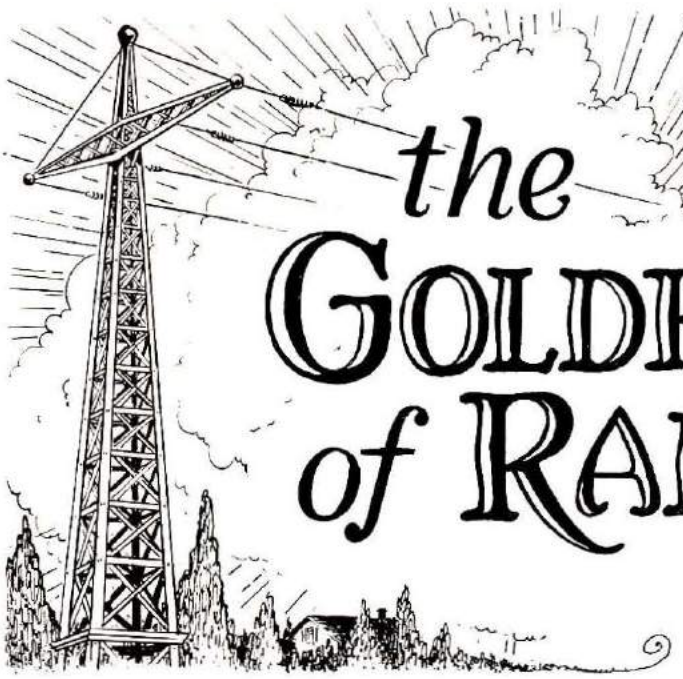
activities that most interest them. They have their own clubs, nets, and even a national organization of dedicated "YLs."

The "green stamp"

You'll discover the road to HAM a broad highway to fun and adventure, with various and interesting side roads to explore, all leading to development of your ability to communicate by radio. At every turn you'll find opportunity to go places, meet people, and do things that you may never have realized existed. The horizon is unlimited, you can go as far and as fast as you like: it's "clean and green" all the way.

Mile markers are the Novice, Technician, General, Advanced, and Extra Class amateur licenses; each reflecting a bit more skill and knowledge on the road to HAM. As you might expect, more privileges and greater freedom go with each marker along the way — and more responsibility, too.

Why don't you join our convoy now? Remember, you'll never be able to start any sooner, and each journey begins with a single step. Write "I Want to be a Ham," *Ham Radio Horizons*, Greenville, New Hampshire 03048. We'll send you a catalog and suggested list of study materials to start you on your way. **HRH**



the GOLDEN YEARS of RADIO

The Way It Was — 40 Years Ago

BY WILLIAM I. ORR, W6SAI

The old timers of today were beginners in 1937 and the wonderful world of amateur radio was just as interesting, confusing, and exciting then as it is now. Today's newly licensed amateurs can gain comfort and knowledge from the thought that the beginner opens the door to radio communication in 1977 in much the same manner as he did in 1937. The names and equipment may be different, but the spirit of amateur radio remains the same.

Old Timers vividly remember their first equipment, their first antenna, and their first contact. And much of the memory is preserved in some of the old radio magazines. The following is an excerpt of material of interest to the beginning amateur of 1937, as seen through the pages of *QST* and *Radio* magazines.

1937 was a good year for amateur radio: About 47,000 amateurs were licensed, the sunspot count was reasonably high, and the 10-meter band was exciting newcomers with transoceanic contacts. The 15-meter band, of course, was not allocated to amateurs at that time but many amateurs trying to get their home-made transmitters working on 10 meters unknowingly ended up on 15 meters and wondered why they could not raise the loud 10-meter signals they heard on their receivers!

QST magazine is the official organ of the American Radio Relay League and has been published continuously since December, 1915 (except during World War I). *Radio* magazine , originally devoted to broadcast reception, gradually changed to amateur radio during the years 1932-1934. It ceased publication as an amateur magazine in 1942.

Fig. 1. Among the many manufacturers of vacuum tubes for radio amateurs, the Taylor Tube Company was well known for rugged, low-priced tubes. Taylor advertisements often featured the artistry of Otto Eppers, W8EA, the ham radio cartoonist of the 1930s. W8EA also drew cartoon QSL cards which are collector's items today. While the Taylor Tube Company no longer exists, the ceramic-based Taylor tubes are hot collector's trophies today among conoisseurs. Ask any old timer about the T-55 or TZ-40 tubes!

Broadcast interference caused by 160-meter phone operation was a headache, but television interference was quite unknown, as W6AAR reported in *Radio* magazine, "The television picture is still rather cloudy. There would have been a hundred amateurs and at least a dozen commercial stations on the air with high-definition pictures at the end of 1936 had the pick-up tubes been available. The only consistent television picture on the air has been the Don Lee Los Angeles station which used mechanical scanning." And in the same magazine, David Sarnoff of RCA predicted that, "While the problems of television are formidable, I firmly believe they will be solved."

However, the 1937 newcomer probably didn't even read these prophecies as he was too intrigued by the articles and advertisements in the magazines. One of the first ones to catch his eye was the *Taylor Tubes* ad featuring a cartoon by Otto Eppers, W8EA (**Fig. 1**). The Taylor Tube Company was fighting it out with RCA and Eimac for the lucrative amateur market, along with Raytheon, all of who had a full stable of inexpensive tubes to separate the amateur and his dollar.

In those dear, dead days, the great majority of amateurs were crystal controlled on one or two frequencies. The accepted method of getting a contact was to call CQ and then announce that you were "tuning the band for a call." A reply might come at any frequency in the band and rare indeed were the contacts that had both stations operating on the same frequency. Smart DX operators, however, had learned the value of the vfo (variable frequency oscillator) and were

able to zero in on a DX station, thus greatly enhancing the chance of a come-back to their call.

QST, January, 1937

Only 25 cents, the red-and-black magazine featured an article on building an oscilloscope with the new one-inch 913 picture tube. Since the oscilloscope has never found its way into the amateur's heart, it is a sure bet that the beginning amateur hurried past this article to find more interesting fare. Sure enough, Walter Roberts, W3CHO, had a short article on an inexpensive 160-meter phone transmitter for local rag chews that was just the ticket for the beginning amateur to build (**Fig. 2**). The 160-meter band was the so-called "beginners band," because it was the only high-frequency phone band available to the newly licensed amateur (aside from 10 meters, which was thinly occupied). This 160-meter phone transmitter operated directly from the 110-volt line and provided a fully modulated carrier of about 2 watts. W3CHO assured the reader that with a suitable antenna, contacts as far out as 20 miles were duck soup, and a strong signal had been reported as far as 70 miles away.

The little transmitter used five inexpensive tubes, readily available from any radio repair shop. No meter was provided, the thrifty designer providing pin jacks at the proper point in the circuit whereby the lucky owner of a milliammeter could plug it in for measurements.

The circuit is of some interest, as it is of a type rarely seen today. The rf portion consisted of a 76 triode as a crystal oscillator inductively coupled to a 43 pentode as an rf amplifier. Similar tube types were used as a microphone amplifier and a series-connected cathode modulator. An amplitude-modulated carrier was the result.

The transmitter used a double-button carbon microphone whose voice-activated diaphragm varied the resistance of carbon cups. This was a widely used instrument, soon to be replaced in modern ham stations by the crystal microphone. A 25Z5 double diode provided plate potential as well as bias voltage for the modulator tube.

A casual remark in the *QST* text mentioned that one side of the primary line (the grounded side) was attached to the negative of the equipment, but left the reader up in the air as to the method of determining the ground connection in his house wiring. An error in wiring could thus possibly leave the negative circuits of the little transmitter "hot" to ground. The possibility of a shock was minimized by "floating" the chassis with respect to dc ground, much as was done in the old ac-dc broadcast receivers of that same period.

The dreamer could turn to the *How's DX* column in *QST* and learn that DX was good and that a few lucky amateurs had been able to contact EA4AP in Madrid, said to be operated by newspapermen at the American Embassy who were covering the Civil War in Spain. The big excitement on 20 meters, however, was the appearance of EL2A, the first station in Liberia who boomed in on 20 meters with 500 watts and an *eight element* Yagi!

The 10-meter band was hopping with DX, including loud signals from Chinese

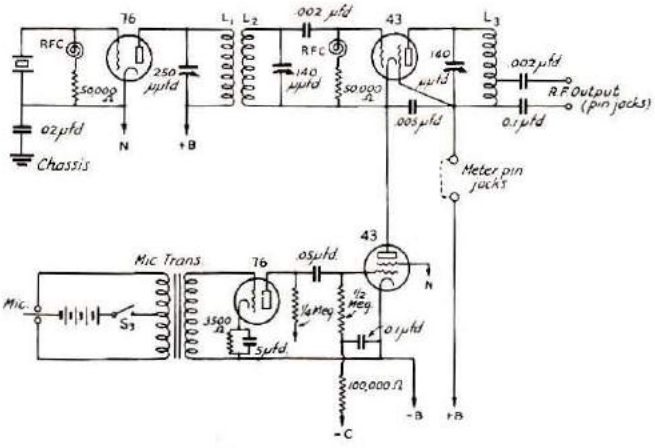


FIG. 1—CIRCUIT OF THE R.F. AND AUDIO SECTIONS OF THE 160-METER RAG-CHEW 'PHONE

L_1—Crystal oscillator plate coil, 35 turns No. 22 d.c.c., 1⅛-inch winding length.

L_2—Final grid coil, 45 turns No. 26 d.c.c., 1⅛-inch winding length.

L_3—Final plate coil, 55 turns No. 20 d.c.c., 2⅛-inch winding length.

All coils are wound on 1½-inch diameter forms. L_1 and L_2 are wound end-to-end on the same form with ⅛-inch separation between coils.

Switches S_2 and S_3 are a single d.p.s.t. toggle.

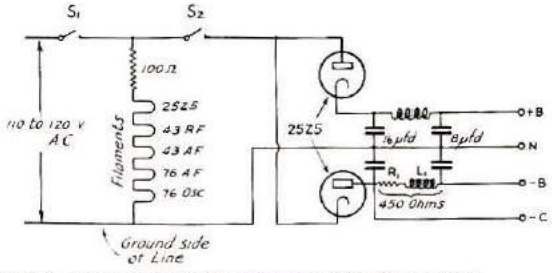


FIG. 2—THE TRANSFORMERLESS POWER SUPPLY CIRCUIT

A total resistance of approximately 450 ohms was found correct for L_1 and R_1 in series, but it may be preferable to use a variable resistor for R_1 and adjust bias to make the d.c. voltage drops between plate and cathode of each 43 about equal when the final amplifier is excited and tuned but not modulated.

Fig. 2. A flea-power a-m phone for 160 meters using 5 tubes was featured in the January, 1937, *QST* magazine. Operating directly from the ac power line, the crystal-controlled transmitter delivered about 2 watts carrier power, using a series modulator. A double-button carbon microphone was featured, along with a two-stage audio amplifier-modulator. The tube filaments were in series for direct connection to the power line. A transmitter of this type could be made of parts taken from a defunct broadcast receiver. Drawings copyright 1936 by The American Radio Relay League, Inc., reprinted by permission.

stations XU8OP, XU8MT, and the first QSO between England and Brazil on 10 meters was recorded.

Buy a good amateur receiver? There were many on the market and you could trade-in your old receiver or get "time sales" for your new receiver with only a six-per cent interest charge at *Henry Radio Shop* (**Fig. 3**). The more affluent amateurs were greatly interested in the announcement of the new Hammarlund *Super-Pro,** a state-of-the-art receiver whose life span lasted from 1937 until at least 1950, a near-record for an age when electronics was making giant strides forward (**Fig. 4**).

And, finally, a *QST Ham-Ad* informed the new amateur that he could get the "world's finest QSL cards," printed by W8DED, who is still advertising QSL printing service in *QST*, 40 years later.

Fig. 3. Henry Radio Shop (now Henry Radio) offered "times sales" at a 6% interest charge in 1937. The newcomer often bought the Hallicrafters *Sky Buddy* receiver at $29.50 or the *Sky Chief* at $44.50. More affluent amateurs bought the *RME-69* at $134.90 and a few dreamed of owning the yet-to-be-announced *Super Pro* receiver at $238.14. To match the 1937 prices to 1977, multiply the above by five.

Fig. 4. The famous Hammarlund *Super Pro* receiver was announced in 1937. Featuring two tuned rf stages and a precision coil turret, the *Super Pro* design lasted well until after World War II. Thousands of these receivers were built for the military during the period, 1940-1946, and the popular BC-779 was used in many ham shacks until the advent of single sideband in the early 1950s.

Radio, January, 1937

Radio magazine, a mildly iconoclastic publication, was published on the west coast for a number of pre-war years. The January, 1937, issue was the annual edition, which ran to a fat 194 pages, chock full of advertisements and articles for the advanced amateur. The beginner was not left out of the picture, however. A fine article by Bernie Ontiveros, W6FFF, described a 20-watt, six-band transmitter that used the newly developed RCA beam power tube, the 807 (**Fig. 5**). Using plug-in coils and six tubes, the little rig was built into a wooden relay rack and boasted a dc milliammeter that could be plugged into various circuits to monitor critical current.

The rf section consisted of a glass 6L6 as a regenerative crystal oscillator, inductively coupled to an 807 as an amplifier. Circuit *connoisseurs* familiar with the 807 will no doubt raise their eyebrows at the simple circuit, as no parasitic suppression was included. But then, since no TV stations were really on the air, who worried about parasitics?

The audio section consisted of a 6A6 twin-triode, parallel-connected as an amplifier for a carbon microphone, and two 42 pentode tubes connected as a class-AB push-pull modulator, featuring battery bias. The whole transmitter was run from a single, heavy-duty power supply which used a "broadcast replacement" transformer and an 83 mercury vapor rectifier. Bernie assured the builder that,"...the quality on voice will be almost as good as with the more expensive type microphones."

The DX column of *Radio* sadly reported that QSL cards had been returned from OS1BR (presumably in Suez, Egypt) marked *Uncorect Adres* and that W9WCE was working

*Old- and not-so-old timers will fondly remember the *Super-Pro* as the war surplus BC-779 receiver that graced many ham shacks during the years immediately after the war.

plenty of 20-meter DX with 45 watts. W5EOW contributed the following poem for posterity:

The DX Contest

Every morning about half-past four,
I slip on my pants and sneak
out the door,
Out to the shack I run like heck,
To warm up the tubes and get a
frequency check.

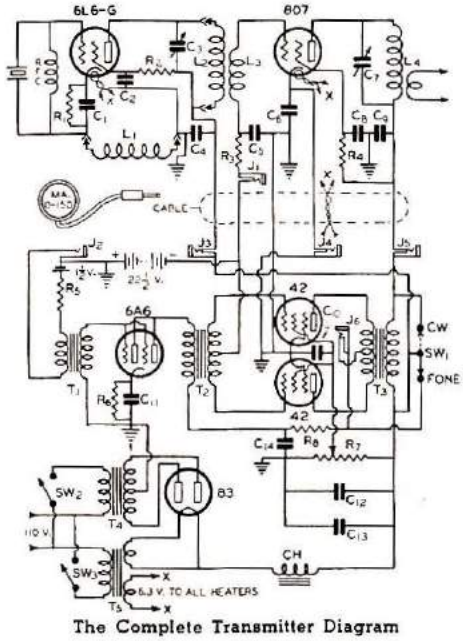
Listen 'bout an hour, don't hear
a thing,
Haven't worked a furriner since
way last spring.

Hear a CQ, my heart gives a bound,
'Til he signs W5, just across town,
Now some folks say there ain't
no Hell,
But they ain't hams, so they
can't tell,
When fall rolls around I take
another chance,
And buy 66's instead of new pants,
Buy a new receiver when the old
one's best,
But I'm durn sure ready for the
next contest!

Yet, the uncomplicated days of ham radio were slowly coming to a close. By the end of 1937 RCA placed a two-page advertisement in *QST* announcing the new television Kinescope picture tube and stated that, "...Television was out of the laboratory." *QST* also featured a long article about FR8VX, Prince Vihn San, exiled from French Indo-China (Viet Nam) because of troubles caused by the local movements for independence. Isolated on Reunion Island, the Prince evolved into 1937's prize DX catch with a 20-watt transmitter. And in 1937, problems were arising in Europe that would affect the destiny of the world, although to hear the number of German amateurs on the air, one would not guess what lay ahead.

So the 1937 newcomer to amateur radio enjoyed the hobby to the utmost, even though by today's standards his equipment was crude, weak, and unreliable. Most of the great communication innovations lay in the immediate future. How could he guess what dazzling developments lay ahead?

Unknown to the new 1937 amateur were single sideband, double-conversion receivers, i-f filters, keyers, quad antennas, vhf fm, repeaters, DXpeditions, DXCC, direct frequency readout, transistors, phase-locked loops, pi-networks, coaxial cable, hf mobile operation, crank-up towers, radio teletype, transverters, solid-state amplifiers, synthesizers, frequency standards, counters, vhf converters, triband beams, active filters, prescalers, Morse-to-video converters, toroids, speech processors, slow-scan television, digital clocks, swr meters, TVI filters (and TVI), handie-talkies, nicad batteries, circuit boards, spectrum analyzers, microprocessors, and other necessities of the advancing 1970s.



The Complete Transmitter Diagram

Fig. 5. The 20-watt, six-band transmitter of W6FFF typifies the beginner's phone transmitter of 1937. Many amateurs substituted the 6L6G ($1.25) for the more expensive 807 ($3.50). Modern crystals would be destroyed by the 6L6G power oscillator, but heavy-duty crystals were available in 1937 with blanks which were larger than a postage stamp. The audio system was designed for a single-button carbon microphone, and the power supply featured an 83-type mercury vapor rectifier which provided high current at a very low voltage drop. The transmitter was designed to be used with an external antenna tuner.

The necessities of today, however, were the unheard of luxuries of yesterday. The beginning amateur of 1937 could buy a good, "all-wave" receiver with a bandspread dial for under $50. He could build a one- or two-tube CW transmitter for about $15, provided he could find a junked broadcast receiver to rip apart for components. A Zepp antenna could be built for a few dollars. And for less than $70, he was on the air! The equipment was simple and even if he couldn't understand all the complexities of the bandswitching receiver, chances were that the beginner could persuade the local radio repairman to get it going for a dollar or two.

And so it was in those less-complicated days that the beginner got his start in amateur radio. He didn't miss the sophisticated gear of the seventies that confronts today's beginner. But the fun, the thrill of amateur radio, was surely present in 1937, as can be testified by the large number of old timers, licensed about that time, who recall with pleasure their first days as a beginning amateur, when each new day brought more discovery of the wonderful world of amateur radio.

About the Writer. W6SAI was licensed in 1934 and in January, 1937, had the thrill of becoming the seventh USA phone station to win the WAC (Worked all Continents Award). On January 16, 1937, he worked VU2CQ in Bombay, India, on 20-meter phone using a home-built 120-watt transmitter and a home-built superhet receiver. The antenna was a dipole. Upon completing this feat — at about 5 AM — W6SAI startled his parents out of their wits by rushing into their bedroom, yelling, "I did it! I did it!" Needless to say, their enthusiasm for the feat was tempered by the early hour and by the fact that they had been sound asleep! **HRH**

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you've read about it

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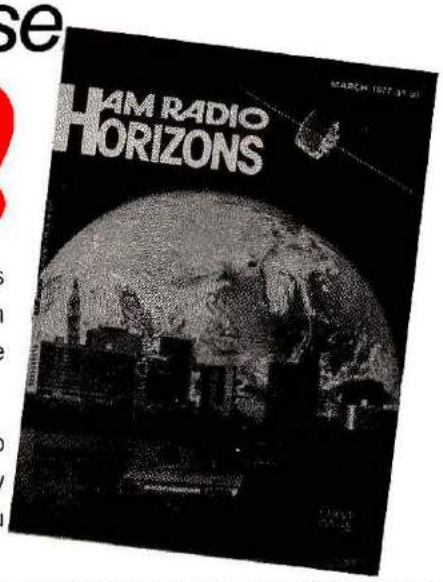

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MAKING WAVES ELECTRONICALLY

A Simple Audio Oscillator

BY DOUGLAS A. BLAKESLEE, W1KLK

Although this unit is called an audio oscillator (or generator), it can also be described as a function generator. Audio generators have been around for quite some time. In the 1930s RCA and others created variable audio tones by using one fixed and one variable radio-frequency (rf) oscillator, beating the two signals together to produce output in the audio range. At that time no simple way existed to build a wide-range tunable audio generator with the oscillator directly producing audio.

Just prior to World War II, two young engineers who had just graduated from Stanford University got together in a garage and developed a tunable audio oscillator that used resistive and capacitive elements to set the frequency. The two, Bill Hewlett and Dave Packard, sold their first units to Walt Disney for use in his movie *Fantasia*. In an American success story worthy of Disney himself, Hewlett and Packard's garage operation grew into the world's largest manufacturer of electronic test equipment.

The function generator is an invention of the transistor age. Pioneered by Wavetek and other firms, a typical unit covers the audio and low rf ranges, producing sine-, square- and triangular-wave output (see **Fig. 1**). Modern function generators also feature sweep and sophisticated modulation capabilities. The simple unit described here develops sine, square, and triangular waves, but the triangular output is disregarded because it is of little use in radio work. The oscillator covers 10 Hz to 100 kHz in four ranges. Separate sine- and square-wave outputs, individually adjustable in level, are provided. The unit can be powered by two 9-volt transistor-radio batteries or by a 12 to 24 volt ac-operated supply.

How it works

For simplicity the audio generator employs a single 8038 integrated circuit manufactured by Intersil. A simplified block diagram of the 8038 is shown in **Fig. 2** (block diagrams are often used when explaining the operation of complex electronic circuits). The 8038 qualifies as a complex circuit — it contains 55 transistors and diodes plus some 50 other components. A capacitor, C, is charged from a constant-current source. A constant-current supply is what the name implies, a circuit that delivers a preset amount of current no matter what the load resistance. When connected to a capacitor, this supply will charge the capacitor in a manner that is linear with time. A second constant-current supply which can absorb or "sink" twice the current of the charging supply is alternatively

connected and disconnected. While connected, it takes all of the output of the first supply and discharges the capacitor in a manner that is a mirror image of the charge cycle. The end result is development of a triangular waveform across the capacitor.

The charge/discharge cycle is started and stopped by two voltage sensors called comparators because they *compare* two voltages — in this case a preset reference voltage and the voltage developed across the capacitor. Comparators are electrical switches that are on (putting out close to the supply voltage) when the varying voltage exceeds the reference and off (putting out zero or a negative voltage) when the input voltage drops below the reference. Two comparators are used in the 8038; the references are set at 1/3 and 2/3 of the supply voltage, respectively. The outputs of the comparators control a switching system which works as a single-pole, single-throw switch (called a flip-flop in logic terms). This switch connects and disconnects the constant-current sink as the voltage across the capacitor reaches 2/3 and 1/3 of the supply potential, respectively. The same switch produces a square-wave signal which is at the same frequency as the triangular wave.

