APRIL 1977

HAM RADIO HORIZONS

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TR-4Cw with RV-4C Remote VFO

the New Drake TR-4Cw

sideband/cw transceiver

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Drake TR-4Cw, Ssb/Cw Transceiver	**$649.00**
Drake AC-4, Ac Supply	**120.00**
Drake DC-4, Dc Supply	**135.00**
Drake RV-4C, Remote VFO	**120.00**
Drake 34PNB, Noise Blanker	**100.00**

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thoughts to consider about the New Drake TR-4Cw

Of the many questions and comments we receive, we feel the following are very significant. Please spend a moment, and consider these points with us:

The TR-4Cw still uses tubes.

True. While using a combination of transistors and tubes, the TR-4 system makes greater use of tubes. Tubes are easy to change, and with the use of a spares kit, they can be readily replaced from the jungles of the Amazon to the arctic tundra—anytime, anyplace.

Also, the TR-4 system uses a *triple* tube power amplifier. It runs more power *output* than most transceivers run *input*. Serious DX-ers and contesters know the value of power when the going gets rough in heavy QRM. The system is also ideal to drive the various grounded grid linears that require higher drive levels.

The TR-4 system has been around a long time— what does it offer me today?

True again. The system has been around, and improved, over a 13 year period. It is one of the most "bug-free" systems we know.

Interestingly, the TR-4Cw offers some features still not found on most "new" rigs today. For example, frequency tuning in the TR-4 system is accomplished by the use of a precision permeability tuned oscillator (PTO). This makes use of a slug traveling through a coil instead of the older variable capacitor technique. The PTO gives us extra good frequency stability and dial linearity. Speaking of something old, the variable capacitor technique dates back over 50 years!

The cw filter in the TR-4Cw can be independently switched from the front panel. You're not "locked" in to the cw filter when in cw mode as in most transceivers. Many operators prefer to tune randomly with the wider filter. You can do it with the TR-4Cw.

The optional 34PNB noise blanker works so well, you'll have to try it to believe it! It's a miniature 17 transistor receiver with full noise gating functions. Try it in a side by side test at your dealer's.

And what about service on the TR-4Cw?

We service what we sell, and parts are always available. After nearly 20 years, we are still able to service Drake 1-A receivers, so we know there are many in use today. We've been around since 1943, and we fully intend to serve radio amateurs for the long haul. Does the other company you may be considering have the same intentions?

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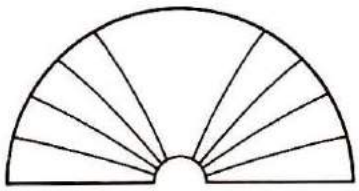
THIS MONTHS



HORIZONS

DX Vacation

It is common knowledge among radio amateurs that the proper time to erect antennas is during the winter. Author Blakeslee decided that he needed to put up an antenna in the month of December, but he has a neat idea to help stay comfortable while doing so — if the sun won't come to your antenna, take your antenna to the sun!

1750-Meter Band

There is a haven for experimenters that most people do not know about. Further, no license is needed, no paperwork is involved, and you can make up your own call. This niche is far below the familiar broadcast band — 1750 meters in wavelength. W2IMB does more than whet your interest; he tells you how to get started.

Backpack Portable

There are times when you would like to be able to take your two-meter equipment into the "boonies," but it's just not practical. Dick Jansson tells you how he solved this common problem in a neat and simple manner without sacrificing power or operating capability. A completely portable backpack station can be yours for very little money, time, or effort.

From The Ground Up

Ground: basis, beginning, bottom, earth, foundation, fundamental. No matter how you define it, *use* it, to make your station efficient and safe.

Contests

At various times during the year the amateur bands seem to become filled with endless numbers of stations engaged in the shortest possible contacts with each other. Those of us who have been around long enough recognize that there is a contest going on. To many clubs and individuals a contest is the high-point of the year. W1GQO gives you a synopsis of the challenge of contesting — why, how to do it, and above all — what it is.

SSB Receiving

Detection of ssb signals makes use of some processes that we talked about last month — mixing, heterodyning, filtering. A lot of things appear to be happening inside that box called a receiver, but if you take it one item at a time it isn't all that bad. The steps involved in getting an ssb signal into an amateur band (and getting it back out again) are discussed too.