The sine-wave signal is developed from the triangular wave by a converter within the integrated circuit. It consists of a series of transistor switches and resistors which increasingly shunt (load down) the triangular wave as its amplitude increases. A similar circuit operates on the negative half of the signal. To understand the process, refer to the simplified diagram of **Fig. 3.** In the example, we will consider only the positive half of the cycle. S1, S2, and S3 are transistor switches which increase the load resistance,

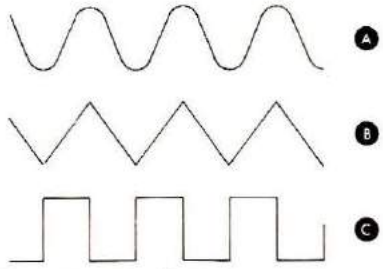


Fig. 1. Waveforms of sine (A), triangular (B), and square waves (C).

decreasing the impedance, as they are activated. S1 cuts in when the ascending waveform reaches a preset level; resistor R1 loads the circuit, and the amplitude of the waveform is decreased. Soon S2 and then S3 close, further loading the circuits. Then, as the triangle waveform starts down in amplitude, the switches open in reverse order. The end effect is that the triangle is rounded off to a close approximation of a sine wave with distortion of two per cent or less.

Any final circuit design is a set of compromises. The compromises made are usually a trade off between cost and availability of components, circuit complexity, and given levels of performance. In this project, and those to follow, inexpensive components available at local outlets such as Radio Shack, Lafayette, or Calectro dealers have been chosen. Mail-order sources are needed for the etched circuit board and a few other hard-to-find items. Because many components are often less than ideal, the design goal must be to find ways to make them usable with a given IC or transistor.

The schematic diagram of the audio generator is shown in **Fig. 4.** All that needs to be done to the 8038 is to add appropriate components around the IC. The frequency of oscillation is set by the resistive and capacitive components. Resistors R7 and R8 assure that the rise and fall time of the triangular wave are equal. The tuning range for each frequency band is set to be slightly more than 10 to 1 by R2 through R6. The adjustable trimmers (also called controls, potentiometers, or simply "pots") make up for small differences in the frequency-determining capacitors, C1 through C4. R1 is a panel-mount control which tunes the generator across each range. Unfortunately, the frequency produced by the 8038 does not track linearly with resistance. In fact, quite the opposite occurs if a linear-taper pot is used for R1; the higher part of each range will be "scrunched up" at the top end of the dial. The best solution would be to use a control with a logarithmic taper. However, Radio Shack and similar sources do not

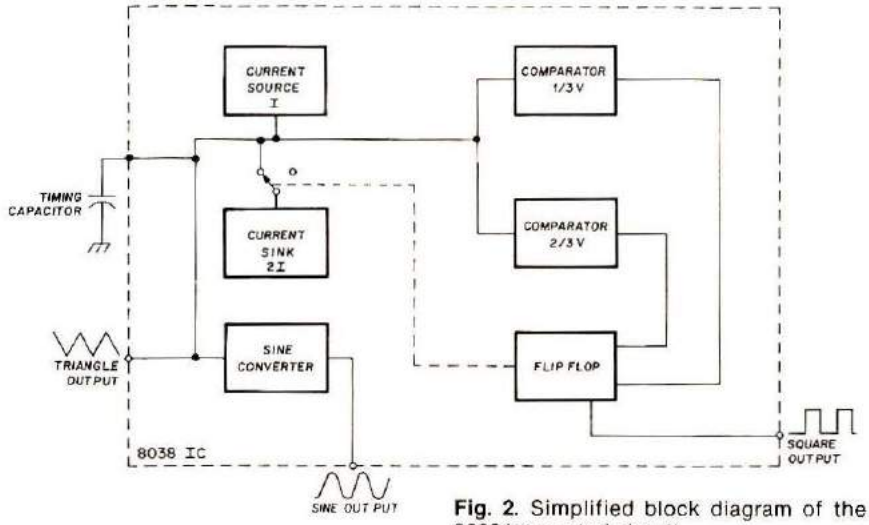
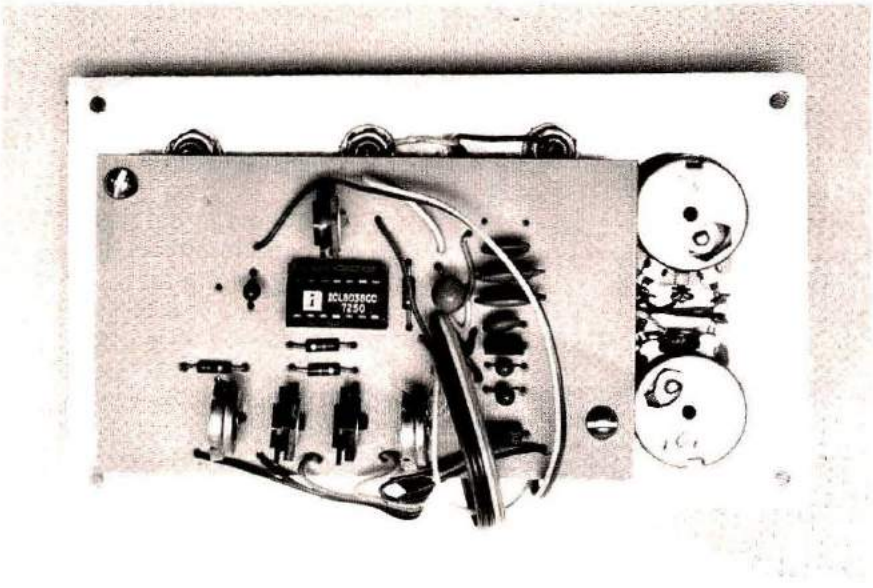


Fig. 2. Simplified block diagram of the 8038 integrated circuit.



The two controls on the right in this view are the sine and square wave level adjustments. Four range-calibrating potentiometers can be seen standing on edge immediately below the IC. Ribbon cable is used to connect the circuit board to the components on the panel.

carry such parts. A Radio Shack audio-taper control (part number 271-1721) will provide usable — if not ideal — tuning range.

Purchasing components from local sources is always an adventure. Unusual difficulty was encountered in finding 500-ohm pots. Visits to the four Shack stores in the greater Hartford area produced nothing. The salesperson in each store had the same story — the day before a gentleman had come in looking to purchase 200 of the 500-ohm pots. Each store had a few, and he bought them all. What project could possibly use 200 trimmers is a question that boggles the mind. Anyway, at the last stop, two 1000-ohm units were purchased (all the store had in stock). Then, a trip to the local electronic parts distributor produced two more trimmers; these were Mallory MLC types. If 500-ohm pots are used, then R6 should be 470 ohms as shown on **Fig. 4**. If 1000-ohm units are the only ones available, then change R6 to 330 ohms. The 500-ohm trimmers are preferred because they are somewhat easier to adjust. Just hope the mad pot buyer hasn't hit your area.

S1 selects the appropriate capacitance for each tuning range. Again I had a problem obtaining desired values. They can be purchased from James along with the 8038 (see appendix). If you do your shopping at the Shack, it is necessary to combine two capacitors in parallel to obtain the desired value; 0.01 and 0.0047 μF to get close to the 0.015 μF needed for C3, for example. Mounting holes for two capacitors in each range position have been provided on the circuit board.

The tolerances of capacitors vary widely, from +200 per cent, −100 per cent for electrolytics to ±1 per cent for micas. The trimmer pots will correct for some variation in capacitance. It is possible to get some capacitors that are so far from the marked value that they are not usable. In this unit one ceramic capacitor was so far from its marked value that one range would not calibrate. I replaced this capacitor and all was well.

A trimmer control, R10, is used to set sine-wave distortion to a minimum. If you have no way of checking distortion, then R10 can be replaced by an 82k-ohm fixed resistor. The sine- and square-wave outputs are capacitively coupled to output level controls R11 and R12, respectively. The triangular wave is available at a point on the circuit board but is not used. If you want triangular-wave output, it can be brought out through a capacitor/control combination with the same values as C5/R11.

Power for the audio oscillator may be obtained from two 9-volt batteries or from a 12- to 15-volt power supply. Approximately 16 mA is needed. Diode CR1 is included to prevent accidental application of dc power of the wrong polarity. If battery power is used, CR1 and J1 can be eliminated.

Construction details

The unit is built on an etched circuit board. If you have the capability, you can make one from the foil pattern of **Fig. 6** or you can purchase one from Whitehouse (see appendix). Although other assembly techniques such as point-to-point wiring on perf board may be employed, use of the etched board will minimize the chance

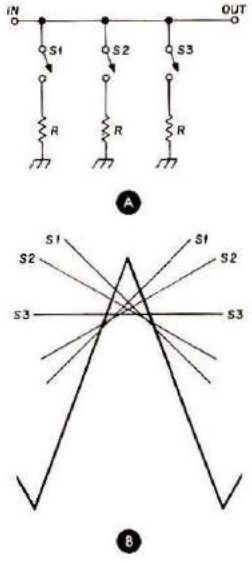


Fig. 3. Simplified circuit (A), and approximate effect of the triangle to sine converter (B).

for wiring errors. When soldering, use a 20- or 40-watt pencil-tip iron; excessive heat can damage components or raise the foil from the board. Before mounting components, make sure that the foil on the etched board is clean and shiny. If not, touch it up with some fine steel wool. Mount components a few at a time, bending leads slightly to hold the parts in place. Then solder the leads using a minimum amount of rosin-core solder. The appropriate procedure is to heat the lead and the foil for a moment, then apply a little solder and remove the iron. The finished joint should be smooth and shiny. A dull joint or matted solder indicates that you may have a "cold" joint (produced when insufficient heat is applied) which may not be good either electrically or mechanically. Use a socket for the IC (Radio Shack part number 276-027) so that if you get a bad 8038 or you damage the unit, it can be easily replaced. The last step on the board is to connect the wire leads which go to the panel components. Ribbon cable is ideal for this purpose. Once the circuit board is complete, check that no solder splashes have shorted out adjacent leads and that all components are installed in the appropriate places.

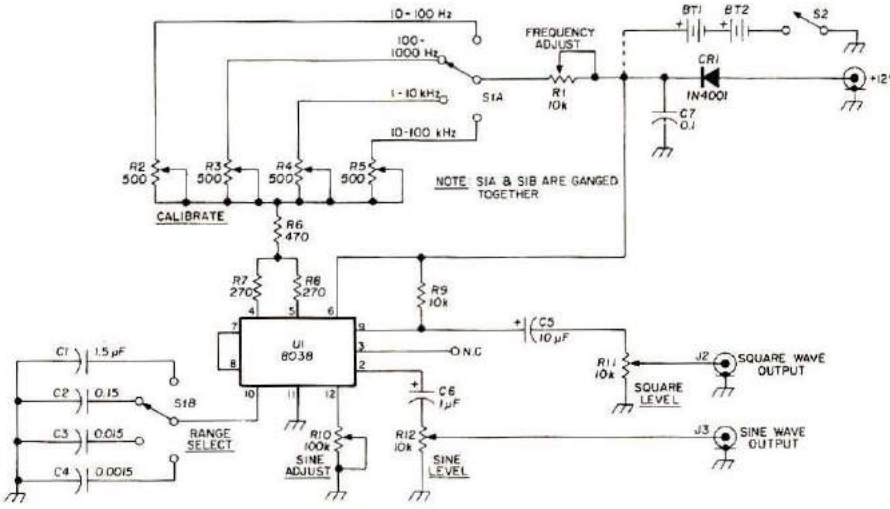
Our unit is housed in a 6-1/4 x 3/4 x 2-inch (160x95x51mm) plastic case with a metal front panel (Radio Shack part number 270-627). If the unit is to be used to test high-power rf transmitters, a metal box (part number 270-238) should be used — it only costs 10 cents more. Also for the rf environment, ferrite beads should be used on the leads of each of the panel jacks along with a 0.005 μF bypass capacitor. These components must be located at the jacks. Whitehouse sells ferrite beads (see appendix).

It is best to lay out all components on the front panel, marking their locations with a pencil, before drilling holes. The holes can be made by using a variable-speed electric drill or a hand-held drill and taper reamer. Use a low speed for the larger holes. For appearance sake the front panel can be given several coats of spray paint in your favorite color. Controls and connectors can be marked using a *Dymo* label maker or press-on labels. The knobs are Radio Shack parts 274-415 and 274-416.

The circuit board is mounted to the panel using 1-inch (25mm) standoffs and no. 6 (M3.5) hardware. Of course, the panel components should be wired first. Then, the leads from the board should be connected. Leave sufficient wire length so that the board can be disconnected from the front panel for troubleshooting purposes. When the wiring is finished, check the resistance from the 12-volt supply terminal to ground; it should be approximately 10,000 ohms.

Calibration and use

Calibration of the generator will depend on the test equipment that you have available. If no test gear can be begged or borrowed, set R2 through R5 at midrange of their rotation. Spot checks of individual frequencies can be obtained from the tones of 440, 500, and 600 Hz transmitted by WWV and WWVH. Likewise, the notes of a piano can provide checkpoints. A known audio



BT1,BT2	9-volt battery (33-464)	R1	Audio taper, 10k (271-1721)
C1	Tantalum (1 and 0.47 μF, 272-1406 and 272-1404)	R2-R6	500- or 1000-ohm trimmer (271-226 or 271-227)
C2	Mylar (0.1 and 0.0047 μF, 272-1069 and 272-1068)	R7-R9	½- or -watt composition resistor (series 271-000 or 271-1300)
C3	Ceramic (0.01 and 0.005 μF, 272-131 and 272-130)	R10	Trimmer control, 100k (271-220)
C4	Ceramic (0.001 μF and 470 pF, 272-126 and 272-125)	R11,R12	Panel mount, 10k, ½ watt (271-1715)
C5,C6	Tantalum (10 and 1 μF, 272-1411 and 272-1406)	S1	2-pole, 4-to-6 position, rotary switch (275-1386)
C7	Ceramic (0.1 μF, 272-135)	S2	Spst slide switch (275-401)
J1-J3	Phono jack (274-346)	U1	Intersil 8038B or 8038CC (see appendix)

Fig. 4. Schematic diagram of the audio oscillator. Except for U1, all parts are available at Radio Shack; their part numbers are given for each component.

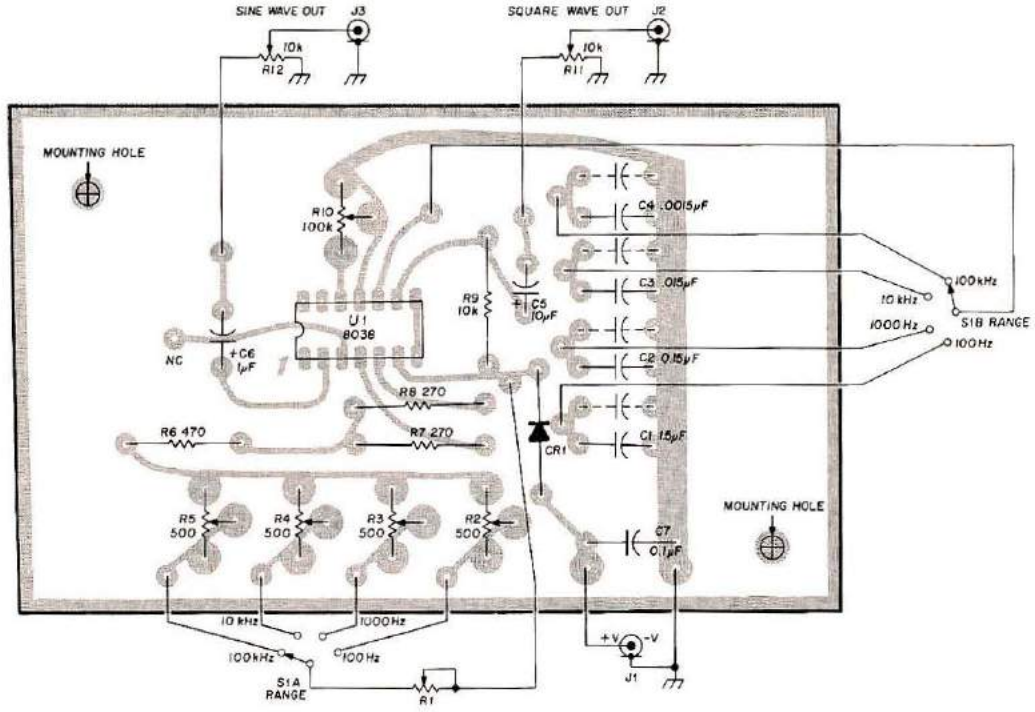


Fig. 5. Full size circuit-board and parts-placement guide. A printed-circuit-board pattern is shown in Fig. 6.

frequency can be compared with the generator by feeding both tones through a pair of 10k ohm resistors to high-impedance headphones.

If you have access to a frequency counter, oscilloscope with calibrated time base, or a direct-reading frequency meter, a more precise calibration is possible. R1 should be set for the highest calibration mark on the dial. Then, R2 through R6 should be set for 100 Hz to 100 kHz, respectively. If an oscilloscope or distortion meter is available, R10 should be set for minimum sine-wave distortion (best appearance). Otherwise, it should be set for approximately three-fourths total resistance. With 18 volts supplied by the two transistor batteries, the maximum output at the sine- and square-wave jacks is 3.3 volts peak-to-peak and 15 volts, respectively.

A complete applications guide for audio generators is beyond the scope of this article. Audio oscillators are used to test transmitters, receivers, amplifiers, filters, and digital circuits. The generator can be connected to high-impedance circuits directly. If you need a connection to low-impedance circuits, use an external transformer with a 10k-ohm primary and suitable low-impedance secondary. For digital circuits where the square-wave output is used as a clock or test signal, the level translator of **Fig. 7** is suitable. The collector voltage at transistor Q1 should be obtained from the digital-logic circuit under test, 5 volts for TTL and 12 volts for CMOS. When using the level translator, the square-wave signal output should be set with R11 until Q1 acts as switch. The switching action can be seen by connecting a voltmeter to the collector of Q1. When switching action is taking place, the collector voltage will

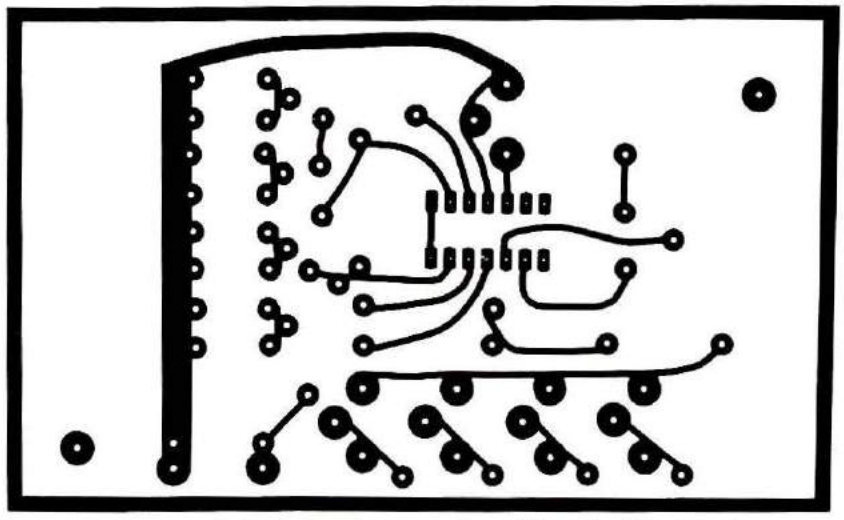


Fig. 6. Full size printed-circuit board pattern viewed from the foil side. A component placement guide is shown in Fig. 5.

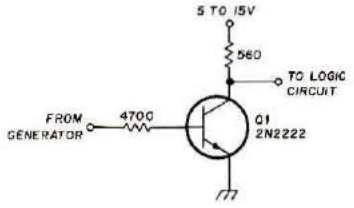


Fig. 7. Circuit diagram of a level translator. Q1 is a 2N2222; the resistors may be ¼- or ½-watt composition. The collector voltage should be taken from the logic supply.

appear to drop to approximately half of the supply voltage.

The generator can be used to check distortion in an ssb transmitter. A two-tone test can be generated by taking approximately an 800-Hz tone from the generator and connecting it to the microphone jack of the transmitter. Then, unbalance the carrier of the transmitter until a two-tone test pattern is produced on an oscilloscope. Details of two-tone testing are contained in the ssb chapter of the ARRL *Radio Amateur's Handbook* . Another application of the oscillator is to measure a received frequency. A crystal-controlled calibrator is needed. The audio-frequency difference between the unknown and the calibrator signals produces an audio signal. The generator is then used to provide a reference signal which is set to the same tone as the unknown. The frequency of the generator can then be read from the dial and added to or subtracted from the standard (as appropriate) to determine the exact frequency of the unknown signal.

Appendix

A. The frequency of the 8038 IC is set by the total resistance between the supply and pins 4, 5, plus the capacitance attached to pin 10. Frequency may be calculated by:

$$f = \frac{0.15}{RC}$$

The manufacturer claims that the frequency is independent of supply voltage even though none of the voltages inside the integrated circuit are regulated. This is because both currents and thresholds are direct, linear functions of the supply voltage and their effects cancel. This is almost true. Tests on the finished generator (which used the CC version, the lowest quality gradeout) changed 2 Hz when the supply was varied from 12 to 15 volts with the generator set at 2000 Hz. Changes from 15 to 20 volts produced approximately 6 Hz change. This should indicate more than sufficient short-term stability. With no voltage adjustment, a random drift of less than 0.5 hertz was noted.

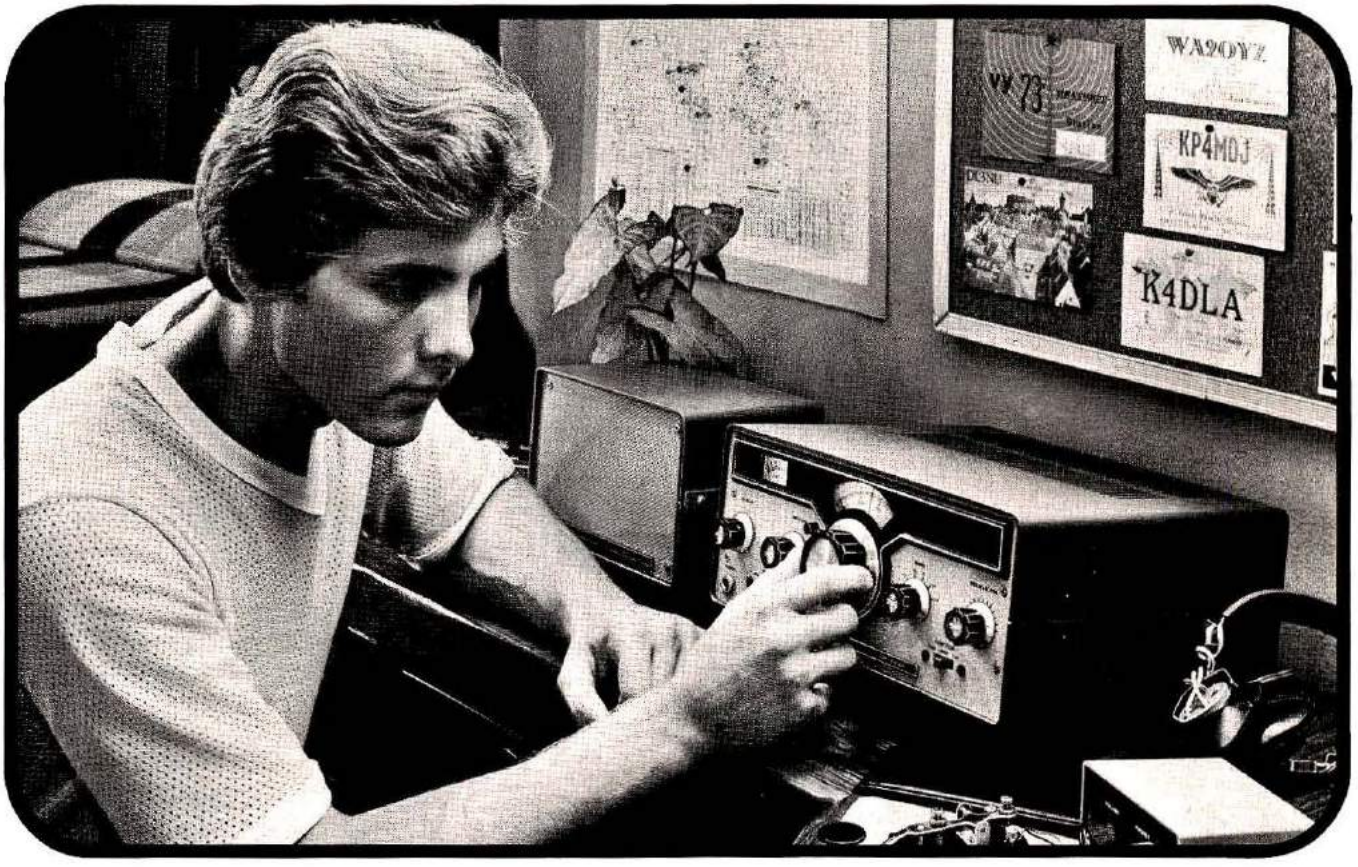
For detailed information about the 8038 write to the Marketing Department, Intersil, Inc., 10900 N. Tanton Avenue, Cupertino, California 95014, and request the "8038 Waveform Generator Voltage-Controlled Oscillator" specification sheet and "Application Bulletin A-012, A Precision Waveform Generator and Voltage-Controlled Oscillator."

B. The B version (middle gradeout) of the 8038 is available at $4.95 from James Electronics, P.O. Box 822, Belmont, California 94002. James also offers 0.0015 μF Mylar and 0.15 and 1.5 μF Tantalum capacitors for 12, 28 and 30 cents, respectively.

C. G. R. Whitehouse, 15 Newbury Drive, Amherst, New Hampshire 03031, offers an etched circuit board only for this project at $3.00 postpaid in the U.S. and Canada. The PC board plus 8038 IC, 0.15, .015, .0015 μF (all Mylar), and 1.5 μF Tantalum sells for $9.50 postpaid. Also, they sell ferrite beads (FB-73-801) for rf suppression at $1.50 per dozen.

HRH

From Novice...



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THE FAR HORIZON- AN EVENING OF DX

Talking with people in distant lands is fascinating, thrilling, and can become addictive.

BY BOB LOCHER, W9KNI

Of the many hobbies within Amateur Radio, one of the most fascinating is called "DXing." It is by nature truly an international avocation, with many thousands of devotees. At a later date we'll go into a complete description of it, frequencies used, equipment required, definitions used, etc. This time, however, let's take a look at what might be a typical late-winter evening devoted to this part of our hobby . . .

Dinner is finished, and things are under control. Conditions were fairly good last night, and I am hopeful that they will be even better tonight. I go into the corner of the basement where my station is. Someday it would be nice to move the station to an upstairs room with windows, but it isn't important. I pull out the old captain's chair, put on the headphones, and turn on the receiver and transmitter. While the equipment is warming, I turn the antenna to point straight north — the path to deep Asia.

As the receiver comes to life, I tune it down to the CW (code) end of the band. Some DXers today prefer voice operation but I prefer CW — communication is more precise, especially with stations who speak little English, and the range is far greater. Also, a camaraderie exists among good CW operators that is often unknown to the phone operators.

I start carefully tuning the receiver. A few dying signals from Europe are coming in; the band has been open to Europe all afternoon, but now the path is fading out. I tune on.

There — there's a nice signal calling CQ (looking for a contact). I recognize it immediately as a DX station.

The tone of the signal carries the quirks of a propagation path thousands of miles long

CQ CQ CQ DX DE UI8KDA
UI8KDA CQ CQ DX CQ DE
UI8KDA UI8KDA

As I first read his call, I hit the switches on the 800-watt amplifier. I bring my transmitter to his frequency, and call him.

UI8KDA UI8KDA DE W9KNI
W9KNI W9KNI AR K

I listen — yes, there he is.

W9KNI W9KNI DE UI8KDA R R
TNX OM ES GE BT UR RST 579
579 BT QTH HR SAMARKAND
SAMARKAND BT NAME IS
BORIS BORIS BT HW CPY?
W9KNI DE UI8KDA AR KN

W9KNI from UI8KDA — Roger — Thanks, old man, for the call, and good evening to you — Your signals are clear and good copy — I am located in Samarkand — My name is Boris — How do you copy me? W9KNI from UI8KDA. Please transmit now.

Samarkand! Sun drenched city in Soviet Uzbekistan where Marco Polo found an already ancient city, where caravans from East and West met to trade rare spices and costly silks for Toledo steel and Western gold. City of spectacular Mosques, where Tamerlane held forth. I've worked Samarkand a number of times, but it never fails to excite my imagination.

R UI8KDA DE W9KNI R TNX DR
BORIS ES GM BT VY PSD QSO
BT UR RST 569 569 HR NR
CHICAGO CHICAGO BT NAME
IS BOB BOB BT WX HR FB
CLEAR ES 8C 8C BT RIG HR
800 WATTS ES 2EL QUAD AT
18 METERS BT HW CPY NW
BORIS? UI8KDA DE W9KNI AR KN.

Roger, UI8KDA from W9KNI. Roger, dear Boris, and good morning — I am very pleased to contact you — your signals are clear and good copy here near Chicago — My name is Bob — Weather here is fine, clear and 45 degrees F(8 degrees C) — My transmitter is 800 watts and my antenna a 2-element quad at 60 feet (18 meters) — How do you copy, Boris? UI8KDA from W9KNI, go ahead.

Boris returns:

R W9KNI DE UI8KDA R FB BOB
TNX RPT FRM NR CHICAGO BT
HR RIG 200 WATTS ES
GROUND PLANE BT WX HR 31C
31C HOT ES CLR BT QSL OK
BOB VIA BOX 88 MOSCOW BT
QRU NW 73 TNX QSO BT W9KNI
DE UI8KDA SK

Roger W9KNI from UI8KDA Roger, fine Bob, thanks for the report from near Chicago — Here my transmitter is 200 watts and the antenna a ground-plane vertical — Weather here is hot, 88 degrees F (31 degrees C) and clear — I will send a card confirming this contact via Post Office Box 88 in Moscow — I have nothing else here so best regards and thanks for the contact — W9KNI from UI8KDA, end of contact.

Boris is like most Soviet hams — very brief in the contacts — partly due to lack of English, and partly due to the regulations of their ham licenses.

R UI8KDA DE W9KNI R OK TNX
BORIS FOR NICE QSO BT QSL
BOX 88 SURE BT 73 NW HPE CU
AGN SO LONG UI8KDA DE
W9KNI SK

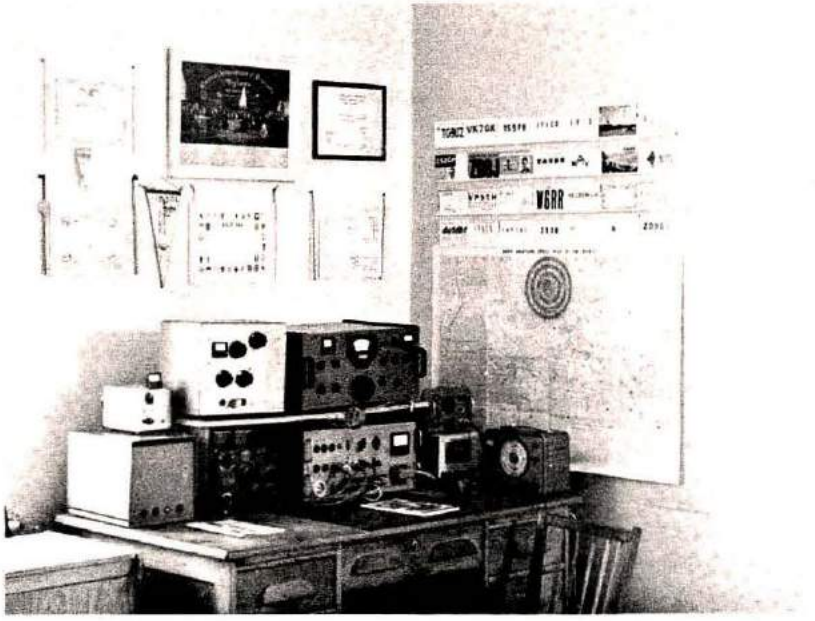
Roger UI8KDA from W9KNI Roger okay Boris, thanks for the nice contact — I will send you a confirmation card via Box 88, Moscow, for sure — Best regards for now and I hope to contact you again UI8KDA from W9KNI.

Having completed the contact with Boris, I write the details in my log book, and make a note to send him a card tomorrow confirming the contact. The card will be sent, as per his request, to Box 88, Moscow — the address of the Krenkl Central Radio Club, which is the National Association of Soviet Hams. They will forward the card to Boris. The club is named after Ernst Krenkl, a Hero of the Soviet Union, famed for saving a Polar expedition by use of his radio.

I begin tuning again, listening, looking. I hear a number of hams in the Kazakh — the land of the steppes — but I have worked many of them and I tune on. The Siberians are coming through too, some of them extremely loud.

There, a weak signal calling CQ — it's VU2GK — my friend Ramad in Bangalore, India. I move my transmitter to his

Amateur station of Karl Kaalemaa, UR2BU, in Tartu, Estonia, USSR. Karl is active on all the amateur bands, high-frequency through vhf. Look at all the operating awards on the wall!



Amateur station of OK1JKX in Czechoslovakia. As with most Eastern European amateurs, most of the equipment is homebrewed.

frequency as he continues his general call, and send a couple dots just off his frequency. The power-output meter kicks up, indicating all is well in my transmitter, and I zero in on his frequency. He finishes his call, and I call him.

Ramad comes right back, and greets me by name. I have worked him a number of times before, and we chat. He tells me of the weather in Bangalore, and inquires about my wife and children. I ask him about his family — we have exchanged pictures by mail. He is a civil engineer for the state railroad. Ramad's equipment is very simple: a military surplus WW II receiver, a two-tube homebuilt transmitter, and a simple wire for an antenna. As I pull in his signals I reflect that his transmitter runs 40 watts, less than the power used in the lightbulb illuminating my station; my transmitter runs 800 watts.

I remember I once asked Ramad if he worked in the torpedo factory in Bangalore by way of a joke; he never replied. I ask him if he has any news of VU2FBZ, the very rare station in the Andaman Islands I have been seeking for months. He tells me that the station has been on, but only irregularly. Ramad's signals begin to fade, so we sign out before we lose contact.

It is 9 PM now, quite late for the deep Asia path to stay open, and a bit of tuning confirms that it is pretty well gone. I turn the antenna more to the northeast — the direction for the Near East. The sun is just now rising in that area, and many of the hams there get on the air before it gets too hot.

Ah, yes — there's Owen, A9XU in Bahrein — I listen for a few minutes and tune on; I worked Owen a week ago, and many are standing by to call him. There is a 4X4 in Israel — the band is opening into the Near East quite well. I tune a little further, and there — a huge pileup! — dozens and dozens of American stations calling someone. I turn up the volume and switch in the sharp receiving filter, bring the transmitter quickly up on frequency, and listen intently. This is the competitive aspect of the game. There is a signal coming back to someone.

K4GSU K4GSU DE
A7XA R 579 579 BK

It's Qatar! One of the rarest of the Near East countries! I quickly look for K4GSU who is now coming back to him with that beautifully deliberate CW; Bill, a Doctor near Lexington, Kentucky, is one of the finest CW DXers in the country. I find Bill's frequency, up 2 kilohertz from A7XA's frequency, and I move my transmitter ½ kHz above Bill. Bill gives a quick signal report and breaks back — good! That means that the A7 is going fast, trying to rack up a lot of contacts. That should make it easier to work him. There he is . . .

K4GSU DE A7XA R TU QSL
DJ6XQ 73 BK

I listen an instant before calling him — it sounds like half the world is in there. I begin to call:

A7XA DE W9KNI
W9KNI W9KNI K

I listen again. He's in there, but covered up by other stations still calling him. Then they stop and he's in the clear . . .

579 579 OK?
W1DAL DE A7XA K

Ugh — my arch rival, George, near Boston has him. We're both striving to be top dogs in the listings for most countries worked on CW — the competitive angle that this is all about. Now I need a contact even more.

I look for George. There he is — almost exactly on the same frequency I called on. I adjust my transmitter a hair higher in frequency, and as George signs clear I dump my call in once, DE W9KNI and listen. There's A7XA again . . .

R W1DAL DE A7XA
OK 73 SK NW
W9BG W9BG DE A7XA
569 569 BK

I felt a rising thrill as the W9

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came through — but instant disappointment as the BG came right after. Ross up in Madison had the same idea that I did, only it worked better for him than it did for me. But I'll try it again. The big guns are out in force tonight.
There's Ross

579 579

He is a touch higher than I was, so I move just above him, and as he signs I dump my call in again, DE W9KNI. I listen . . .

W9BG DE A7XA R
TNX 73 NW W9KNI
W9KNI UR 569
569 DE A7XA K

Hot Dog!

R A7XA DE W9KNI
TU 579 579 QSL OK
73 A7XA DE W9KNI SK

I listen intently for the confirmation that he has received my transmission okay . . .

R W9KNI DE A7XA
R QSL ES TNX
73 NW W9DWQ . . .

Ah, Ed got him.

I sit back and enjoy the feeling of success — a very rare new country. And with a German handling the confirmation cards for him, I can hope for a fairly quick card — the trophy that proves the contact.

I run upstairs and get a cup of coffee, and tell my wife of my success, then I run back to the station. I'll read up on Qater later in my atlas, but now I want to listen for a few minutes of the madhouse calling him. I put the headphones back on — there's K9WEH, my friend John, signing clear, and the pack calling. The pileup continues to get bigger as more and more stations discover him. It's a good feeling to have him in the logbook.

Who's he working now? It's VU2FBZ, the elusive Andaman islander. Most of the gang don't recognize it; the VU2 prefix indicates India usually, but it can also mean the Andaman Islands. I know he is in the Andamans, but most don't. Yuck — this is going to be a real mess — with now hundreds calling the A7 my chances of snagging VU2FBZ are slim indeed, but nothing ventured, nothing gained. There he is, almost dead on the A7's frequency. The A7 signs clear — I ignore him — rare DX is anything you haven't worked — all the rest is common!

I give the VU2 a long call 2 kHz below the A7's frequency, hoping that I will be in the clear and that the VU2 will tune down and find me. I listen — everyone calling the A7 and no sign of the VU2. I move down five more kHz and give him another long call. I listen; I only hear W1DAL calling the VU also. I give another call — again silence — then a brief "HI HI," which is a snicker on CW. I grin and respond. George and I call a truce and give up on the VU2. We chat a few minutes, and exchange tips on rare DX we have been chasing, then sign clear. I go upstairs and make another cup of coffee, and catch the news on TV. Then I go back to the shack and start tuning again. Now all signs of the Near East stations have disappeared, as the band has closed in that direction.

I start to turn my antenna from the Near East to the Southwest for the late evening opening into the Pacific area — it's time for the Australians and New Zealanders to be coming through. But, as the antenna sweeps through the North into the Northwest, on impulse I stop its rotation and have a look in that direction. There normally is no path open in that direction at this hour, but in general conditions are good and you can never tell.

I almost immediately come across a weak but solid

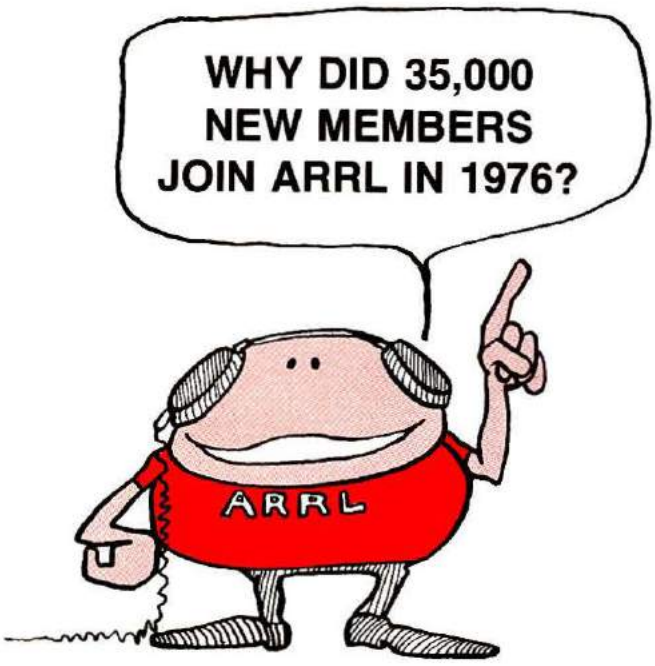
CQ CQ CQ DE
FB8XT FB8XT AR K

It's Kerguelen Island — a far flung French Island in the far south Indian Ocean — a rugged mountainous Island perhaps 50 miles across, always shrouded in fogs and mists caused by Antarctic cold meeting Indian Ocean warmth. They are almost exactly opposite us on the globe, and can come through on any path that is open. Tonight the path is Northwest.

The French maintain a scientific and meteorological station on the otherwise uninhabited Island. I have Kerguelen worked and confirmed, but I call him anyway. He comes right back and we chat for several minutes. I try my mangled school French, and he is delighted. Fortunately, he does not get too advanced for me, doubtless sensing that I'm not the best in French. He tells me of the weather — cold and foggy — as usual.

Soon my French is exhausted and we sign clear. Further checks reveal no other stations coming in from the Northwest, so I move my antenna into the Southwest.

Leo, UT5AA and his amateur station in the Ukraine. Leo is especially active during contests, and can often be heard on 20-meter ssb.



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Dr. Bob Berge operates amateur station ON4QX in Antwerp, Belgium. Bob is very active on the high-frequency bands, and can often be found looking for rare DX on the low end of 20 meters.

Almost immediately, I begin to hear the New Zealanders with good signals. I listen to several of them, but there doesn't seem to be much action, so I tune my receiver into the phone part of the band where stations use voice. The hour is late now, and the band is quieter. The old standbys of the Pacific are coming in nicely — there's Trevor in Suva in the Fiji's, there's a new fellow in Pago Pago. I hear a contact in French and listen carefully. Perhaps it's Wallis Island, a small and rare French Island in the South Pacific — but it's not — it's FO8ET in Papeete, Tahiti, talking to Claude, FK8BT in Noumea, New Caledonia.

I tune on. There's K6AAR calling VR6TC, obviously on schedule. VR6TC is an interesting fellow; he is Tom Christian of Pitcairn Island, and a direct descendant of Fletcher Christian, leader of the Bounty mutiny. The mutineers settled on Pitcairn and their descendants still live there. Tom is the only ham on the Island. Maybe later I'll give Tom a call if he is not busy.

Continued tuning of the phone band fails to turn up anything unique, but I run across Rod, ZL3FM, of Christchurch, New Zealand. Rod is an old friend, and once he visited the States and spent an evening with us. Rod had the good fortune to win a major lottery in New Zealand, and since then has been traveling all over the South Pacific and New Zealand. I give him a call, and we have a very pleasant chat as usual. We talk for about half an hour, but the band is starting to fade out now, so we eventually sign clear. I tune back to VR6TC's frequency. He's there, all right, with good signals, but a bunch of fellows are standing by to have a word with him, so I tune on.

The band now is practically dead. A few South and Central Americans are still coming in quite well, but it's nearly midnight, so I decide to close down the station and hit the sack. I turn off the switches, and clean up the table. Not a bad evening; one rare new country worked, several interesting contacts. Better than a lot of evenings, and maybe tomorrow night I'll catch the Andamans, or even Wallis Island. **HRH**

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TAKING THE MYSTERY OUT OF SINGLE SIDEBAND

BY THOMAS McMULLEN, W1SL

You run into it everywhere — in the advertisements, in conversations with other electronics buffs, in engineering publications, — another addition to the endless alphabet soup terminology that people toss around so freely. The way the term is used you would expect it to be the cure of all times — the solution to the crowded frequencies, to interference, to the problem of getting a signal through when conditions are not so good — right? Well, maybe yes, maybe no; it depends on just how perfect a cure you are looking for.

Before I get further into the how of ssb, let me digress a moment to fill in a few notes about the background of ssb and the development.

The system of transmitting only part of the energy contained in a range of voice frequencies has been of interest to communications engineers for some time. It boils down to a basic premise that the wider a signal is (the more broad the range of frequencies used) the more likely it is to cause trouble to a neighboring channel. Early telephone systems used the brute-force method of transmission over long distances whereby the voice was amplified and passed along over the wires to the next station or amplifier. This was great for one-way transmission, but people like to talk back and forth without having to throw a switch to change the direction of information flow. It is difficult to make an amplifier work in both directions at once, and double lines would be prohibitively expensive. The solution was to use a radio-frequency signal as a carrier, modulating it with the voice content, and to amplify the carrier at the proper intervals along the way. By the proper selection of filters and tuned circuitry, two or more carriers could be sent along the same wire or cable. It wasn't long before the increased demand for telephone and message services began to overload the system, causing the economy-minded planners to start asking for some way to avoid stringing more cables to meet the need. The answer was to make the carrier work harder — since one of the sidebands was a mirror-image duplicate of the other, why not get rid of it and replace it with something useful like another sideband that bore no relation to the other.