Zero-Bandwidth SSB

Evidence of the population explosion can be found everywhere — even in the radio world. The problem manifests itself by preventing a gap between communications. Professor Karryer (twice selected for the Ignobel prize) has found a promising solution.

Call From Cedro Canyon

When a State Policeman patrolling the canyon area outside Albuquerque, New Mexico, finds himself alone and in grave difficulty, a lone watcher from a wheelchair high above the arroyo uses his good sense and his amateur equipment to effect a rescue.

Radio Propagation

The most consistent means of sending and receiving long-distance radio signals in the high-frequency amateur bands uses the ionosphere as a mirror. An insight into the composition and behavior of this natural radio mirror, together with how and when it may best be used to improve the quality and quantity of your radio contacts, is given by one of the country's top DXers and propagation forecasters. By using these insights carefully and correctly, you are on your way to success.

HAM RADIO HORIZONS April 1977, Volume 1, No. 2. Published monthly by Communications Technology, Inc., Greenville, New Hampshire 03048. One-year subscription rate, $10.00; three-year subscription rate, $24.00. Application to mail at second-class postage rates is pending at Greenville, New Hampshire 03048.

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

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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!

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APRIL, 1977
Volume 1, Number 2

HAM RADIO HORIZONS

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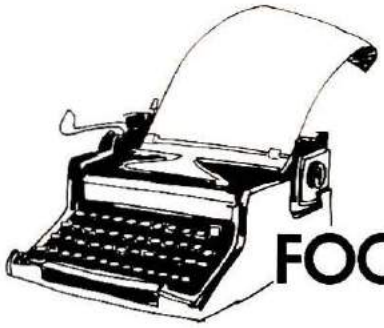
The Cover
A tropical island, beaches, sunsets, and Amateur Radio with a DX callsign. An irresistible winter-time combination, and an adventure shared by W1KLK, starting on page 14. Photograph by H. Armstrong Roberts.



FOCUS & COMMENT

Images can mean different things to different people, depending upon what kind of image is being dealt with. To a person concerned with public relations, a favorable image is something to be sought after, nurtured, shaped, and maintained. A great number of professional people spend a lot of time, money, and effort in providing a client with a favorable view in the eye of the public.

To electronics people, an image is something else again. As a product of a mixing or heterodyning process in either a transmitter or a receiver, it must be removed, ignored, or designed around, as the case may be. This type of electronic image is seldom useful to an Amateur.

There is another type of image that can be harmful to Amateur Radio if it is ignored or even if it doesn't exist: your "private image." If you would like to find out what I mean, just ask your children what they say when their friends inquire about your hobby. Or find out how your wife feels when her friends or neighbors wonder, "What does he do with all that stuff?" The answers may dismay you, but this does not necessarily mean that you are doing something wrong, but rather that you are not doing enough things right.

And you younger people, just starting out in ham radio, what sort of "tag" does your non-ham friend or parents hang on you because of your devotion to your hobby?

We should all embark on a personal campaign of "image enhancement." The benefits of this do-it-yourself project can be far reaching and very satisfying. When your children (wife, friends, parents), know enough about your hobby to be able to explain things to someone else, just watch them beam with pride as they answer the inevitable questions. It is quite likely that you'll have to bone up a bit on your answers too. Just when you think that you have explained something, they'll hit you with a question that you didn't think they knew how to ask. It is often said that the best way to learn something is to teach it — to which I add; if you properly excite your audience, you will have to run to stay ahead.

And don't worry about competition if your wife becomes interested to the point of getting her license and joining you in the fun of a world-wide hobby. The chances are that she will find a facet that really turns her on without detracting from what you like to do. Even if you both wind up in the same game, there is plenty of room for variations — you can work DX to collect certificates; she can collect new acquaintances and friends.

However, your family may not be all that interested in carrying this far enough to get their license and join you in the fun of ham radio: you'll still come out ahead. The more they understand of your hobby, the less they will resent the time that you spend at it. In the process of gaining their understanding, perhaps you will learn a bit about their needs and desires as well.