Thus commercial interests developed ssb transmission techniques and hardware quite some time ago — back in the early '30s — and have been using it (with variations) since then. It was not adopted by the Amateur Radio fraternity for several reasons, the chief one being that the equipment then available was very expensive, little understood by those outside the business of communications, and quite specialized for the purpose intended.

Even after the equipment became more available and less complex, the mode was not welcomed with open arms by amateurs, who had an understandable reluctance to switch from their "high-fidelity" (but inefficient) a-m rigs to something that sounded somewhat like a cross between a duck speaking a foreign language and a transmitter with an intermittent final amplifier tube. The receiving equipment available at that early stage of amateur involvement did little to help the situation either — proper tuning-in of an ssb signal required accuracy to a degree of a few cycles (yes, they were still called cycles then), but the old beloved receivers could drift several hundred cycles just from the after-effects of someone sneezing in the same room with them!

Things gradually improved, thanks to efforts of some stalwart pioneers who could see the many advantages (and the handwriting on the wall) and kept up the educational efforts until the features of the new mode became clear to an increasing majority of amateurs.

Some of the farsighted equipment manufacturers did their share to promote the growth of this new mode of amateur communications by developing and marketing

transmitting and receiving units that made it as easy to tune in ssb as it had been to work with a-m. The durability of some of the equipment speaks well for the design — many of the units are more than 20 years old and still going strong.

What's this carrier thing?

The full terminology that goes with the letters ssb is Single Sideband, Suppressed Carrier, and early attempts to alphabetize it did indeed use the full SSSC designation. While descriptive, it was difficult to say and definitely non-euphoneous! By abbreviating the abbreviation, the term ssb, for single-sideband, came into general usage. Now, I've told you what the letters stand for, but you still want to know what it means, right?

Ok, let's pry a little farther into the mystery. In order to understand why we can do without a carrier, I'll have to tell you why a carrier is needed in the first place. (Sounds like the tactics of some bureaucrat — convince you that you need something, and then take it away from you.) Just as in the early days of telephone line, you could get your voice from one place to another by simply amplifying it and passing it along, but it would take a monstrous amplifier and speaker system, and the noise pollution would be sure to raise the hackles of every environmentalist (and everyone else) in the neighborhood. Talk about a headache!

So once again technology comes to the rescue by providing one signal at a high-frequency which can have the information (voice) signal impressed on it. Because the high-frequency signal is way above the hearing range of everyone, it can go zipping through the quietest of neighborhoods with no one the wiser. This high-frequency signal is in the range that we call *radio frequencies*, and since it carries your voice along with it as it goes, it is naturally enough called a *carrier*.

Sidebands?

Ahhh . . . Um . . . yes, sidebands — I was afraid you would ask that. Just in case it isn't obvious, let me point out that your voice is not just a single frequency, but rather a mixture of many frequencies in combination and at varying degrees of loudness. Therefore a voice can be said to encompass a range or *band* of frequencies. This band of frequencies is in what we call the audio (or audible) range, which starts somewhere below 100 hertz (cycles-per-second) and extends upward to several thousand hertz.

But for purposes of clarity. I'll pick out a single frequency (2000 Hz) in the audio range and use it in the following explanation of how the carrier does its thing.

The process of impressing the audio information on the carrier is called modulation. According to the dictionary, to modulate means to adjust or adapt to a certain proportion; to vary the pitch, tone, or intensity; or (electronics) to vary the frequency, amplitude, phase, or other characteristic of (any carrier wave). Well, now, since things started out as amplitude modulation (a-m) you would expect that the result of all this would be to have the carrier bobbling up and down in strength in accordance with the voice information that you applied to it, right?

Well . . .yeah, it does, but not to any extent that you would find very useful. The most important product of the modulation process is really the result of a mixing action more than anything else. Mixing, is radio terms, is much like mixing anywhere else. You can mix so many parts of A with so many parts of B, and the result is so many parts of C (1 part of red plus 1 part of yellow equals orange).

So let's see what happens when you mix a couple of frequencies together, and to make it easier to follow the numbers around, let's use 100,000 Hz as a carrier and 2,000 as the voice frequency (hello, squeaky!). The carrier frequency could be abbreviated to 100 kHz, but numbers are impressive, so we'll keep the whole thing. The most obvious product of mixing these two is that you now have an output at 102,000 Hz (100,000 + 2,000 = 102,000). Right about here is where things get tricky, and you can forget about the paint store; there is also a product of the subtraction process, which

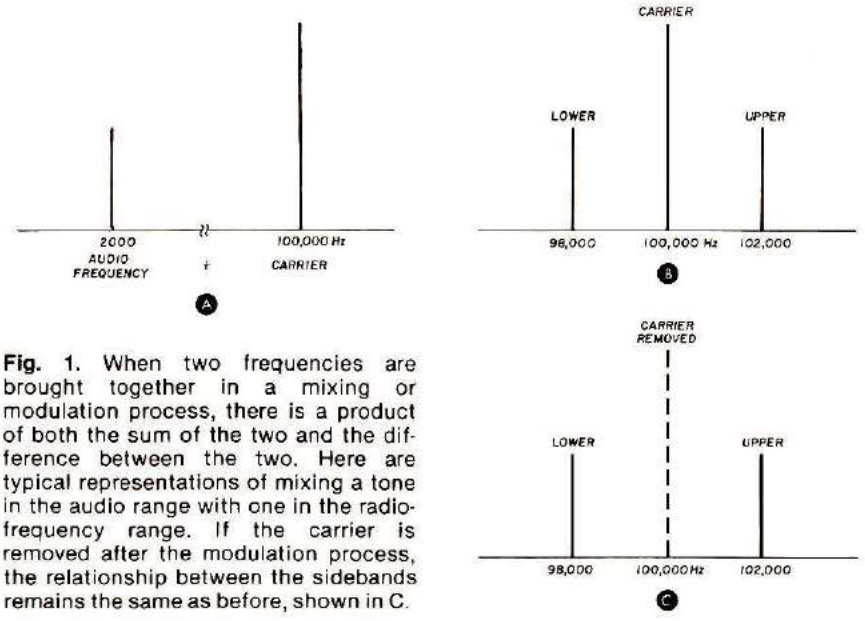


Fig. 1. When two frequencies are brought together in a mixing or modulation process, there is a product of both the sum of the two and the difference between the two. Here are typical representations of mixing a tone in the audio range with one in the radio-frequency range. If the carrier is removed after the modulation process, the relationship between the sidebands remains the same as before, shown in C.

is the *difference* between the two frequencies! And for all intents and purposes it is happening at the same time as the addition is being done. (For the time being, don't worry about *how* it happens; it has to do with phase angles and current flow within the mixing device, and can be explained with the use of some pretty impressive mathematics, so don't ask me any embarrassing questions. Okay?) As I said, 100,000 – 2,000 = 98,000 Hz. This is illustrated graphically in **Fig. 1**, which is just the way you would find things if you had a very good receiver and could tune across that part of the radio-frequency spectrum. There are devices, called spectrum analyzers, that can do just this and display the signals picked up on a screen so that you can actually see the relationships involved. There is a direct proportion between the amount of energy (loudness) in the 2,000 Hz signal and the strength of the 98,000 and 102,000 Hz products. Obviously if you reduced the voice signal to zero, the products would go away, and if you increased the strength of the signal the products would get stronger — up to the point at which the system became overloaded. (It's red-lined at 100%, which means that is as far as it will go without undesirable things happening). At 100-per cent modulation, the amplitude (strength) of both the sum and difference products will be just half that of the original carrier. Yes, it is possible to make them more and half as strong, but when they get that large, they tend to feel pretty self-important, and do a little mixing (modulating) of their own, which produces further sum and difference products, (96,000 and 104,000 Hz, for instance) which is not exactly what we had in mind.

So, there you have it. A carrier is mixed with the signal (information) frequencies, and launched into space, to eventually find its way into your receiver, still carrying the information along with it. In your receiver you have a detector (demodulator) circuit that sorts out the signal and carrier frequencies, and applies the signal to a headset or loudspeaker so that you can hear it as a faithful reproduction of the original.

But it is a little difficult to speak (or understand) a single frequency, so it is rather convenient that the carrier is capable of handling a pretty good range of audio frequencies all at once. If you had a receiver that would tune in a carrier that was modulated with the voice-range of frequencies, you would find that it resembled that in **Fig. 2.** You would see the carrier standing tall the same as before, and it would have the sum and difference frequencies keeping it company. That part of your voice that was in the lower range would be closest to the carrier and the higher tones would be farther away. These bands of frequencies appear on either side of the carrier, and hence are called *sidebands* (thought I would never get there, didn't you?)

Single, sideband, suppressed carrier?

Not so faaaast — one thing at a time there! To answer your last question first, let's take a look at the carrier and why we can get rid of it (and more importantly, why we should want to).

Just in case you missed the point earlier, I say again, the carrier is a single frequency in the range that we call radio frequencies (because you can tune them in on your radio, why else?). The example that we have used is 100,000 Hz. Now just suppose that someone up the street a bit decides to have a carrier too, and further suppose that he picks 101,000 Hz. He can transmit his carrier in any direction he wants, and you can do likewise. The two carriers don't bother each other at all — coexistence is a happy thing. But when they both get into your receiver, — look out! Receivers are full of devices that can and do perform the mixing (modulating) function with great gusto. In fact, several of the stages are designed to do just that. So,

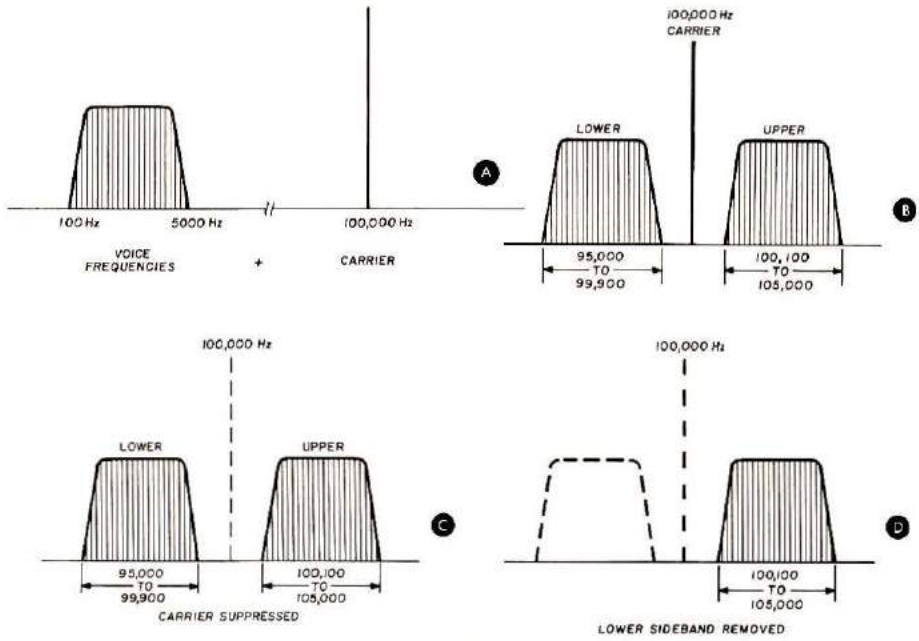
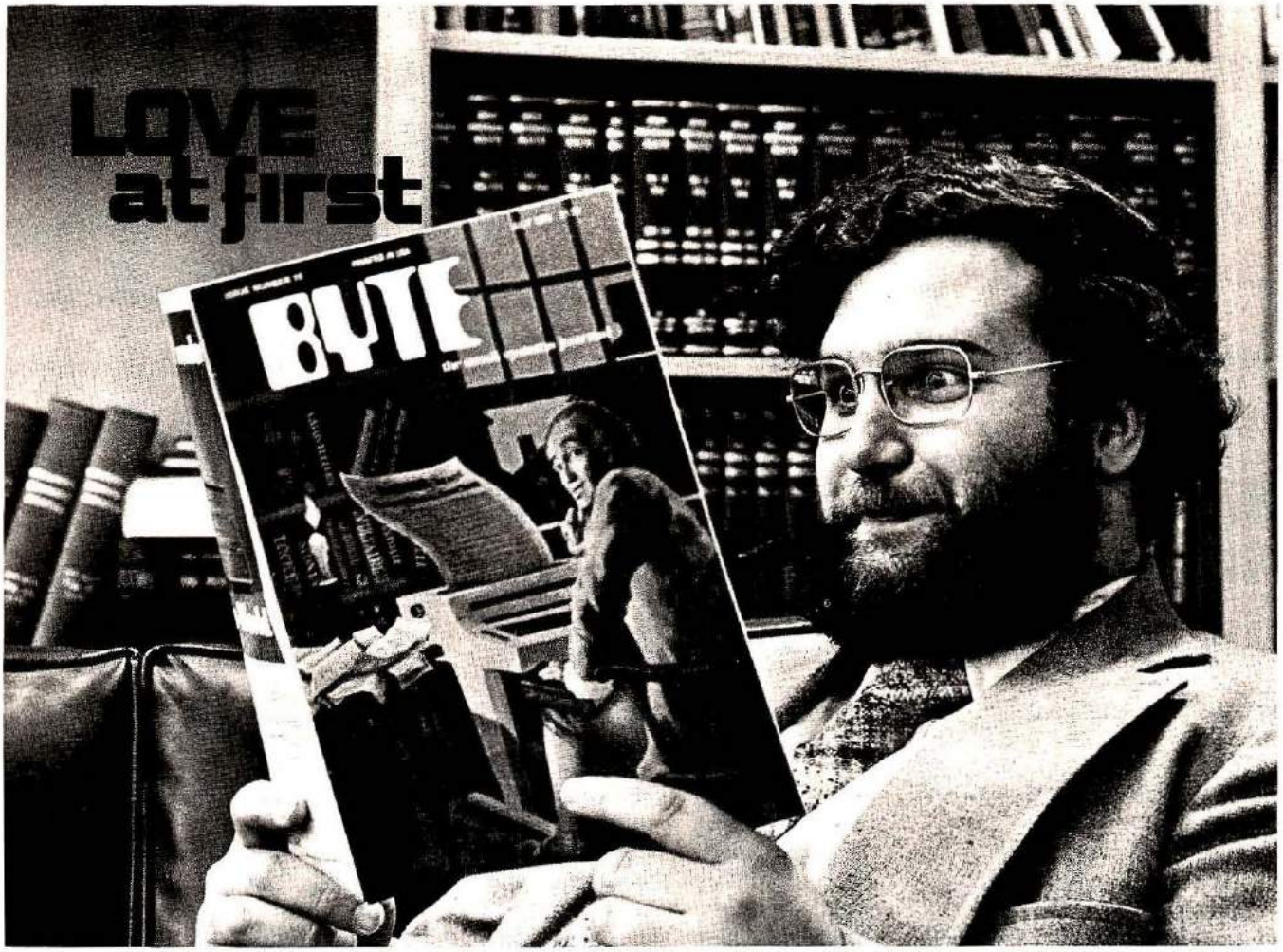


Fig. 2. When a range of frequencies, such as that found in the human voice, is used instead of a single tone, the result of the modulation process shows the carrier with "bands" of frequencies on either side. To obtain single-sideband-suppressed-carrier, it is necessary only to remove the carrier and one sideband.



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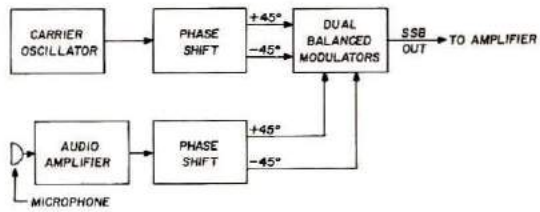


Fig. 3. A block diagram of the essential portions of a phasing type of ssb generator shows that some tricky application of phase shift is required for both the audio and the radio frequency. The carrier and one sideband are removed, leaving only one sideband at the output. This remaining sideband can be amplified and further processed to make it useful for communications purposes.

look at the numbers again and remember what we said about the mixing products before. 100,000 + 101,000 = 201,000 Hz. What? Yeah, I know it is above your hearing range but you didn't let me finish. 101,000 *minus* 100,000 = 1,000 Hz and you can sure hear that. That is exactly the process that produces all of those whistles and squeals that you hear when two or more a-m carriers get together. If you haven't heard them you just haven't ever turned on a CB receiver. There used to be a lot of them on the amateur bands too, before ssb caught on.

A couple of things suggest themselves here. If you will look again at **Fig. 1** you'll note that the carrier is the biggest (strongest) thing there, so it follows that the carriers are creating the strongest difference frequency (which we can call a beat-note, or to use the colloquial term "heterodyne"). Therefore it also follows that if you get rid of one of the carriers you will get rid of the heterodyne, right? Very true, but it might be just as hard to talk your neighbor into turning his off as it would be for him to convince you to turn yours off. So the thing to do is for both of you to get rid of the carriers — exit heterodynes.

There, now you know why.

How?

I'll get into the grimy details of exactly how it is done and what circuits are required to accomplish removing the carrier at a later date. But to boil it down to a few words, you make it cancel itself. This electronics business is full of interesting terms such as phase and amplitude (no, it doesn't have anything to do with the moon). By running the carrier through the proper maze... uh, circuitry, it can be split up into two phases, and if the two are exactly opposite they cancel each other. Sort of runs into itself coming around the corner and — blooey! The tricky part is that you can apply the signal (voice) frequencies in such a manner that this doesn't happen to them — in fact they usually come out of the modulator in such a relationship that they help each other. This is called the *phasing* type of generator (not phas*or*, phas*ing* — you Star Trekkies). An essential part of this generator is called a *balanced modulator,* which tricks the carrier into cancelling itself. Without even pausing for breath, let me point out that there are two ways to get rid of one sideband. The first is to add refinement to that phasing circuit that I just told you about: If the phase of the *audio* frequency is shifted a bit before you apply it to the modulator, then the same phase shift that cancels the carrier also changes the signal (voice) phase in such a fashion, that one sideband does not get cancelled.

A look at **Figs. 2** and **3** will reveal that a bit more clearly. The carrier at 100,000 Hz has been cancelled, so it is no longer there. A phase shift was applied to the audio signal, so, that one is cancelled and one remains — in this example the *upper* sideband. It works exactly the same way if we want to retain the lower sideband, it just takes a little bit different path through the circuitry so that the phases get shifted in the right direction.

A second method is called the *filter* system of ssb. generation (**Fig. 4**). One thing that the filter type of generator has in common with the phasing type is that it too requires a balanced modulator. Remember that the balanced modulator is the essential circuit that gets rid of the carrier, leaving the sidebands. In this type of generator a filter is used that will allow only the proper sideband to get through. In its most simple form, a filter would be a resonant circuit that was adjusted to 102,000 Hz. Actually, such a basic filter would not be completely effective in getting rid of the unwanted sideband, so a more complicated version is used. **Fig. 5** illustrates the properties of filters that are needed for this function. Filters can be made up of many resonant circuits in the form of inductance and capacitance, or

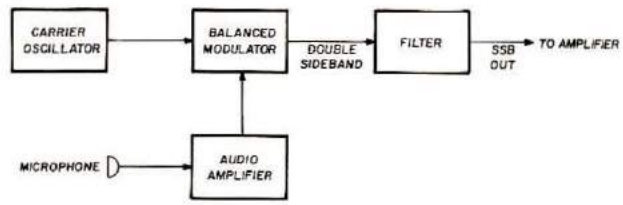


Fig. 4. A filter type of ssb generator appears to be simpler to build and work with. Actually, it will require more processing later on to obtain sideband output on the proper frequency. This processing is termed "heterodyning," and in spite of the additional stages required, is one of the most popular types of transmitter used for communications today.

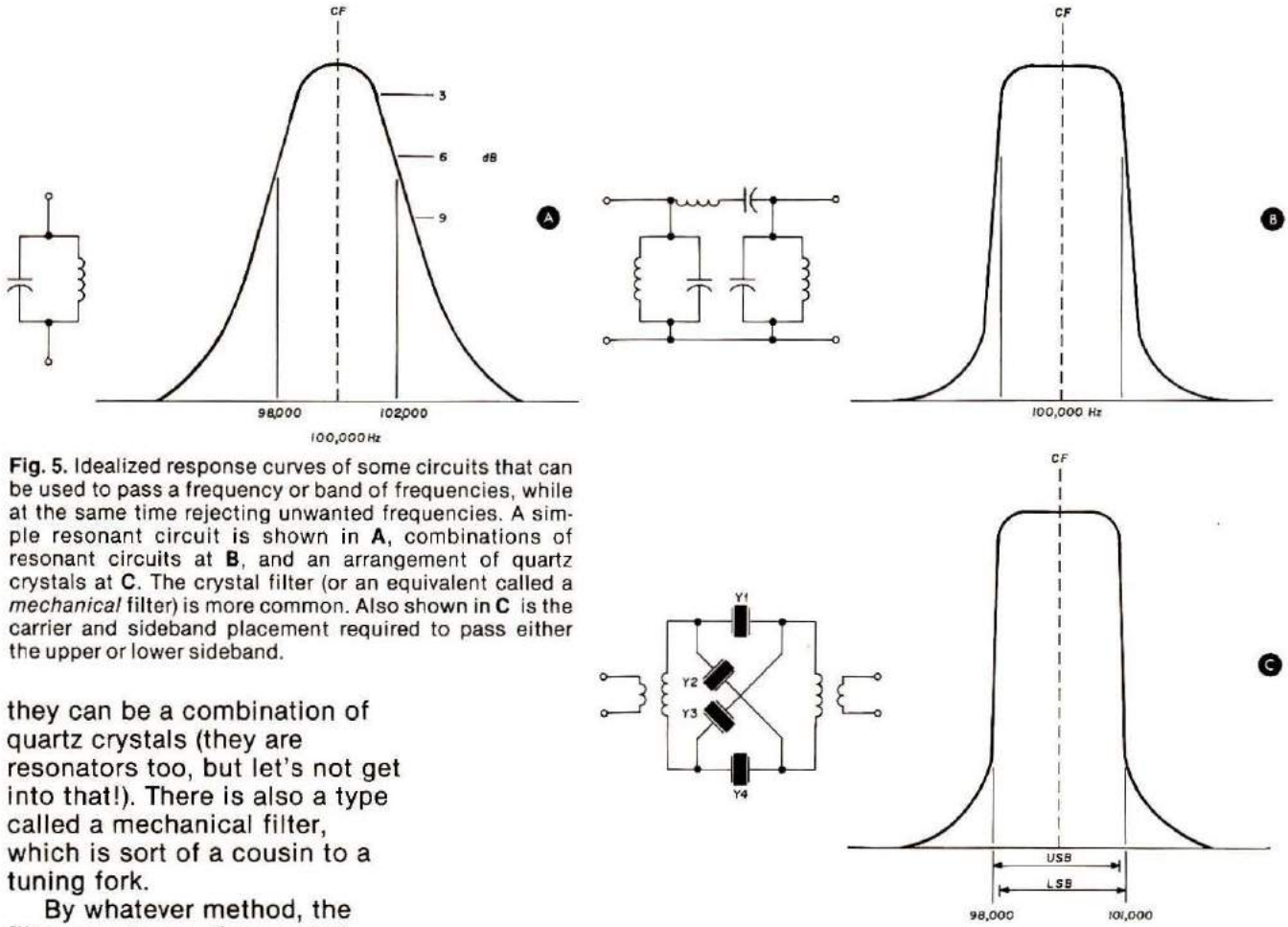


Fig. 5. Idealized response curves of some circuits that can be used to pass a frequency or band of frequencies, while at the same time rejecting unwanted frequencies. A simple resonant circuit is shown in **A**, combinations of resonant circuits at **B**, and an arrangement of quartz crystals at **C**. The crystal filter (or an equivalent called a *mechanical* filter) is more common. Also shown in **C** is the carrier and sideband placement required to pass either the upper or lower sideband.

they can be a combination of quartz crystals (they are resonators too, but let's not get into that!). There is also a type called a mechanical filter, which is sort of a cousin to a tuning fork.

By whatever method, the filter must pass the wanted sideband and keep the unwanted one from getting through. At first glance it would seem that you would need two filters; one for the upper sideband and another if you wanted to use the lower sideband. But, no, filters are just a bit expensive, so there must be a better way. There is, and it is so simple that I wonder that I didn't mention it before: All you have to do is move the carrier. That is easy. A carrier can be generated by an oscillator that is either variable or is fixed in frequency by a crystal. If you change the frequency of the oscillator so that it is no longer at 100,000 Hz, but is somewhat lower — say 99,000 Hz, then you have plunked the upper sideband right in the middle of the filter. Conversely, if you want to use the lower sideband, then you move the carrier up a bit, to perhaps 101,000 Hz, which then places the lower sideband in the window... er, filter.

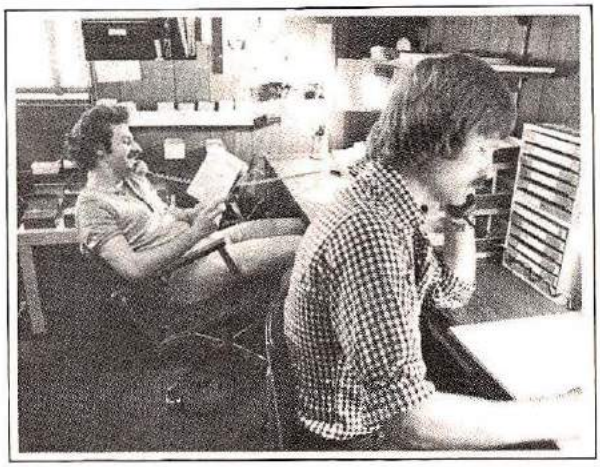
Only one sideband?

Oh, yes, the reason for using only one sideband is really rather easy. All of the voice frequencies that you transmit are contained in both sidebands, so if you tune in to just one of them you will still hear every word. Look back at **Fig. 1** again. Remember that your receiver translates the sideband (98,000 Hz or 102,000 Hz back into the original 2,000 Hz that you started out with, so you could tune in to either one and hear the same 2,000 Hz tone; it's the same with voice. So if everything you need to hear is contained in just one sideband, why leave the other tag-along flopping around in mid air, with no one listening to him? Besides it takes power to transmit sidebands, and the power you don't use for the lower can be applied to helping the upper. (Or to express it so Mother Earth will love you, you are saving half the power by only sending one sideband.) Clear enough?

So there you have it. By getting rid of the carrier you eliminate most of the whistles and squeals that plague a-m operation. By using only one sideband you save space on the band, conserve power, and allow room for another operator to sneak in close to you without causing trouble and interference. Ssb may not cure *all* of the troubles in the communications world, but it will surely help to make life a lot easier.

Receiving SSB?

Hold it! Let's not get carried away. I'm saving that (and a few other goodies) for next time. **HRH**



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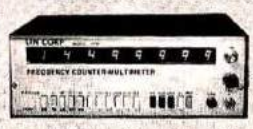

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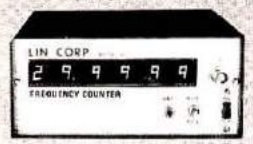

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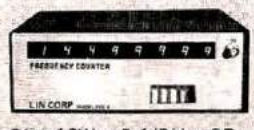

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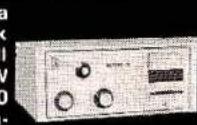

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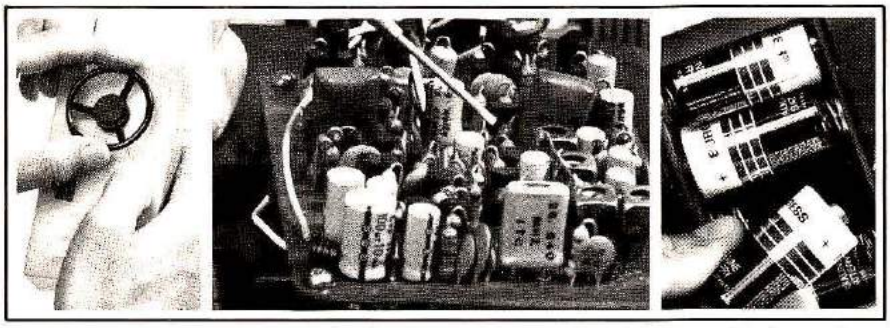

The remote control unit (left) controls the race car's electronics (center). The four "C" cell batteries fit in the underside of the Racer.

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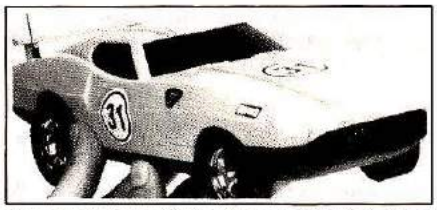

The sleek lines of the Remote Control Racer follows the designs of some of the more popular race cars. The car measures 3½"x5"x12".

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BY JAMES R. FISK, W1DTY

Putting Your First Amateur Station on the Air Doesn't Necessarily Have to Put a Big Dent in Your Wallet. Here are Some Guidelines for Choosing Your Receiver and Transmitter, and Some Tips for Getting the Most Value for Your Dollar

Regardless of what you may have heard, or read somewhere, Amateur Radio is *not* a rich man's hobby. Sure, you can spend a thousand dollars if you want to, or even ten times that much — but you can put together a very good station for much less than a stereo system or a set of golf clubs, a good 35mm camera, or even a pair of skis. And what other hobby is there, that you can think of, which you can pursue any time of the day or night, rain or shine, summer or winter? Reading, perhaps, or stamp collecting, but neither of these offers the round-the-world, person-to-person adventure of Amateur Radio.

Almost a million men and women, of all ages and occupations, in almost every country of the world, are enthusiastic Radio Amateurs, and each night's operation in front of your radio set is a whole new adventure. As you tune your receiver across the amateur frequencies, you may hear King Hussein of Jordan talking to a fur trapper in the *steppes* of Siberia, a priest in remote Nepal discussing the weather with a meteorologist in the Antarctic, or even position reports from a drifting raft in the azure blue waters of the South Pacific. All the world is fair game, and Amateur Radio is your ticket.

Tuning further up the band you may find pipeline workers in Alaska running phone patches to their families in the States, a missionary in the mountains of Peru requesting medical supplies, or an amateur DXpedition to Bear Island, near the Arctic Circle, exchanging signal reports with what sounds like a thousand different stations. It's all there, at the tip of your fingers. But listening is only a small part of the thrill of Amateur Radio — turning on your own transmitter and talking to these same stations is even more exciting.

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Station Equipment

When it comes to putting your first amateur station together, there are many possible choices including second-hand or brand-new, factory-built equipment, surplus radio gear, commercial kits, or home-built from scratch. Your local radio club may have some "loaner" equipment to get you started, or a local amateur may have some spare equipment he will let you borrow, but eventually you will want to have a station of your own.

At this point you are probably asking yourself, "What, exactly, is the minimum equipment required for a practical, working amateur radio station?" Well, the four basic items are a communications receiver and a transmitter (or transceiver), a telegraph key, and an antenna. You'll also want a station logbook to record your radio transmissions (and contacts, if you wish), and a good clock, but you can use a spiral-ring notebook for your log, and your bedside alarm clock, so cash outlay for these items is practically nil. Later on you may want to add a changeover relay which automatically switches your antenna between your receiver and transmitter (built into most transceivers), an swr bridge that tells you how well your transmitter is matched to your antenna, or a variable-frequency oscillator (vfo) that allows you to quickly move your transmitter from one frequency to another, but these

are not necessary to get started.

In addition to your radio equipment, you'll also want a good, sturdy table to put it on, and a *comfortable* chair — there's nothing that cuts into the fun of Amateur Radio more than a chair that bites into your bones. You may find a suitable table stored away in the garage, or even discarded at the dump, but if you can't, you can often find a reasonably priced kitchen table or old desk at your local Salvation Army store. You can even press an old picnic table into service, but stay away from folding card tables — most of them are much too flimsy and radio equipment is heavy. If you have to buy a table, I recommend the 8-foot folding "conference" tables that are available from Sears. These are just the right height for an operating table and are strong enough to hold all the radio equipment you're likely to acquire over the years.

The Receiver. Of all the equipment in your Amateur station, your receiver is the most important . . . and also the most expensive. However, if you buy a good receiver when you first get started, you won't have to replace it for a good many years. When you do decide to update your station sometime in the future, you may elect to keep the old receiver if it's a good one — you can use it to check activity on the other bands while you're working a station on one band, to chase DX stations that operate outside the American phone segments, or with vhf converters if you decide to try the Amateur frequencies above 30 MHz.

On the other hand, if you opt to buy a poor receiver in the beginning, you won't be happy with it for very long — it will be so noisy that you can't hear any weak signals, perhaps the tuning will be such that all the stations seem to be piled one on top of the other, or the selectivity will be so bad that stations operating near your working frequency will completely obliterate the station you're trying to contact. Within a couple of weeks you'll be looking for a better receiver!

Although some beginners build their own receivers, this approach is full of pitfalls unless you are an experienced technician or have a more experienced amateur looking over your shoulder. If you have the expertise, and the time, you can probably homebrew a communications receiver as good as any on the market, but it won't save you any money, and you must be willing to spend several months of spare time just putting it together. Later on, as you get more experience, and have homebrewed some simple projects, you may decide that you'd like to build your own receiver, but in the beginning I'd recommend that you buy a good new or used receiver.

Performance is the most important consideration when you buy a receiver, and you want as much of that as you can afford, but you also have to think about operating convenience and the "feel" of the controls. If a receiver's performance is everything you want, but it doesn't "feel" right, you'll never be happy with it.

In that respect, buying a receiver is a bit like buying a good camera. From looking at the magazine ads, that new German camera looks perfect for your needs, has super optics, and a complete line of accessory lenses from the very widest to the very longest. However, when you stop by the camera shop for a personal demonstration, you find that it's too heavy, or that the controls don't fall naturally under your fingers, or you have to go through a five-step program to use the built-in lightmeter. Obviously, if you bought this camera you'd never be completely happy with it. You decide instead to buy a Japanese import — the optics are excellent, the price is about the same, the metering system is completely automatic, and most important, your fingers fall naturally on all the controls and it "feels" good in your hands. Here's a camera you'll be happy with for years to come.

Before you plunk down your hard-earned cash on a receiver, plan to spend some time with it. If possible, connect it to an antenna and tune around the Amateur bands. In addition to giving it a quick checkout to make sure that everything is working the way it should, this will give you a chance to see if you feel comfortable with the

More details? Ad Check page 86.

controls. For example, is the main tuning knob at the right height for your fingers, or do you have to lift your hand off the table as you tune the dial? Ideally you should be able to leave the heel of your hand on the table. If you have to lift your hand every time you want to tune to a new frequency, after several hours of operating you'll find that your arm is very tired — your head may feel like another hour of operating, but your hand won't!

Does the main tuning knob turn smoothly and easily as you tune across the band? If it sticks (or slips) in one spot, that spot will inevitably be right on top of your favorite operating frequency. Does it tune across the band slowly enough that you can easily separate stations, or is tuning so critical that you have to have the patience of a monk to tune in a sideband station? Is there only one tuning control, or two — *bandset* and *bandspread*? Although there are a few receivers with bandset and bandspread that are acceptable for Amateur communications, a single tuning knob is preferable. And finally, how about dial calibration? Are the calibration marks far enough apart that you can read frequency to 5 kHz or less, and are they accurate? (You can check dial accuracy with a crystal calibrator, if the receiver has one).

How about the other controls? Are they easy to use and where you'd expect to find them? One thing to look for here is the location of the rf and audio gain controls. They should be located well away from the main tuning control because, as you tune across a band, many times you have to "ride" the gain control with your hand. If the tuning knob is too close to the gain control you won't be able to use both hands at once, so you have to move your hand from one knob to the other. This can be very annoying, even during short operating periods.

What about the other controls? If the set has a crystal calibrator, does the receiver go into the *standby* mode when you switch in the calibrator? If you're operating close to a band edge, you might like to turn on the calibrator while monitoring another station. You can't do this if the calibrator automatically switches everything to standby. And can you hear the calibrator on 10 and 15 meters? You may discover that while the calibrate signal is very strong on 40 to 80 meters, it is buried in the noise on 10 and 15.

How effective is the noise limiter? Although most noise limiters don't work well on sideband, they can often be put to good use on CW to kill ignition or impulse noise (remember that they aren't designed to get rid of atmospheric noise or lightning static).

Check the phone jack. Is it on the front panel where you can get to it, or hidden somewhere in the back? Does it automatically disconnect the speaker when you plug in your headphones, or does the speaker continue to work? If your Amateur station has to share a room with another family activity, you're going to get a lot of static from them if the dits and dahs from your receiver interfere with their favorite television program (or their sleep)!

Receiver Performance. Basically, the performance of a communications receiver boils down to three main categories: Sensitivity, selectivity, and bandspread. Sensitivity is a measure of the receiver's ability to receive weak signals and is specified in terms of input voltage at the receiver's antenna terminals in microvolts (millionths of a volt) to produce a 10 dB signal-to-noise ratio (signal ten times as loud as the receiver's background noise). Many modern receivers have advertised sensitivity of 0.25 microvolt or less, but unfortunately, in most cases a very sensitive receiver is more prone to overload from strong signals. What this means is that strong signals in the band may generate noise and interference *inside* the receiver which actually degrades the sensitivity of the set.

At one time, not many years ago, when all receivers used noisy vacuum tubes, sensitivity was the *one* limiting factor in

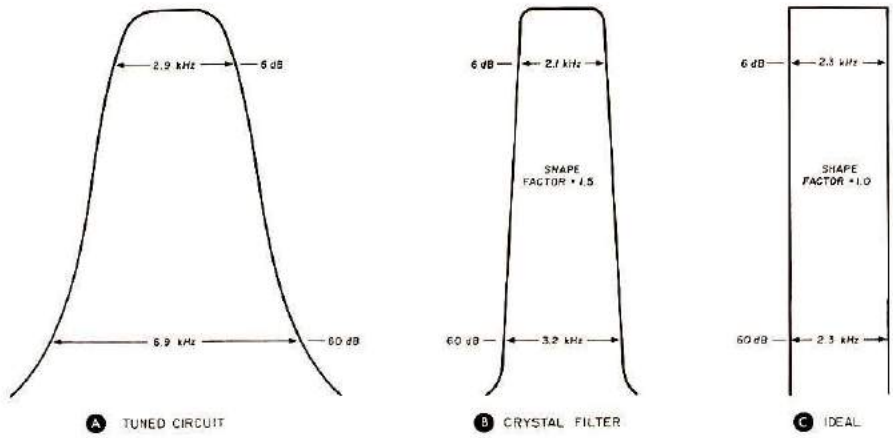


Fig. 1. Bandpass curves for various receiver i-f filters. The passband at **A** is that for a typical tuned resonant circuit and is typical of older communications receivers. Since the passband "skirts" flare out badly, the circuit isn't able to discriminate against strong nearby signals. The passband shown in **B** is that for a crystal lattice filter found in most modern amateur receivers. Because of the steep filter skirts, selectivity is greatly improved. The ideal filter passband shown in **C** cannot be attained in practice, but many modern crystal filters come close to it.

receiver performance so most Amateurs chose their receivers strictly on the basis of sensitivity. Some still do. However, with modern transistors, it's possible to achieve far more sensitivity than you can ever use. This is because the earth is being continuously bombarded with atmospheric and galactic noise over which you have no control. Building a very sensitive high-frequency receiver just lets you hear that noise better — it does *not* improve your ability to hear weak signals. And, as I pointed out a minute ago, extreme sensitivity usually means the receiver overloads more easily and distorts those signals which you can hear above the internally generated noise.

So the question arises, just how much sensitivity should you look for? Well, on the 80- and 40-meter bands, sensitivity of 1 or 2 microvolts is more than adequate, while 0.5 to 1 microvolt sensitivity will do the job on 15 and 10 meters. And luckily, there's a very easy way to see if your receiver has enough sensitivity — just connect it to your antenna. If, after the preselector has been peaked up, you can hear a noticeable increase in noise level when the receiver is connected to the antennas, sensitivity on that band is good enough.

Receiver selectivity determines how well the receiver separates desired signals from interference, and is closely tied to bandspread, tuning rate, and dial calibration. Many low-cost receivers, for example, use only an inch or so of dial space to cover a complete amateur band so it's practically impossible to separate one signal from another. On the other hand, more expensive receivers which are designed specifically for Amateur communications spread each of the bands out over a foot or more so adjacent signals are further apart on the dial. However, if the main tuning dial is calibrated in 5-kHz steps, but is geared so fast that it's difficult to tune in a sideband signal, the manufacturer missed the boat — and you should choose another receiver.

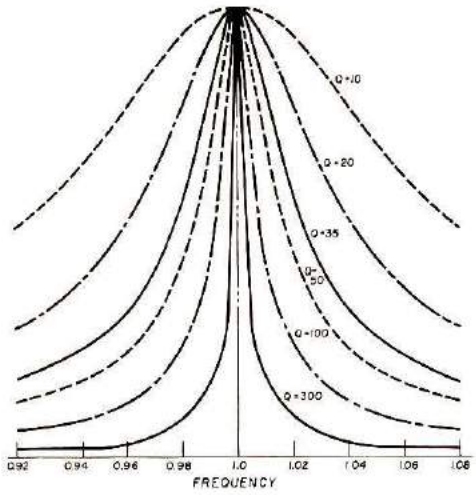


Fig. 2. Since the bandwidth of a tuned circuit is directly related to its *Q*, as shown here, selectivity in older receivers can be improved by using an electronic circuit which effectively multiplies the *Q* of the circuit. Some receivers are provided with built-in *Q*-multipliers.

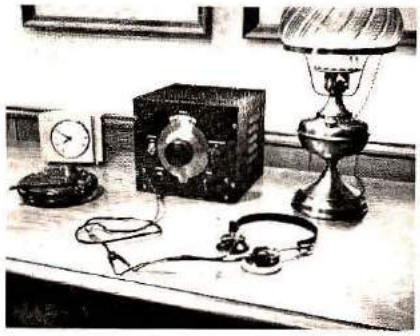
Receiver selectivity is provided by narrowband filters or amplifiers that can be visualized as a narrow gate (or passband) through which the signals pass. If the passband is too wide, more than one signal can get through at one time, so you can't separate them. If the passband is narrow but the receiver tunes by it too quickly (narrow bandspread), it's difficult to line the desired signal up with the passband.

Also important when discussing selectivity is the so-called "skirt" selectivity of the receiver as shown in **Fig. 1**. Normally, selectivity is specified at the 6-dB (half-power) points as shown here, but if the selectivity skirts are wide as in **Fig. 1A** the receiver won't be able to reject strong adjacent signals very well, if at all. The selectivity curve in **Fig. 1B** will provide much better performance because the filter skirts drop sharply so the passband at −60 dB (one-thousandth) is only 1.5 times as wide as it is at −6 dB. This is called the *shape factor*. If the selectivity bandwidth at −6 dB is 2.1 kHz, for example, and the shape factor is 1.5, the bandwidth at −60 dB is 3.15 kHz (2.1 kHz times 1.5). The ideal filter (**Fig. 1C**) would have exactly the same passband at all points (shape factor = 1), but building such a filter is a practical impossibility.

How much selectivity do you really need? This depends upon your operating habits because you can use a much narrower passband on CW than you can on ssb. For sideband, however, a bandwidth of 2.1 kHz (and 1.2 shape factor) is nearly optimum. This passband will also provide excellent CW performance in most cases, although you might like narrower CW bandwidth on occasion because of heavy interference. Many modern receivers have narrower bandwidth accessory filters that can be switched in as required, but this is an option you may want to pass up if you're working on a limited budget.

If a receiver's performance measures up in all respects except selectivity, and the price is right, you can improve selectivity with an external *Q*-multiplier or audio filter. Both are relatively low-cost accessories that can be wired into your receiver for improved performance. The operation of the *Q*-multiplier is based on the fact that the bandwidth of a resonant, tuned circuit is directly related to *Q*, as shown in **Fig. 2**. If the *Q* of the circuit can be increased, selectivity will be improved. This is accomplished electronically by the *Q*-multiplier.

Buying a Receiver. Before you buy your receiver, talk to local amateurs and ask their opinions. They can also give you an idea of pricing and may even know another amateur who has a good receiver for sale. And, when you have made



Newer doesn't necessarily mean better — some older receivers provide very good performance on the amateur bands, particularly 80 and 40 meters. Receivers such as the one shown are still used during the Old Timers Contest sponsored by the Antique Wireless Association.

your choice, try to arrange to use the receiver for a short period on a trial basis to find out if it really meets your needs.