You need not embark on a crash program of concentrated sessions; this could have an effect that is opposite to what is desired. Just the simple expedient of never being "too busy" to explain something can do wonders. Once the interest is aroused, you can start building your "private image" upon that foundation. When your hobby and your family get along with each other, the outside world will know. Thus you have the start of a public viewpoint that is based on family and home, rather than one "shaped" by an agency.

While it is unlikely that Amateur Radio will ever equal the Macho image of the hard-driving trucker with his CB mike in hand, we can certainly benefit by a public image that gets us out of the category of "recluse tinkerers!"

Tom McMullen, W1SL
Managing Editor

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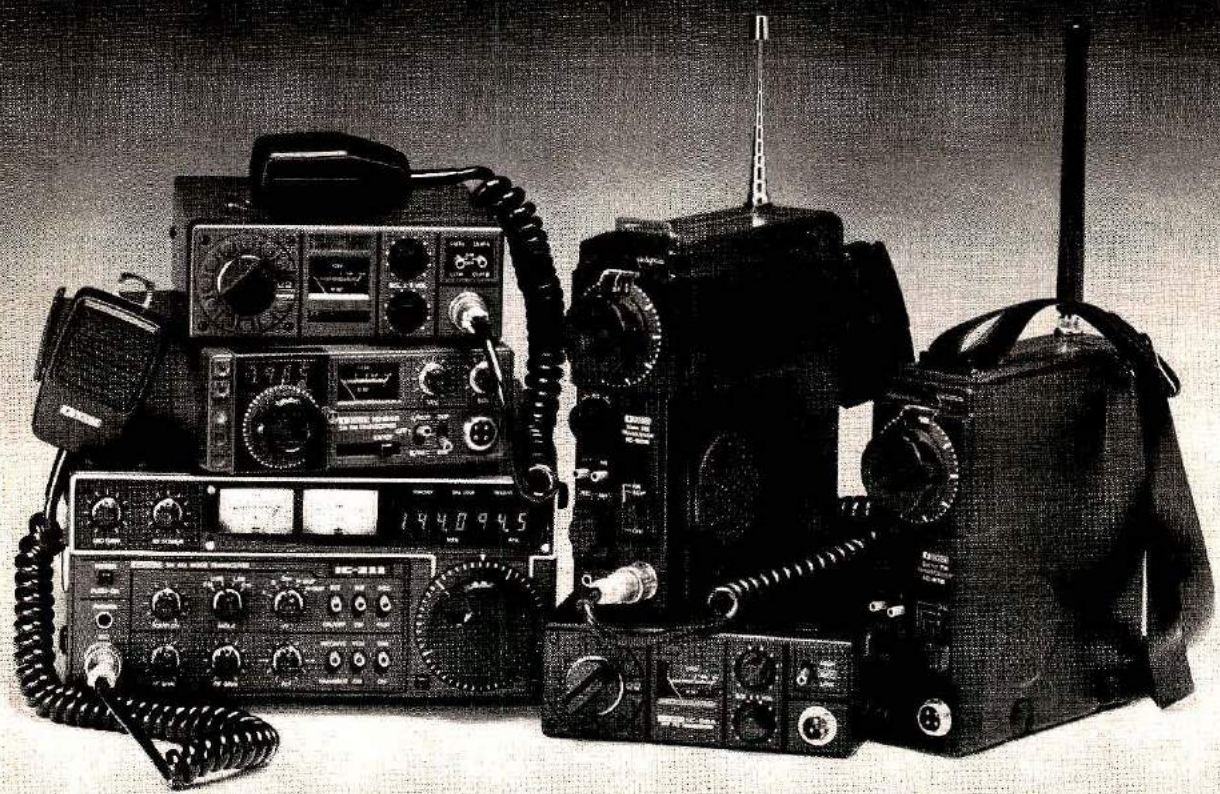

Clockwise from lower left: **IC-211** 4MHz, 2 meter, All Mode Transceiver; **IC-245** Mobile 2 meter Transceiver; **IC-22S** Mobile VHF FM Transceiver; **IC-502** Portable 50 MHz SSB Transceiver; **IC-215** Portable 2 meter FM Tranceiver; **IC-30A** Mobile UHF FM Transceiver.