When you're shopping for a receiver you're going to find the best bargains on the used equipment market, but this means that you should check for external damage, sticky knobs, noisy volume controls, and other signs of heavy use (or misuse). Was it used by a "little old lady from Pasadena," or by an expedition to the Mojave Desert? (I vividly remember a transmitter I bought sight unseen a few years ago, because the price was right — when I opened up the package it looked like the rig had been through a sandstorm; there was fine, red dust on everything! It worked fine, as advertised, but I always worried that it would give up the ghost when I needed it most. When I sold it I lost money because I couldn't, in good faith, sell it as I had bought it, sight unseen).

With the number of new amateurs getting on the air in recent months, the supply of good, used equipment is rapidly drying up, but you can still find good buys if you look around, and are patient. Following is a list of communications receivers, arranged in ascending order by price, that will give a good account of themselves on the Amateur bands. Resale value was also considered when making this list so, in general, if the receiver is still in good condition when you decide to sell it (or trade it in on a more expensive model), you can expect to sell it for nearly what you paid.

One final note: Don't pass up a receiver just because it's "too old." There are a number of second-hand receivers on the market that are well past voting age and still provide good performance by modern standards. The Collins 75A series, for example, or the Drake 1A. And to give you an idea of resale value, the Collins 75A4, when it was discontinued in the 1950s, sold new for $595. The same receiver, in mint condition, is still worth $475.

BC342. Military surplus general-coverage receiver for 1.5 to 18 MHz in six bands. Two rf amplifiers, crystal filter, 117 Vac operation (BC312 and BC348 are similar but are designed for 12 or 28 volt dc power supplies). Many still in use on the Amateur bands. 1942-1945. $50 to $75.

Hammarlund Super-pro. Designed for Amateur use in the late 1930s this general-coverage receiver saw widespread use during the war. Heavy, built like a battleship. Many of those still in service were originally acquired from the surplus market. Most common is the BC779 (2.5 to 20 MHz), but BC794 (3.0 to 20 MHz) and BC1004 (540 kHz to 20 MHz) are also available. Narrow bandspread, image rejection, and internal noise are a problem on 20 meters, but receiver is very usable on 80 and 40. 1942-1945. $75 to $125.

Hammarlund HQ110. Amateur-band receiver with double conversion above 7 MHz. One rf stage, product detector for ssb, built-in clock, and S-meter. Somewhat difficult to tune because of bandspread and bandset dials. Introduced in 1958, replaced by HQ110A in 1962. $100-$150.

Drake 1A. Five-band Amateur receiver with good sensistivity, selectivity, and bandspread. Built-in crystal calibrator and S-meter. Forerunner of the popular Drake 2A. 1958-1959. About $125.

Hallicrafters SX101. Dual conversion Amateur-band receiver with one rf stage, selectable sideband, crystal calibrator, and S-meter. SX101A is later model. 1967-1971. $125 to $175.

National NC300. Double-conversion Amateur-band receiver. 1.7 to 30 MHz, plus 30 to 35 MHz for vhf converters. 1955-1958. $100 to $150. NC303 is updated version introduced in late 1958. $150 to $200.

National HRO-60. Amateur-band receiver with plug-in coil assemblies, dual conversion above 7 MHz. Has rf amplifier stage, S-meter, good bandspread and selectivity. Many still in use. $175 to $200.

Drake 2C. Triple-conversion Amateur-band receiver with 500-kHz tuning segments on each band (1968). Hybrid design using both vacuum tubes and transistors. Drake 2A (1960) and 2B (1961) are earlier versions.

"It started out as a simple ham station, but that's how Arnold is . . . when he gets involved in something, he goes all out."

Very popular with beginners and old timers alike. $175 to $225.

Heath SB-300. Amateur-band receiver covers 3.5 to 30 MHz in 500-kHz segments. Rf amplifier, crystal lattice bandpass filters, S-meter (1963). SB-301 (1969) and SB-303 (1971) are later models featuring increased use of semiconductors. Homebuilt from kits. $200 to $300, depending upon model.

Drake R4. High-performance triple-conversion Amateur-band receiver with selectable bandwidths for CW and ssb. 80 through 10 meters. Built-in S-meter, passband tuning, and notch filter. Replaced by Drake R4A. R4B and R4C are later versions. Designed for transceive operation with the Drake T4 series of transmitters. Late 1960s. $250 to $300.

Collins 75S1. Five-band double-conversion Amateur-band receiver featuring mechanical i-f filters and linear tuning dial. Built-in S-meter, crystal calibrator, and rejection tuning. Replaced by the 75S3 and 75S3B. Designed for transceive operation with the Collins 32S series of transmitters. Early 1960s. $300 to $400.

Collins 75A4. High performance Amateur-band receiver with variable i-f, highly selective i-f filters, crystal calibrator, noise limiter, Q-multiplier, and S-meter. Generally agreed to be one of the best Amateur receivers ever produced. $350 to $475, with high serial numbers (5000 and above) demanding premium prices. Replaced by Collins 75S-series. The 75A1, 75A2, and 75A3 are earlier versions priced from $135 to $275.

This is only a small sample of the many makes and models of used communications receivers on the market, but it will give you a fair idea of what is available. Generally speaking, the newer models offer somewhat better performance, better strong-signal handling capability, or improved sensitivity, or such built-in accessories as crystal calibrators, selective filters, and Q-multipliers; but just being newer doesn't necessarily make them better — some older, well built receivers will run circles around brand-new, low-cost sets fresh off the shelf.

The Heathkit HR-1680 dual-conversion receiver is designed for amateur communications and includes selective filters for both ssb and CW. Covering the five high-frequency amateur bands, the kit costs about $200.

Receiver Kits. If you can't find a good, used receiver that meets your needs, you might consider building your own from a kit. This approach has few of the pitfalls associated with building a receiver from scratch; you learn a lot about radio construction in the process, and the finished receiver often offers better value, dollar for dollar, than a factory-built receiver. If you've built a stereo amplifier or an electronic voltmeter kit, building your own receiver from a kit should be a snap. Even if you've never built any electronic gear before, you shouldn't run into any trouble — the construction manuals are well illustrated and provide step-by-step assembly instructions.

The new solid-state Heathkit HR-1680 five-band Amateur receiver kit, for example, covers the five high-frequency Amateur bands, includes a selective crystal filter for ssb (and a built-in audio filter for CW), and offers performance comparable to much more expensive factory-built receivers. The HR-1680 features dual conversion, sensitivity of 0.5 microvolt, selectable ssb/CW reception, built-in S-meter and spinner type dial, separate rf and audio gain controls, and is priced at less than $200. Best of all, after you have it built, you can completely align it without any external test equipment.

The Transmitter

Since Novices are limited to CW (telegraphy) operation, and transmitting power of 250 watts, as you progress up the Amateur ladder the first item in the station to get replaced is the transmitter — usually with a higher power unit that can be used for single-sideband as well as CW. This means that new Novices have a large selection of used equipment from which to pick, especially if you limit your transmitter to 100 watts or less. Here again the rapid growth in Amateur

Radio during the past few months has placed a drain on the used equipment market, but many new Amateurs are going to transceivers, so older 75-watt Novice transmitters are still in pretty good supply. There are also some excellent older CW-only transmitters on the market which are very good values. Many of these are still being used by old timers who prefer CW operation to phone, but they can still be found if you look around. There may even be an Amateur in your own hometown who has an old, unused CW transmitter sitting on the shelf — the one he started with and has held onto for sentimental reasons.

Novices have the choice of either crystal control or vfo operation. Although a vfo allows you to move quickly from one frequency to another, you have to make sure you have a well calibrated vfo or receiver so you don't operate outside the Novice band limits. Crystal control, on the other hand, is less expensive (although you do have to buy crystals) and you know exactly what frequency you're operating on. Unless you find an exceptionally good deal on a transmitter with vfo control, I'd recommend that you start with crystal control, and after you've gotten your feet wet with some actual on-the-air operation, you can consider going to a vfo.

Twenty years ago most Amateurs started out with military surplus transmitters, but except for the old ARC-5 series (also known as Command Sets), military transmitting equipment usually presents more problems than the beginning Radio Amateur can cope with — or even that an old timer can cope with, for that matter. That may be why the selling prices are so low. For the most part, military transmitters are very poorly shielded, so you will probably have problems with television and stereo interference. You may also need a special power

"I spent $1572.30 getting all set up, and now I can't think of a thing a say."

supply to run the transmitter. If you happen to run across a surplus military transmitter that has already been successfully debugged by another Amateur, it may be a good buy, but I'd recommend that you stick to transmitters which were designed specifically for the Amateur service.

You may also decide that you'd like to build your own transmitter. Compared to a receiver, CW transmitters are relatively simple, but here again, if you don't have any electronic building experience, if you try to build one from the ground up you may run into more frustration and aggravation than it's worth.

You may also consider building your transmitter from a kit. The new Heathkit HR-1675 CW transmitter, for example, sells in kit form for about $150, has a built-in vfo, and will work on all five high frequency Amateur bands. This transmitter makes an excellent starter rig because it will provide good service as you advance to a higher class license.

For the budget-minded beginner, however, the used transmitter market represents a vast resource. Once virtually untapped, this resource is now dwindling, but it appears that many beginners are buying equipment in the 200 to 250 watt class. If you set your goal at around 100 watts, there are still a lot of bargains to be had if you shop around. And don't worry because your transmitter is rated at only 50 or 75 watts. In most cases this is all the power you need for good, reliable communications. And since the higher power units are more popular, there are better bargains among lower power transmitters.

Following is a list of excellent CW transmitters that will provide good service on the Amateur bands. The market price of most of these rigs has changed little in the past few years, so once again, when you decide to upgrade your station, you won't lose any money. My first transmitter, a Heathkit DX20, is now selling for more than I paid for it in the mid 1950s!

Heath DX20. 50-watt crystal-controlled transmitter, originally built from a kit. 80 through 10 meters. Accessory vfo, the Heath VF1, is sometimes available. 1955-1959. $20 to $35.

Heath DX35. 90-watt crystal-controlled transmitter built from a kit. Includes built-in a-m modulation for phone operation. Accessory Heath VF1 vfo can be used for vfo control. 80 through 10 meters. DX45 is a later version with different cabinet styling. 1958-1961. $30 to $60.

Ten-Tec TX100. 75-watt crystal controlled transmitter designed for Novice operation on the 80-, 40-, and 15-meter bands. Features preset antenna loading control for simplified tune up. Early 1970s. $60 to $90.

Heath DX100. 180-watt transmitter with built-in vfo and modulator for a-m phone. Very heavy, and drifts slightly. 80 through 10 meters. DX100B is later version. Accessory sideband adapters for DX100B were originally available, but are rarely offered for sale. 1958-1965. $50 to $100.

Drake 2-NT. 100-watt five-band CW transmitter with built-in antenna changeover relay and CW break-in circuit. Optional vfo available. Companion to the Drake 2C receiver. Designed especially for the Novice. 1967-1969. $75 to $125.

Johnson Ranger. 90-watt five-band CW transmitter with built-in vfo. Originally available as a kit *or* factory built. Still very popular (and scarce), price is stable. About $100 to $135, with higher prices for factory-built units.

Collins 32V3. 150-watt five-band CW transmitter with excellent built-in vfo. Ruggedly built, very stable, typical price for this transmitter has changed little in 15 years. Companion to the Collins 75A series receivers. 1950s. $150 to $200.

Johnson Valiant. 200-watt CW transmitter with built-in vfo, CW break-in, antenna changeover relay, and provision for optional ssb adapter. This unit has been very popular with CB operators during the past few years, so it's hard to find one in good condition at a bargain price. Factory built and kit versions. Valiant II is a later model. $150 to $225.

Drake T4XB. 180-watt CW/ssb transmitter for 160 through 10 meters (accessory crystal required for 160-meter operation). Built-in vfo, vox, CW break-in, and changeover relay. Very reliable. Replaced Drake T4 Reciter which used receiver vfo for transceive operation. T4XB is designed for transceive operation with the Drake R4A and R4B receivers. Replaced by T4XC. 1967-1972. $375 to $425.

Collins 32S1. 180-watt CW/ssb transmitter for 80 through 10 meters. Features linear vfo with excellent calibration and negligible drift, built-in vox and changeover relay. Still very popular, and the selling price reflects it. Designed for transceive operation with the Collins 75S series of receivers. Replaced by the Collins 32S3. 1960-1966. About $400 to $450, with power supply.

Transceivers

Although most Amateurs start out with a separate transmitter and receiver, you may decide that you'd like to begin with a transceiver. A transceiver is nothing more than a combination receiver/transmitter in one cabinet, so it's much more compact than "separates." Originally designed with mobile and portable operation in mind, their popularity has grown over the years to the point where the majority of Amateurs now use transceivers in their home stations. Although transceivers lack some of the versatility of separate units, you are not apt to notice the difference unless you have special interests such as chasing DX or working contests. However, because of their popularity, transceivers tend to be more expensive. Also, they are usually designed for both CW and ssb operation, so as a beginner you're buying more capability than you really need. On the other hand, if you select a transceiver to start, you won't have to replace your station when you upgrade your license.

"Well, I've stopped short of actually twisting your arm . . . but please don't tempt me!"

As with receivers and transmitters, there are all types of transceivers on the market: Old and new, kits and factory built, single band and all-band, 100 watts to 500 or more. Used transceiver prices vary from about $250 for a Galaxy V, Heath HW100, or Swan 260, to about $500 for a National NCX5, Atlas 210, Drake TR4, or Swan 500. If you decide to build a kit, the 170-watt Heathkit HW-101 is available for about $340.

Summing Up

Inflation has hit Amateur Radio, as everything else, but if you're on a limited budget like the rest of us, you can still put an Amateur station together for a pretty reasonable price. Unless you run across a super bargain, about the minimum you can plan to spend is $100 to $125. This will get you a bare-bones station that will provide quite satisfactory operation, although you'll probably want to improve your receiving capabilities after a few months of operating.

If you can spend $200 to $250, you'll have a station that will serve you in good stead both as a Novice and higher class licensee; many Amateurs are content with much less. And if you can justify an expenditure of $400 to $500, you're really cooking — it will be a long time before you'll feel a need to replace your equipment.

All of us have a "wish" list, so don't feel too badly if you can't start out with the ultimate. Just remember that Rome wasn't built in a day. Practically every Amateur I know started with something less than he really wanted, but the price of used Amateur equipment being what it is, if you buy wisely, are patient, and perhaps do a bit of horse trading, you'll find it's a relatively painless process to acquire all the equipment for your own "dream" station.

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SN7405N	24	SN7474N	32	SN74160N	1.25
SN7406N	20	SN7475N	50	SN74161N	99
SN7407N	29	SN7476N	32	SN74163N	99
SN7408N	29	SN7478N	5.00	SN74164N	1.10
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SN7411N	30	SN7483N	70	SN74167N	5.50
SN7412N	33	SN7485N	89	SN74170N	2.10
SN7413N	45	SN7486N	39	SN74172N	8.95
SN7414N	70	SN7488N	3.50	SN74173N	1.50
SN7416N	35	SN7489N	2.39	SN74174N	1.25
SN7417N	35	SN7490N	45	SN74175N	99
SN7420N	21	SN7491N	75	SN74176N	99
SN7421N	33	SN7492N	49	SN74177N	99
SN7422N	49	SN7493N	49	SN74180N	99
SN7423N	37	SN7494N	79	SN74181N	2.49
SN7425N	29	SN7495N	79	SN74182N	95
SN7426N	29	SN7496N	89	SN74184N	1.95
SN7427N	37	SN7497N	4.00	SN74185N	2.20
SN7429N	42	SN74100N	1.00	SN74186N	15.00
SN7430N	26	SN74107N	39	SN74187N	6.00
SN7432N	31	SN74121N	29	SN74188N	3.95
SN7437N	27	SN74122N	39	SN74190N	1.19
SN7438N	27	SN74123N	50	SN74191N	1.25
SN7439N	29	SN74125N	60	SN74192N	89
SN7440N	15	SN74126N	60	SN74193N	89
SN7441N	89	SN74132N	1.09	SN74194N	1.25
SN7442N	59	SN74136N	95	SN74195N	75
SN7443N	75	SN74151N	1.15	SN74196N	1.25
SN7444N	75	SN74142N	4.00	SN74197N	75
SN7445N	75	SN74143N	5.50	SN74198N	1.75
SN7446N	81	SN74144N	4.50	SN74199N	1.25
SN7447N	60	SN74145N	1.15	SN74200N	5.50
SN7448N	.79	SN74147N	2.35	SN74279N	.90
SN7450N	26	SN74148N	2.00	SN74251N	1.79
SN7451N	.27	SN74150N	1.00	SN74284N	6.00
SN7453N	.27	SN74151N	.79	SN74285N	6.00
SN7454N	.29	SN74153N	.89	SN74367N	.75

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	25	CD4035	1.85	74C04N	.75
CD4001	.25	CD4040	2.45	74C10N	.65
CD4002	.25	CD4042	1.90	74C20N	.65
CD4006	2.50	CD4044	1.50	74C30N	.65
CD4007	.25	CD4046	2.50	74C42N	2.15
CD4009	.59	CD4047	2.75	74C73N	1.50
CD4010	.59	CD4049	.79	74C74	1.15
CD4011	.25	CD4050	.79	74C90N	3.00
CD4012	.25	CD4051	2.95	74C93N	2.00
CD4013	.47	CD4052	2.95	74C107N	1.25
CD4016	.56	CD4053	2.95	74C151	2.90
CD4017	1.35	CD4056	3.25	74C154	4.00
CD4019	.55	CD4060	1.75	74C157	2.15
CD4020	1.49	CD4066	.45	74C160	3.25
CD4022	1.25	CD4069	.45	74C161	3.25
CD4023	.25	CD4071	.45	74C163	3.00
CD4024	1.65	CD4081	.45	74C164	3.25
CD4025	.25	CD4511	2.50	74C173	2.60
CD4027	.69	CD4518	2.50	74C192	2.75
CD4028	1.65	CD4566	3.00	74C195	2.75
CD4029	2.80	74C00N	.38	MC9044	4.50
CD4030	.65	74C02N	.55	MC14016	.55

LINEAR

LM300H	.89			LM1310N	2.95
LM301H	.35			LM1351N	1.65
LM301CN	.35			LM1414N	1.75
LM302H	.75			LM1458C	.65
LM304H	1.00	LM378N	1.15	LM1496N	.95
LM305H	.95	LM379N	3.25	LM1556V	1.85
LM307CN	.35	LM377N	4.00	LM2111N	1.95
LM308H	1.00	LM380N	1.39	LM2901N	2.95
LM308CN	1.00	LM380CN	1.05	LM3065N	.69
LM309H	1.10	LM381N	1.79	LM3900N	.55
LM309K	.69	LM382N	1.79	LM3905N	.60
LM310CN	1.15	NE501K	8.00	LM3909	1.25
LM311H	.90	NE510A	6.00	LM5556N	1.85
LM311N	.90	NE531H	3.00	MC5558V	1.00
LM318CN	1.50	NE536T	6.00	LM7525N	.90
LM319N	1.30	NE540L	6.00	LM7535N	1.25
LM320K-5	1.35	NE550N	.79	8038B	4.85
LM320K-5.2	1.35	NE555V	.79	LM7545B	.49
LM320K-12	1.35	NE560B	6.00	75491CN	.39
LM320K-15	1.35	NE561B	5.00	75492CN	.39
LM320T-5	1.75	NE562B	5.00	75493CN	.39
LM320T-5.2	1.75	NE565H	1.25	75494CN	.39
LM320T-8	1.75	NE565N	1.75	75491CN	.79
LM320T-12	1.75	NE566CN	1.25	75492CN	.89
LM320T-15	1.75	NE567H	1.95	75494CN	.89
LM320T-18	1.75	NE567V	1.50	RCA LINEAR	
LM320T-24	1.75	LM703CN	.45	CA3013	2.15
LM322K-5	9.95	LM709N	.29	CA3035	2.58
LM324N	1.80	LM709N	.29	CA3035	2.48
LM339N	1.70	LM710N	.79	CA3039	1.35
LM340K-5	1.85	LM711N	.39	CA3046	1.38
LM340K-6	1.95	LM723H	.55	CA3059	3.25
LM340K-8	1.95	LM723N	.55	CA3060	3.25
LM340K-12	1.95	LM733N	1.00	CA3080	.85
LM340K-15	1.95	LM739N	1.00	CA3081	2.00
LM340K-18	1.95	LM741CH	.35	CA3082	2.00
LM340K-24	1.95	LM741CN	.35	CA3083	1.60
LM340T-5	1.75	LM741-14N	.39	CA3085	.85
LM340T-6	1.75	LM747H	.79	CA3089	3.75
LM340T-8	1.75	LM747N	.79	CA3091	10.20
LM340T-12	1.75	LM748H	.39	CA3123	2.15
LM340T-15	1.75	LM748N	.39	CA3130	1.39
LM340T-18	1.75	LM1303N	.90	CA3140	1.25
LM340T-24	1.75	LM1304N	1.19	CA3600	1.75
LM350N	1.00	LM1305N	1.40	RC4194	5.95
LM351CN	.65	LM1307N	.85	RC4195	3.25

74LS00 TTL

74LS00	29	74LS74	.49	74LS139	1.05
74LS02	29	74LS75	.69	74LS151	1.55
74LS03	29	74LS76	.49	74LS153	1.89
74LS04	.35	74LS78	.69	74LS157	1.55
74LS05	.35	74LS86	.49	74LS162	2.25
74LS08	.29	74LS83	1.75	74LS163	2.25
74LS10	.29	74LS85	2.49	74LS164	1.95
74LS13	.69	74LS86	.49	74LS175	1.95
74LS14	1.75	74LS90	1.25	74LS181	3.69
74LS20	.29	74LS92	1.25	74LS190	2.85
74LS26	.39	74LS93	1.25	74LS191	2.85
74LS27	.39	74LS95	1.95	74LS192	2.85
74LS28	.39	74LS96	1.89	74LS193	2.85
74LS30	.29	74LS107	.59	74LS194	1.89
74LS32	.39	74LS109	.59	74LS195	1.89
74LS40	.39	74LS112	.59	74LS257	1.75
74LS51	.29	74LS132	1.25	74LS260	.55
74LS55	.29	74LS136	.59	74LS279	.79
74LS73	.49	74LS138	1.89	74LS670	3.95

CLOCK CHIPS

MM5309	6 Digit, BCD Outputs, Reset Pin	$9.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1 PPS Output	6.95
MM5318	Video Clock Chip, For Use With MM5841	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.95

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
Linear	Pin-out & Functional Description	$2.95
	ALL THREE HANDBOOKS $6.95	

FAIRCHILD TECHNOLOGY KITS FAIRCHILD

TECHNOLOGY KIT

- Complete Specifications on back of each kit
- Packaged for WALL DISPLAY APPEARANCE
- Dealer's Inquires Invited — Price List Available