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NEWSLINE

SUSPENSION OF FCC LICENSE FEES went into effect January 1. The fee suspension applies to all FCC licenses — Broadcast and Commercial as well as Amateur and CB; the result of a court decision in a suit brought by cable TV and other interests who had charged that the FCC's fee structure was arbitrary and thus improper.

Duration Of Suspension will probably depend on Congressional action, but could favorably affect the growth of Amateur Radio. Until the matter has been settled permanently, do not send any money to the FCC when applying for a new Amateur or CB license, or when renewing an old license.

"INSTANT UPGRADE" will finally become a reality and give the Amateur who successfully passes an exam at an FCC Field Office his new privileges immediately. The temporary authority is to be issued on the spot by the examining Field Office, and will be good for 90 days or until an upgraded license is issued. It will require the user to indicate his "interim" status with a special identifier added to his call, and will probably go into effect in the next few months.

AUTOMATIC LICENSE EXPIRATION REMINDERS for CBers are being considered by the FCC according to an item in Communications Retailing. The reminder, to be mailed 2-3 months before license expiration, would include a renewal form; a free service which ham radio has provided Amateurs since 1974.

REQUESTS FOR MULTIPLE NOVICE exams must be accompanied by the name and necessary qualifications of the person (or persons) planning to administer the exams, names of the individuals to be examined, and the date you expect to administer the exams. FCC reports they've been getting a number of exam requests such as, "I'll need a dozen or so exams in the next six months," which they've had to reject.

CW COMPREHENSION EXAMS are still in the future for most Amateurs, despite item in January 73 that they'd be available in January. The multiple-choice CW tests are being given in FCC's Washington Field Office, but won't show elsewhere for months.

PROPOSED FURTHER DE-REGULATION of the Amateur Radio Service emerged from the FCC in the form of Docket 21033 which would revise Part 97 of the FCC Regulations to permit repeater, auxiliary, and remote control operation of Amateur stations under Primary, Secondary, and Club station licenses, and to discontinue the issuance of separate licenses for such operations;

Delete the requirement that the transmissions of so-called "open" automatically-controlled repeater stations be recorded and the recordings be retained for a 30-day period, and making minor revisions to the logging requirements for remotely-controlled stations; and

Allow Amateur licensees greater flexibility in the choice of frequencies for repeater and auxiliary station use.

K2VN IS A NOVICE CALL issued to Chester Charles, 78, of Sea Girt, New Jersey, who held 2VN back in 1914. Since WN calls no longer exist, he is eligible for this first Novice 1X2 call.

"PERSONAL RADIO SERVICE" was the official new name of the Citizens Radio Service as a result of a third Report and Order on Docket 20120 announced December 15th. Class-D CB became the Citizens Band (CB) Radio Service, while Class A is known as the General Mobile Radio Service and Class C became the Radio Control (R/C) Radio Service.

At The Same Time Part 95 of the Rules has been reorganized into four sections, one each for the three services and the fourth a technical section pertaining to the other three.

The Names And Rules changes became effective January 27.

A NEW TRADE ORGANIZATION — the "Amateur Radio Manufacturer's Association — was formed by a group of manufacturers attending SAROC January 7-9, and a nine-man steering committee was set up to work out a detailed proposal for a broader-based trade group.

At The Steering Committee meeting, the name ARMA was selected and member classifications set up. A tentative statement of purpose, defining ARMA as a self-governing body whose goal is to promote Amateur Radio, promote high ethical standards among its membership and throughout the industry, encourage legislation and rule-making favorable to Amateur Radio, and to support its members' activities through market research, was also written. An acting Chairman, Dennis Had of Dentron, was chosen and the steering committee's statement of purpose approved.

RADIO CONTROL ENTHUSIASTS interested in sharing their knowledge and experiences should consider writing for Ham Radio Horizons. An issue with RC emphasis is being planned for later this year, and manuscripts are being solicited now.