FAIRCHILD

DIGITS

FTK0001	0.5	High Common Cathode Digit	$1.00
FTK0002	0.5	High Common Anode Digit	1.00
FTK0003	.357	High Common Cathode Digit	.75
FTK0004	0.8	High Common Cathode Digit	2.00
FTK0005	0.8	High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display		7.00
FTK0011	24 Hour, 4 Digit Clock Display		8.00

LED LAMPS

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

PHOTO TRANSISTORS

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTO ARRAYS

FTK0040	9 Element Tape Reader Array	16.00
FTK0041	12 Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

COUPLERS

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

MOS CLOCK CIRCUITS

FTK0400	Digital Clock/Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock/Calendar Circuit (FCM7015)	8.00

KITS

FTK0500	Automobile Clock Kit	49.00

DISCRETE LEDS

	125" dia.			90" dia.	
XC209	Red	10/$1	XC111	Red	10/$1
XC208	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
			XC111	Orange	4/$1

	200" dia.			185" dia.			200" dia.			.085" dia.	
XC22	Red	10/$1	XC526	Red	10/$1	XC556	Red	10/$1	MV50		
XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	4/$1	.085" dia. Micro		
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1	red LED		
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	4/$1	6/$1		
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1			

DISPLAY LEDS

DL707 DL335

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	.270	2.95	MAN 3620	Common Anode-orange	.300	1.75
MAN 2	5 x 7 Dot Matrix	.300	4.95	MAN 3640	Common Cathode-orange	.300	1.75
MAN 3	Common Cathode	.125	.99	MAN 4710	Common Anode-Red	.400	1.95
MAN 4	Common Cathode	.187	1.95	DL701	Common Anode-red +	.300	.99
MAN 7	Common Anode	.300	1.25	DL704	Common Cathode	.300	.99
MAN 7G	Common Anode-green	.300	1.95	DL707	Common Anode	.300	.99
MAN 7Y	Common Anode-yellow	.300	1.95	DL 728	Common Cathode	.500	1.95
MAN 72	Common Anode-green	.300	1.75	DL 747	Common Anode	.600	2.25
MAN 74	Common Anode-red	.400	1.75	DL 750	Common Cathode	.600	2.49
MAN 72	Common Anode	.300	1.25	DL 338	Common Cathode	.110	.50
MAN 74	Common Cathode	.300	1.50	FND70	Common Cathode	.250	.75
MAN 82	Common Anode-yellow	.300	1.75	FND500	Common Cathode	.500	1.00
MAN 84	Common Cathode-yellow	.300	1.75	FND507	Common Anode	.500	1.00

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	16	15	24 pin	$.38	37	36
14 pin	.20	19	18	28 pin	.46	44	43
16 pin	.22	21	20	36 pin	.60	59	58
18 pin	.29	28	27	40 pin	.63	62	61
22 pin	.37	36	35				

SOLDERTAIL STANDARD (TIN)

14 pin	$.22	25	24	28 pin	$.99	90	81
16 pin	.30	27	25	36 pin	1.39	1.26	1.15
18 pin	.35	32	30	40 pin	1.59	1.45	1.30
24 pin	.49	45	42				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	27	24	24 pin	$.70	63	57
14 pin	.35	32	29	28 pin	1.16	1.00	.90
16 pin	.38	35	32	36 pin	1.75	1.40	1.26
18 pin	.52	47	43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	41	37	24 pin	$1.05	95	.85
14 pin	.39	38	37	28 pin	1.40	1.25	1.10
16 pin	.43	42	41	36 pin	1.99	1.45	1.30
18 pin	.75	68	62	40 pin	1.75	1.59	1.40

PUSH BUTTON SWITCH

SPDT

PB-123	$1.75
Maintained Action Switch	
PB-126	$1.75
Momentary Action Switch	

MINATURE TOGGLE SWITCH

JMT-221	DPDT	on/off/on	$1.95
JMT-223	DPDT	on/none/on	$1.75
JMT-121	SPDT	on/off/on	$1.50
JMT-123	SPDT	on/none/on	$1.25

CLIPLITE

NEW LED MOUNTING SYSTEM — to be used with XC556 LEDS — SPECIFY COLORS — RED — GREEN — AMBER — YELLOW

4/$1.00

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea	10 OHM 27 OHM 68 OHM	12 OHM 33 OHM 82 OHM	15 OHM 39 OHM 100 OHM	18 OHM 47 OHM 120 OHM	22 OHM 56 OHM 150 OHM	1/4 WATT 5% — 50 PCS.
ASST. 2	5 ea	180 OHM 470 OHM	220 OHM 560 OHM	270 OHM 680 OHM	330 OHM 820 OHM	390 OHM 1K	1/4 WATT 5% — 50 PCS.
ASST. 3	5 ea.	1.2k 3.3k	1.5k 3.9k	1.8k 4.7k	2.2k 5.6k	2.7k 6.8k	1/4 WATT 5% — 50 PCS.
ASST. 4	5 ea	8.2k 22k	10k 27k	12k 33k	15k 39k	18k 47k	1/4 WATT 5% — 50 PCS.
ASST. 5	5 ea	56k 150k	68k 180k	82k 220k	100k 270k	120k 330k	1/4 WATT 5% — 50 PCS.
ASST. 6	5 ea.	390k 1M	470k 1.2M	560k 1.5M	680k 1.8M	820k 2.2M	1/4 WATT 5% — 50 PCS.
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	1/4 WATT 5% — 50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets - 25¢ — Send 24¢ Stamp for 1977 Catalog
Dealer Discount Available — Request Pricing

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All Advertised Prices Good Thru February

WIRE WRAP CENTER

CORDLESS HOBBY-WRAP TOOL-BW-630

$34.95 (batteries not included)

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (.025 inch)
- Complete with built-in bit and sleeve

WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 ft. White 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped white wire

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.95
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21		3.00

Ordering: Order desired switch or switches and add necessary accessories for your particular application.

SF — Front Mount SR — Rear Mount

SERIES SF Front Mount Assembly

SERIES SR Rear Mount Assembly

ACCESSORIES

Part No.	Description	Price
SF EP	End Plate (Pair)	.50
SF DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40

ACCESSORIES

Part No.	Description	Price
SR EP	End Plate (pair)	.50
SR DP	Divider Plate (each)	.40
SR BB	Blank Body (each)	.40
SR HB	Half Body (each)	.40

DIP SWITCH

These switches feature seven SPST slide switches in a molded dip. They are ideally suited for microprocessor applications.

$1.95

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mW	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N5processor	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5230	5.6	500m	2/$	1N4734	5.6	1w	2/$
1N5234	6.2	500m	2/$	1N4735	6.2	1w	2/$
1N5235	6.8	500m	2/$	1N4736	6.8	1w	2/$
1N5236	7.5	500m	2/$	1N4738	8.2	1w	2/$
1N456	25	40m	6/1.00	1N4742	12	1w	2/$
1N458	150	7m	6/1.00	1N4744	15	1w	2/$
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.80
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

MPS A05	5/$1.00	PN2907	.3/$1.00
MPS A06	5/$1.00	PN2907A	.4/$1.00
2N2219A	3/$1.00	PN3568	4/$1.00
2N2221	4/$1.00	PN3569	4/$1.00
2N2222A	4/$1.00	PN3638	5/$1.00
2N2369	5/$1.00	2N3705	5/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00
PN2484	5/$1.00	2N3707	3/$1.00
2N2904	3/$1.00	2N3711	5/$1.00
2N2904A	4/$1.00	2N3724	3 .05
2N2905A	5/$1.00	2N3725	.3/$1.00
2N2925	5/$1.00	2N3903	5/$1.00
2N3053	5/$1.00	2N3904	4/$1.00
2N3055	$ .99	2N3906	4/$1.00
MJE3055	$1.00	2N3908	4/$1.00
MJE2955	$1.75	2N4013	2/$1.00
2N3692	5/$1.00	2N4014	3/$1.00
2N3866	5/$1.00	2N4123	10/$1.00
PN4249	4/$1.00		
PN4250	4/$1.00		
2N4400	4/$1.00		
2N4401	4/$1.00		
2N4402	4/$1.00		
2N4403	4/$1.00		
PN4409	5/$1.00		
2N5086	4/$1.00		
2N5087	4/$1.00		
2N5088	4/$1.00		
2N5089	4/$1.00		
2N5129	3/$1.00		
2N5138	5/$1.00		
2N5139	3/$1.00		
2N5209	5/$1.00		
2N5961	5/$1.00		
C106B1SCR	2/$1.00		
2N5432	$2.69		

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.04mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

1.35V	.28	.23	.17	1.5/35V	.30	.26	.21
15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
47/35V	.28	.23	.17	6.8/25V	.35	.31	.25
68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

	Axial Lead			Radial Lead		
47/50V	15	13	10	.47/25V	15	13	10
1.0/50V	16	14	11	47/50V	16	14	11
3.3/50V	15	13	10	1.0/16V	15	13	10
4.7/25V	16	14	12	1.0/25V	16	14	11
10/25V	15	13	10	1.0/50V	16	14	11
10/50V	16	14	12	4.7/16V	15	13	10
22/25V	17	15	12	4.7/25V	15	13	10
22/50V	24	20	18	4.7/50V	18	14	11
47/25V	19	17	15	10/16V	14	12	09
47/50V	25	21	19	10/25V	15	13	10
100/25V	24	20	18	10/50V	16	14	12
100/50V	35	30	28	47/50V	24	21	18
220/25V	32	28	25	100/16V	19	15	14
220/50V	45	41	38	100/25V	24	20	18
470/25V	33	29	27	100/50V	35	30	28
1000/16V	55	50	45	220/16V	23	17	15
2200/16V	70	62	55	470/25V	31	28	26

PROPAGATION

When is the best time to listen for DX stations? What bands should be used and where will the strongest signals be coming from? Why do radio signals travel different distances at different times, and how are they transmitted beyond the horizon in the first place?

Good questions! The answers aren't always easy to find, and sometimes there is more than one answer to each question, but don't become discouraged; radio "conditions" — like the weather — make a good topic for discussion. The old adage that everybody talks about it but nobody does anything about it is no longer quite true. Here's why.

Forecasting radio conditions is about as frustrating and difficult as forecasting weather conditions; it is much easier to make general, long-term predictions than it is to accurately predict local and short-term conditions. The forecaster has acquired a thick hide, and the "forecastee" has developed a healthy skepticism about his predictions. The proper attitude toward these matters probably lies somewhere between blind faith and utter incredulity, but does require a bit of study and patience.

The sun is the source of all energy and life on earth and, directly or indirectly, influences everything we do on this planet. Although the sun is ninety-three million miles away, the earth is bathed in the solar "atmosphere" and it is not surprising, then, that the sun also influences the behavior of radio waves.

Galileo, inventor of the telescope, was the first to really observe strange, dark spots on the face of the sun — like chickenpox — that appeared, grew, faded, and disappeared according to some mysterious and unknown rhythm.* Other astronomers soon verified this strange phenomenon, started counting sunspots and noting their location, and began making records of their observations. Within a half-century from these first systematic observations, it became clear that sunspots came and went according to two cycles: a twenty-seven day period that corresponded to the rotation of the sun on its own axis, and an eleven-year period whose occurrence could not be explained.

Nearly three-hundred years elapsed between the first regular observations, and cataloging, of sunspots and the discovery that they had a profound influence on radio propagation. It is now generally accepted that when sunspots are few and far between, radio communications suffer, but when sunspots are numerous and close together, radio conditions are excellent. There are exceptions, however.

In the far reaches of the upper atmosphere, where the color of the sky is black — even in the daytime — and temperature hovers around −70°F (−57°C), the air is so thin, and its molecules so few and far between, that it exerts little pressure and particle movement is relatively free. Solar radiation — sunlight — bombards these particles and energizes them. The short-wavelength ultraviolet rays strike atoms of oxygen and nitrogen, causing them to break up into negatively-charged electrons and positively-charged ions. Because of their separation, recombination into atoms and molecules takes time. The outermost atoms and molecules are highly activated by the solar rays, while those closest to earth are least affected. In between, the particles are — as you might expect — only somewhat affected. In this way the upper

atmosphere consists of a relatively thick "shell" of ionized particles called the ionosphere.

When radio waves from earth strike the ionosphere they penetrate for a distance, losing energy and setting free electrons in motion, and finally turn back toward the earth's surface; but they don't necessarily arrive at their point of departure! The ionosphere acts somewhat like a mirror, reflecting radio waves according to the angle at which they strike, and returning the signals to earth hundreds of miles from their source. This is called skip, and is the phenomenon responsible for most long-distance radio communication.

Before these simple facts were discovered, however, it was assumed that radio waves propagated (travelled) through the *ether*, an invisible substance that supported the waves in a manner similar to sound waves in air or pressure waves in water. The concept of an ether that permitted transmission of radio signals was a fiction, and the word a convenience adopted to explain the unexplainable. Scientists and technicians tried to find the ether, to measure it; to taste, smell, feel and hear it — without any success whatsoever. Sooner or later a better word, and a better explanation, had to be found.

In 1902, following Marconi's successful transmission of radio signals from England to America, many experimenters sought to explain this remarkable accomplishment without the elusive ether. Arthur Kennelly, an American, and Oliver Heaviside, an Englishman, thought they knew — or at least had a fair idea — of how it was accomplished. Working independently on opposite sides of the Atlantic, their experiments led them to astonishingly similar conclusions: Somewhere above the earth's surface there had to be an "obstruction" that distorted and deflected radio signals. Moreover, they concluded that the obstruction was probably electrical in nature and, finally, they described the obstruction as a layer. Although the existence of the layer was not to be proved for another two decades, it was acceptable as a working hypothesis, and became known as the Kennelly-Heaviside layer in honor of its "discoverers."

In 1924 Edward Appleton, a British scientist, and his co-workers measured the angle of arrival of radio signals from a nearby transmitter and were able to show that the signals must have been reflected from a height of about 100 miles. Continuing work led Appleton to identify various layers of reflection and absorption for radio signals, and assign them letters D, E, F, and the like. Still later, two American researchers, G. Breit and M. A. Tuve, were able to send short bursts of radio signals straight up and measure the echoes accurately enough to precisely locate Appleton's layers. They also discovered that frequencies above a particular *critical frequency* are not reflected, but are either totally absorbed or passed on through the layers and out into space.* They also discovered that the critical frequency changed hourly, seasonally, and geographically, lending support to the growing belief that these radio-wave reflecting layers depended upon the sun for their behavior.

In 1927 a total eclipse of the sun proved beyond doubt that the sun was the primary factor that influenced the reflection, because of the rapid and drastic lowering of the critical frequency as the eclipse progressed and the sun was obscured, and the dramatic increase after the sun reappeared. Subsequent measurements, including those made during solar eclipses, confirmed that ultraviolet radiation from the sun was the

*Although Galileo Galilei is generally considered to be the inventor of the telescope, he probably was not. He did make the first *improved* telescopes capable of excellent resolution, and observed the major planets, the moons of Saturn and Jupiter, earth's moon and — of course — our own sun. From his observation of the sunspots, Galileo correctly deduced the sun's rotational period of twenty-seven days and made his findings public. His largest telescopes were real monsters, some having focal lengths as great as 170 feet (51.8 meters)!

The telescope was at least conceived in the thirteenth century by Roger Bacon whose writings give a good indication that he understood simple lens-making, and he knew that visual minification and magnification of objects was possible by appropriate selection of lens curvature and size. The modern telescope was probably invented by a Dutchman, Hans Lippershey, in 1608. At least he made full disclosure of the device and its operation to an established body of scientists and government officials, and requested that they grant him the exclusive right to make, use, and sell the instruments. At about the same time, James Metier, also from Holland, applied for recognition for his invention — the telescope! He had independently conceived the instrument from reading of the work of others, and submitted his documents in October of 1608, only a few days before that of Lippershey. Lippershey's work was more complete, however, so he received the credit.

This is another instance of numerous inventors working independently in different locations and arriving at the same point almost simultaneously. It has been said that nothing on earth is as powerful as an idea whose time has come. Then, as now, scientists and experimenters avidly read of each other's works and ideas, and formed "colleges" of inquisitive men dedicated to the expansion of knowledge and the exchange of ideas. It is therefore probable, although not provable, that Galileo, Lippershey, Metier, and others had read of telescopes and telescope making from early reports such as that of Bacon. There is also little question that Marco Polo brought with him from China reports of telescope-likes optical systems in use by astrologers and viziers in the courts of Chinese nobles. The idea, therefore, may be more than a thousand years old — but the "hardware" only three-hundred! **Editor.**

***Critical frequency.** The frequency below which signals will be reflected, and above which the signals will pass through and not be reflected.

means by which the reflecting layers were produced.

"Rights" of spring

In Spring, a young ham's fancy lightly turns to thoughts of . . . propagation and DX? Well, yes, in a manner of speaking. Both are subjects that bear further scrutiny in spite of the fact that *sunspot cycle* 20 has reached a minimum and new cycle 21 has barely begun.Surprisingly, springtime offers the budding DXer and the old timer alike a good opportunity to work some rare stations and long-distance skip, in spite of the generally depressed nature of solar activity in 1977. In Spring (more specifically, the vernal equinox on March 21st) the sun is overhead at the equator, making days and nights of equal length all over the world. People in the Northern hemisphere are looking forward to summer, while their counterparts in the Southern hemisphere look unhappily toward winter; but for a period beginning in late February and extending through late April, high-frequency radio propagation in both hemispheres ranges from good to excellent.

During this period the ionosphere tends toward uniformity — a condition of homogeneity — that creates optimum DX conditions. Therefore it's time to prepare a prognostication of what may be in store for us, and how conditions look for worldwide DX.

General

Conditions on the long path between northern and southern hemispheres will be greatly improved over their winter level. Signals from Antarctica, South Africa, South America and southern Asia should be heard in the United States, and the best all-around DX band will be twenty meters. Fifteen meters will also be open for a number of days during the equinoctial period, and trans-equatorial propagation, with fair to good signal strength on both ends of the path, should be experienced. Twenty will open up on some DX paths shortly after local sunrise, and will continue to provide contacts with various areas of the globe until shortly after local sunset.

During the early evening hours, twenty and forty meters will be open for DX and, as twenty fades away, forty will improve through the hours of darkness.

Forty and eighty meters will continue to offer strong DX possibilities during darkness hours and on into the sunrise period. Remember, however, that Europeans tend to retire at about 8 PM eastern time (1 AM GMT) on all except Friday and Saturday nights, so time your efforts accordingly.

On days of "normal" ionospheric activity, expect some good ten-meter openings during daylight hours, usually between 10 AM and 2 PM local time.

Short skip

Infrequent but excellent short-skip openings will occur on ten, fifteen, and twenty meters over distances of about 750 to 2500 miles (1200 to 1000km). Best times to listen for signals are mid-morning, when the shorter skip distances will start opening up, through mid-to-late afternoon when signals from distances of 2000 miles (3200km) or so will appear. When ten and fifteen open they will be *hot* and signal strengths will be very high for an hour or two, both for short-skip and long-skip distances. In some cases, short-skip stations will override DX stations; even twenty meters will show both types of activity in the afternoon hours on some days.

When ten meters is open at distances of 500 miles (800km) or less, keep an ear cocked for *six-meter* openings. Six will bring in signals from distances of between 1000 and 1500 miles (1600 and 2400km) during these periods, and may possibly be open into Mexico, Central America, and northern South America; a good chance for some of the fellows to pick up needed new countries.

On forty and eighty meters, short skip will be a common occurrence, with signals from 70 or 80 miles (100 or 125km) out to several-hundred miles (about 500km) abounding. Good, "solid" signals will be the rule, but springtime thunderstorm activity will cause lots of static, especially in the southerly directions. When atmospheric noise is low, DX opportunities on these bands will offer good hunting after dark.

Vhf opportunities

Although auroral disturbances are not as frequent during periods of a quiet sun as they are at solar cycle peaks, there is always the chance at this time of year that an unexpected and unpredicted solar disturbance may create an aurora. If so, be on the lookout for it and have your rigs ready to go on six and two meters. Most probable time is the third week in March, right around the vernal equinox, or perhaps slightly later.

Twilight path propagation

The twilight zone is not science fiction, and you will be hearing more about it in coming months. Basically, the idea is that the zone between daylight and darkness provides excellent opportunities to work DX stations. The reason for this is that the high D-layer absorption levels are fading fast (sunset) or have not yet started to build up (sunrise); plus the fact that the long-skip DX F_2 layer is predominant on the night side, while the shorter skip F_1 layer predominates on the day side. This means that there is a merging of the two, with both

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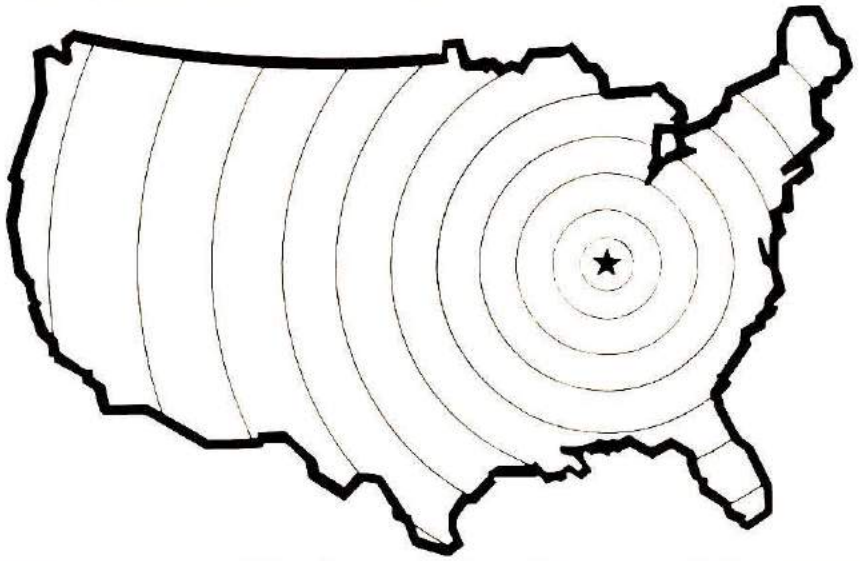

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existing simultaneously along the twilight path, or *terminator* as it is called.

In March, at the equinox, the terminator lies exactly parallel to the meridians of longitude. For example, if it happens to be twilight in Chicago, it will also be twilight in Hudson Bay, Novosibirsk (Siberia), Calcutta, the Andaman Islands and Managua, Nicaragua. Good DX signals along this north-south twilight zone should exist, and it would pay you handsomely to turn your beam directly north or south at such times to listen for those rare stations. Signals will be surprisingly good. Our resident expert, Oak Okleshen, W9RX, has used the twilight zone technique to work a lot of choice stations, and will be telling you much more about it in future issues.

Therefore, when it is about sunrise or sunset in your locality, turn those antennas north or south and perk your ears. You'll hear — and work — some good DX with only modest amounts of power. Don't be afraid to call "CQ DX," either.*

What of cycle 21?

The crystal ball is cloudy, but some evidence of recurring rhythms in sunspot activity indicate a long-term "cycle of cycles" at intervals of about 179 ±1 years. If this is true, cycle 21 should be similar to cycle 5, with a peak smoothed sunspot number of only about 45 occurring in about 1982. Compare this figure with a cycle 20 peak sunspot number of about 110, and a cycle 19 peak sunspot number of over 200 (the highest ever recorded)!

This gloomy outlook means that while DX will be available, the MUF* will not rise to the great heights of the last two cycles, and long-haul six-meter DX, if it occurs at all, will be rare. Occasional solar disturbances during the peak years of cycle 21 will cause the MUF to scoot to abnormally high, but short-lived, levels. The ten- and fifteen-meter bands will be active at the peak of the cycle (1982), with DX available for about the distances and times that occurred in 1966, and again in 1973-1974, when cycle 20 was on its way up and down. Don't expect conditions to be anywhere near as good as they were in 1968, however, and prepare to use "gain" antennas on 80, 40, and 20 meters.

The long-term outlook for DX conditions is only fair-to-good, at least until the year 2000. It won't be until sometime in the 21st century that solar conditions will once again look like they did in 1947 and 1958, if at all. **HRH**

*World-wide sunrise/sunset tables for all DXCC countries, the 48 contiguous United States, all Canadian provinces, and all VK call areas are available in a booklet computed and distributed by John Devoldere, ON4UN, Peelstraat 215, 9220 Merelbeke, Belgium. The price is $10.00 postpaid. Each table includes decimal GMT sunrise/sunset information for 24 different dates throughout the year, and is particularly useful for planning twilight path DX contacts.

*Maximum usable frequency.

Glossary of Terms

Skip refers to the reflection or bounce of radio signals from one place to another on the surface of the earth. Short skip refers to signals reflected one or more times over a distance of 100 to 1000 miles (160 to 1600km), depending on the band of frequencies in use. Long skip refers to signals reflected many times and traveling up to 6000 to 8000 miles (9600 - 12900km). Signals usually skip from ionized layers to earth and back, but they also may bounce between different layers of the ionosphere before returning to earth.

When radio signals travel great distances, they normally follow great-circle routes — the shortest possible paths between two places on earth. Sometimes a signal will prefer taking the longer segment of a great-circle instead of the shorter segment, and is said to be a *long path* signal. Sometimes a signal will take both paths, long and short, and arrive at your station with a slight "garble" due to phase differences and time delay.

Sunspots were measured as early as about 1650, but systematic observations and recordings of their frequency and number were not made until about 1750. Since that time, annual, monthly, and daily charts of sunspot occurrence have been kept and each cycle (minimum-maximum-minimum) recorded. The current cycle, presently at a minimum, is number 20. Cycle 21 has just begun (there is slight overlap) and will reach a peak in about 1982. Although the cycles are nominally 11.2 years apart, some as short as 9 years and others as long as 13 years have been recorded.

Terminator is the name given to the edge of the shadow line between sunlight and darkness on a planet's surface. Atmosphere, as on earth, tends to make the line fuzzy — twilight — and lack of an atmosphere makes the line sharp and distinct, as on the moon. It is interesting to watch an earth satellite pass into darkness as it crosses the terminator. First, there is a slight color change due to atmospheric refraction and then it "winks out" as it enters total night.

Maximum usable frequency, MUF, refers to the highest frequency that will be reflected by the ionosphere at any particular time. Lowest usable frequency, LUF, is the lowest frequency that will not be absorbed by the ionosphere. Theoretically, the usable frequencies lie between the MUF and the LUF. To be sure of communication, however, it is wise to be a little conservative and choose a frequency somewhat below the MUF and slightly above the LUF. The LUF and MUF make hourly, daily, monthy, and yearly changes. Propagation forecasts take these into account.

More details? Ad Check page 86.

DX forecaster

March, 1977

Radio Propagation and Weather are Clearly Tied to the Sun's Activity which, in Turn, is Greatly Influenced by the Planets. This month "...Beware the Ides of March"

The DX forecaster is intended as a guide and not as a certainty. Where a particular band appears (40, 20, 15, etc.) there is a good possibility of that band being usable to the part of the world indicated. If an asterisk (*) appears, there is a possibility that the next higher amateur band may be usable as well. Where no band is shown and only a hyphen (-) appears, an opening is not likely.

The nature of the ionosphere is such that the predicted paths may be open and usable as often as 75% of the days, or as few as 25% of the days, with an average of 50% of the days being the rule. If a path fails to produce the desired results, try the next lower band for that area at an appropriate time. If a given path is open with good signals coming through, try the next higher band, even if no asterisk (*) is shown.

Greenwich Mean Time (GMT) is given adjacent the left-hand edge of the chart. The four major United States time zones are given in the clolumns to the left of GMT, with corresponding local times listed. Light face numerals indicate AM, while bold face numerals indicate PM. *Note*: For daylight savings time, add one hour to local times.

Last-minute predictions indicate a disturbed period for March 13th, with the possibility of ionospheric instability beginning as early as March 11th and extending through March 15th. There is a strong possibility of aurora during this period, with its attendant effects on vhf propagation. The *Ides of March* should be interesting with respect to unusual weather phenomena, following within about two days or so of the predicted ionospheric upset on the 13th. In general, the week should be most interesting atmospherically and ionosopherically. Be alert.

band	frequency range
80 meters	3.500 to 4.000 MHz
40 meters	7.000 to 7.300 MHz
20 meters	14.000 to 14.350 MHz
15 meters	21.000 to 21.450 MHz
10 meters	28.000 to 29.700 MHz
6 meters	50.000 to 54.000 MHz
2 meters	144 to 148 MHz

GMT	PST	WESTERN USA ↑	↗	→	↘	↓	↙	←	↖	MST	MID USA ↑	↗	→	↘	↓	↙	←	↖	CST	EST	EASTERN USA ↑	↗	→	↘	↓	↙	←	↖
0000	4:00	—	—	20	20	15	15	—	20*	5:00	40	—	20	20	—	—	—	15	6:00	7:00	40*	40	40	—	20	20	20	20
0100	5:00	15	—	—	20	15	15	15	20*	6:00	40	40	—	20	—	20	—	—	7:00	8:00	40*	40	40	40	40	20	20	20
0200	6:00	20*	—	—	20	—	15	15	20	7:00	—	80*	—	20	20	20	—	—	8:00	9:00	—	80	80	40	40	20	20	20
0300	7:00	20	—	40	20	—	20	20	20	8:00	—	80*	40	40	20	20	—	—	9:00	10:00	—	80	80	40	80*	20	20	20*
0400	8:00	20	40	40	20	20	20	20	20	9:00	—	80*	40	40	—	20	—	—	10:00	11:00	—	80	80	—	80*	—	—	—
0500	9:00	—	80	80	40	20	20	20	20	10:00	—	80*	40	40	—	20	—	—	11:00	12:00	40	80	—	—	40	—	—	20
0600	10:00	—	40	—	40	—	40*	—	20	11:00	40	80*	—	40	—	—	—	—	12:00	1:00	40	80*	—	—	40	—	—	—
0700	11:00	—	40	—	40	—	40*	—	—	12:00	40	40	—	40	—	—	—	—	1:00	2:00	40	40	—	—	40	40	40	—
0800	12:00	—	40	—	40	—	40	—	—	1:00	—	40	—	40	40	40	—	—	2:00	3:00	—	—	—	—	40	40	40	—
0900	1:00	—	40	—	40	—	40	—	—	2:00	—	—	—	40	40	80*	—	—	3:00	4:00	—	—	—	—	—	40	40	—
1000	2:00	—	40	—	—	40	40	—	—	3:00	—	—	—	40	40	80*	40	40	4:00	5:00	—	—	—	—	—	40	40	80*
1100	3:00	—	—	—	—	40	80*	40	80	4:00	40	—	—	40	—	40	40	40	5:00	6:00	—	—	—	—	—	—	—	80*
1200	4:00	40	—	—	—	—	80*	40	40	5:00	40	—	—	40	—	40	40	40	6:00	7:00	20	—	—	—	—	20	20	40*
1300	5:00	40	—	—	—	—	80*	40	40	6:00	20	—	—	20*	—	20	20	20	7:00	8:00	20	—	—	—	—	20	20	20
1400	6:00	40	—	—	—	—	—	40	40	7:00	20	20	—	20*	—	20	20	20	8:00	9:00	20	20	—	—	15	20	20	20
1500	7:00	20	20	40	—	—	—	—	40	8:00	20	20	—	15	—	20	20	20	9:00	10:00	—	20*	—	—	15	—	—	—
1600	8:00	20	20	—	—	20	—	—	20	9:00	20	20*	—	15	—	—	20	—	10:00	11:00	—	20*	15	—	15	—	—	—
1700	9:00	20	20	—	—	20	—	—	20	10:00	—	20*	15	15	—	—	—	—	11:00	12:00	—	20	15	15	—	—	—	—
1800	10:00	—	20*	15	—	—	—	—	—	11:00	—	20	15	15	—	—	—	—	12:00	1:00	—	20	15	15	15	—	—	—
1900	11:00	—	20	15	15	—	—	—	—	12:00	—	20	15	15	—		—	—	1:00	2:00	20	20	20	15	15	—	—	—
2000	12:00	—	20	15	15	—	—	—	—	1:00	—	20	20	20*	—	—	—	—	2:00	3:00	20	—	20	—	15	15*	—	20
2100	1:00	—	—	20	15	—	—	—	—	2:00	—	20	20	20*	—	—	—	—	3:00	4:00	20	—	20	20	20	15*	—	20*
2200	2:00	—	—	20	15	—	—	—	—	3:00	20	20	20	20	—	—	—	—	4:00	5:00	—	—	—	20	20	15	—	20*
2300	3:00	—	—	20	20	—	—	—	—	4:00	20	—	20	20	—	15	—	15*	5:00	6:00	40	—	—	20	20	15	—	20*
MARCH		CENTRAL ASIA	EUROPE	S. AFRICA	S. AMERICA	ANTARCTICA	NEW ZEALAND	W. AUST/OCEANIA	FAR EAST		CENTRAL ASIA	EUROPE	S. AFRICA	S. AMERICA	ANTARCTICA	NEW ZEALAND	AUSTRALIA	FAR EAST			FAR EAST	EUROPE	CENTRAL AFRICA	S. AFRICA	S. AMERICA	OCEANIA	W. AUST/NZ	AUSTRALIA

HAM CALENDAR

March 1977

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
*All International events such as contests are shown on the GMT days on whith they take place even though they may actually begin on the evening of the preceding day in North America.		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) West Coast Qualifying Run 1	2	3	4	ARRL International DX Contest (Phone) — 0001Z 3/4 - 2359Z - 3/6* YL-OM Contest — 1800Z 3/5 - 1800Z 3/6 — Info: Carol Bourne, 362 Hawthorne, Glen Ellyn, Illinois 60137 5
Sterling-Rock Falls ARS Hamfest — High School Field House — Sterling, Illinois 61081 WA9BSD 6	7	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) Moon Perigee occurs at 2300Z 8	Microcomputer Interfacing Workshop Info: Dr. Norris, VPI & SU Continuing Education Center, Blacksburg, VA 24061 (703) 951-6328 March 9 - 11 9	10	11	Virginia State QSO Party — By the Sterling Park ARC — 1800Z 3/12 - 0200Z 3/14 — K4VT* 12
South Dakota State QSO Party — By the Prairie Dog ARC — 0001Z 3/13 - 2359Z 3/14 — WBØEVQ* 13	14	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) 15	WIAW Qualifying Run 16	17	18	ARRL International DX Contest (CW) — 0001Z 3/19 - 2359Z 3/20* Western Personal Computing Show, International Hyatt House — Los Angeles, CA — Info: Personal Computing, 401 Louisiana SE, Suite 6, Albuquerque, New Mexico 87108 March 19-20 19
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27	28	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) 29	30	31		

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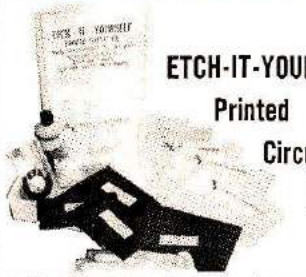

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Dear Horizons:

Please send me your subscription rates as soon as available. I want to be your *first* subscriber.

The idea of a beginners magazine is great. I suggest that you sponsor a slow-speed world-wide CW contest for "non-professional" contesters.

David Novoa, KP4BDL
Levittown, Puerto Rico

In this day of the computerized listings, David, it is difficult to say just who is the first. Rest assured, however, that you are among those who got to us very early. Your contest idea has us thinking. ***Editor***

Dear Horizons:

Congratulations on your new idea in ham radio publications. May I take this opportunity to wish you every success in your new venture. I hope that *Ham Radio Horizons* will fulfill the need of the would-be ham in much the same way that *QST* did when I started in ham radio in the 20's. The addition of "Tom Swift" type stories woven around ham radio will certainly serve to arouse interest of your younger readers. Who knows, perhaps some of us old timers will enjoy them too! . . .

L. M. Rundlett, K4ZA
Sterling Park, Virginia

Dear Horizons:

I commend you on your choice of names for this new journal. K8RXM and I have been doing an amateur radio show with the same name . . . which airs on WLQA and WVXU (Cincinnati). This show is now 10 months old . . . K8RXM is producer and I am host . . .

James E. Weaver, W8COA

This brings to mind the saying "When an idea is ready to be thought about, several minds will be thinking about it." The name Ham Radio Horizons *was chosen from a list of more than 125 that were submitted to the publisher by the staff and friends. Two of the staff, WA1WPP and W2EUQ, came close by independently suggesting "Amateur Radio Horizons." From there it was just natural that "Amateur" be replaced with "Ham." I hope that your show enjoys as much success as we anticipate for our publication.* ***Editor***

Dear Horizons:

As an avid *HR Report* reader, I was extremely pleased to learn of your new publication, *Ham Radio Horizons*. I find the concept of a non-technical, general interest magazine for the Amateur Radio community very exciting, and naturally I have already entered my subscription order . . .

G. R. Patton, WA3VUP
Duncanville, Pennsylvania

Thanks, Gerald, for your support. There will be technical material in Horizons, *but we hope at a level that will be instructive rather than mystifying. Comment from the field will tell us if we are reaching that goal.* ***Editor***

Dear Horizons:

You are to be congratulated. Finally someone has had the foresight to come out with a magazine that will (I hope) have articles and projects which will be aimed at persons other than engineers. I have felt for a long time that it couldn't be possible that I was the only one that could not comprehend some of the material in the major Amateur Radio Magazines. I am a life member of *ARRL*; I have been reading *ham radio* and *HR Report* for a long time now.

Now, however, you have restored my faith in myself. You not only publish a story of a youngster, five years old receiving his *Novice* ticket, (I must be at least as smart as he is) but you also announce the beginning of your new publication. I sincerely hope that there will be many articles and home building projects that will be aimed at persons like myself, who can handle a soldering iron and follow a schematic to a fair degree, but who do not understand all of these engineering terms and two and a half page mathematical formulae . . .

Thanks again for *Ham Radio Horizons* and I am expecting great things from it so please do not let me down.

Gilman M. Gates, WB4ATY
Niceville, Florida

Dear Horizons:

Congratulations on the new magazine *Ham Radio Horizons*! I have been surprised at the amount of correspondence I have received in the past from *ham radio* readers who were beginners, and felt they needed "their own" magazine, but one having the quality and authenticity that *ham radio* presently provides for more advanced amateurs . . .

Bill Wildenhein, W8YFB
Elyria, Ohio

Dear Horizons:

It did my heart good to hear that someone was going to give us beginners a magazine that we could really get into. I am waiting for the results of my Novice exam and starting to plan my station setup. Here's hoping that the pages of your magazine will give me some ideas . . .

Larry Stenebek
Cinnaminson, New Jersey

Thanks, Larry, and you have given us an idea too. How about a photograph of the "Station-of-the-Month" for starters? Readers — send a good, sharp, photograph and a one- or two-typewritten-page description of your station to Ham Radio Horizons, Greenville, New Hampshire 03048. The photographs should be glossy finish, black and white, 8x10 preferred but a smaller size is useful if it is really of good quality. The size of your station doesn't matter; we'll present a variety of ideas to Larry and any of our readers that want to see what Hams can do. ***Editor***

More details? Ad Check page 86.

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INDEX

Amcomm ___ 500	Heights ___ 061
ARRL *	Hoosier ___ 546
Antenna Mart ___ 009	Icom ___ 065
Antenna Spec. ___ 010	Inter. Mag. ___ 536
Atlas ___ 198	JS & A ___ 537
BBC Elect. ___ 529	James ___ 333
Beacon ___ 531	Jensen Tools ___ 293
Burghardt ___ 530	KLM ___ 073
Buyers & Sellers ___ 329	Kengore ___ 538
Byte ___ 487	Kenwood *
CRS CO. ___ 532	Larsen ___ 078
CW Elect. ___ 533	Lin ___ 451
Comm. Center ___ 534	Long's ___ 468
Comm. Spec. ___ 330	Madison *
Cush Craft ___ 035	Palomar ___ 093
Data Signal, ___ 270	Peninsula ___ 539
Dentron ___ 259	Processor Tech. ___ 540
E. T. O. *	Radio Pub. ___ 5[illegible]
Elect. Dist. ___ 044	R F Power ___ 542
Erickson ___ 047	SST ___ 375
Excel Circuits ___ 535	Shmegg ___ 543
Ham Center ___ 491	Standard ___ 109
Horizons ___ 150	Teco ___ 113
Heath ___ 060	Triplett ___ 544
Henry ___ 062	Unadilla *
	Whitehouse ___ 378
	Yaesu ___ 127

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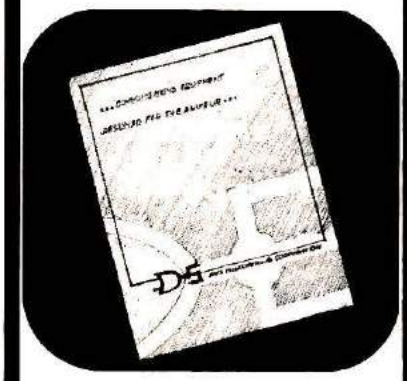

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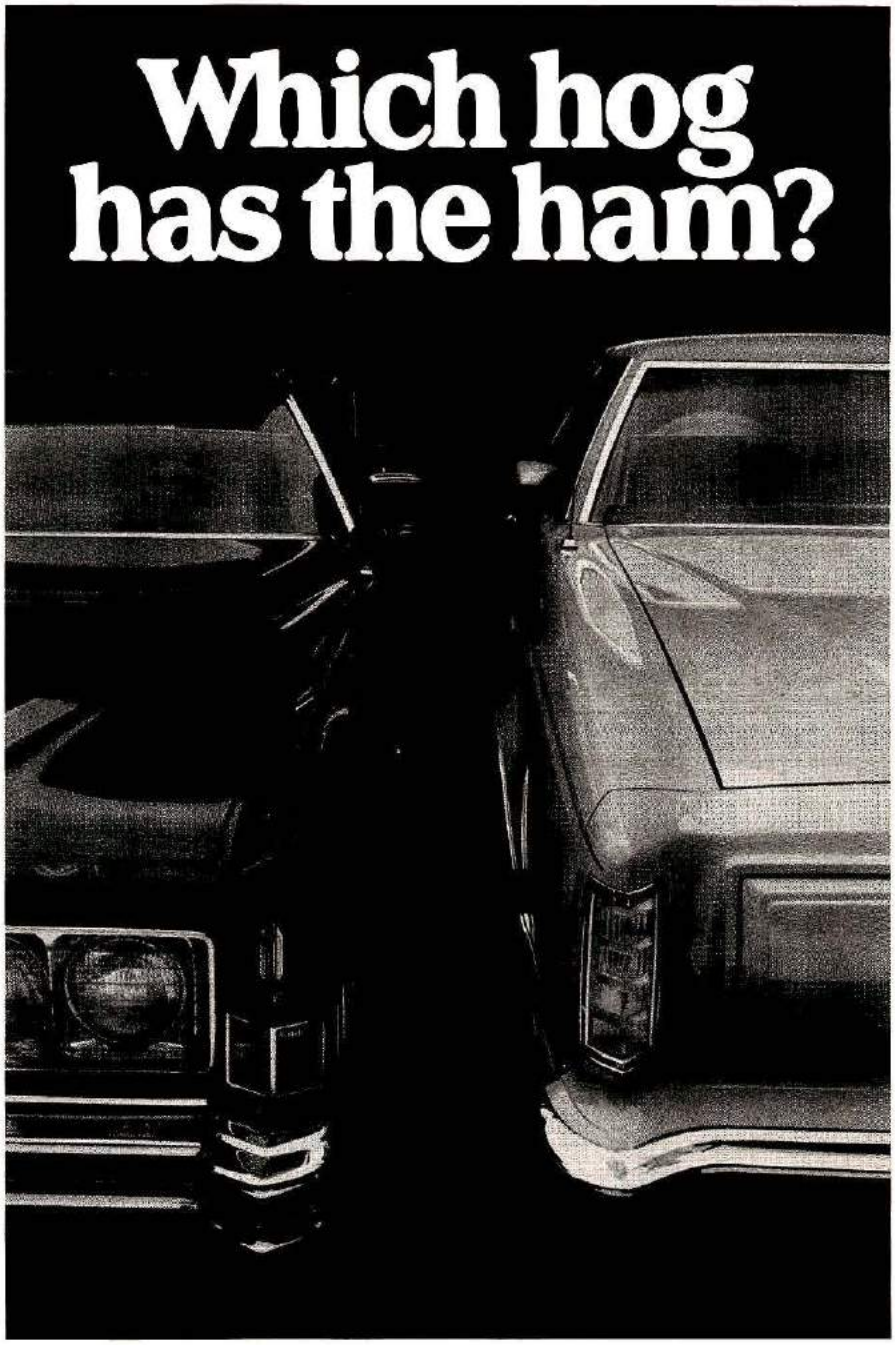

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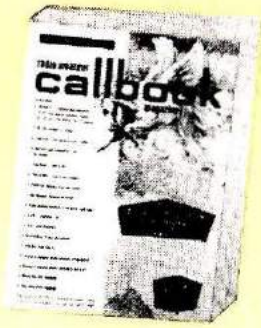

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