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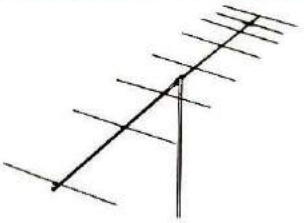

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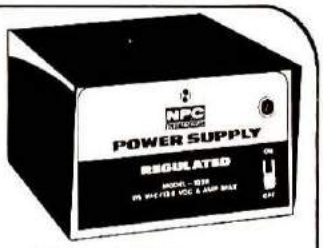

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HRH INTERVIEWS

JOHN JOHNSTON, K3BNS
Chief, FCC Amateur and Citizens Division

Last month we ended the first segment of our in-depth interview with FCC Amateur and Citizens Chief John Johnston with the first part of John's answer to the question, "Where is Amateur Radio really headed today? We've certainly got a revolution in numbers going . . ." and John was saying, "I see definite trends — some good and some not so good. The one bothering me the most is the trend by a growing number of hams to sometimes forget the purpose of the Amateur Radio Service. Ham Radio has its mission, just as the other radio services have their missions, and frequencies are allocated to each of the various services on the basis of their need to carry out their respective missions. But from the questions we receive, it seems that more and more Amateurs want to use the Amateur frequencies to carry out, or help carry out, the mission of some other service.

For example, we are being increasingly asked by hams if they can use their autopatch for business calls — like a regular mobile radio telephone system, or if they can rebroadcast weather stations and the like. These are not necessarily "bad" uses of radio — they're just *not* Amateur Radio. This trend could weaken the Amateurs' case for having their frequencies.

Just how far Amateurs can go before they bring real problems down on themselves, I frankly don't know. From the stories we hear from time to time, some hams must be very determined to find out!

Now we're seeing more and more channelized operations . . .

Whether these trends will lead to something that still can be clearly recognized as Amateur Radio remains to be seen, but what hams should remember is that there are limits, or it simply won't be Amateur Radio.

HRH: Where do you think those limits lie?

John: Hams often ask me that question, and I'm really the wrong one to say. That may sound strange, but my experience is that every time we try to set limits on the Amateur Service, some hams seem to miss the whole objective and concentrate on testing the new limits, trying to find loopholes. It would be far better for Amateurs to recognize their responsibilities, to develop their own "code of ethics" they want to have their service judged by, and to promote self-enforcement — such as they are doing with their Official Observer program.

Another trend I see developing is the growing need for better spectrum management by hams. Historically, Ham Radio was something done during free time. It was one operator talking with another on frequencies selected at random, from those available at that particular time. Now hams are moving more and more to channelized operation — and I'm not only talking about repeater stations — where systems monopolize a channel practically continuously, often 24 hours a day, 365 days a year. There is nothing wrong with this situation *per se*, in fact, there are a great number of advantages to channelization. The problems arise when someone doesn't think he is being treated fairly by other Amateurs.

In the early days of repeaters, for instance, hams had some "repeater wars," but — with few exceptions — they have worked out their problems in a cooperative fashion. If Amateurs could now come up with a good spectrum

management system which further extended this cooperation between hams, so repeaters could be set up in a complimentary way, there would be a basis for backing off on some of the coverage restrictions. The system would have to be one that gave everyone the chance to have his case heard, and resulted in fair decicions everyone would agree to abide by.

HRH: In other words, you're suggesting that repeater councils should take a broader look at the potential repeaters have, and work systematically toward, for example, state-wide repeater coverage, instead of simply being a conflict preventer or resolver in the case of competition?

John: Yes, something on that order. But remember, there are other types of Amateur stations and operations that could benefit by this approach: networks, bulletin stations, control station, link stations, and possibly a few others.

HRH: Does that mean you endorse the proposal that Lew McCoy and the ARRL made recently for a national repeater coordinating program?

John: Not exactly. They were taking a different approach to making the system work. I understand they were talking about making coordination a condition of license grant. That isn't very practical in Amateur Radio, where the hams already have their licenses. Ideally, it would be a voluntary, cooperative arrangement between hams, but it might have to be a rule requirement if it was absolutely needed. The traditional "listen before you talk," and "first come, first served" method is still a pretty good system for casual and non-channelized operating. Rule 97.63 permits any Amateur station to be on any frequency within any Amateur band, subject to the control operator privileges. It might be expanded to require coordination with everyone else in the coverage zone also having access to a particular channel in the event someone wanted to use it for a prolonged period. The coordination work could be done through the Amateur councils.

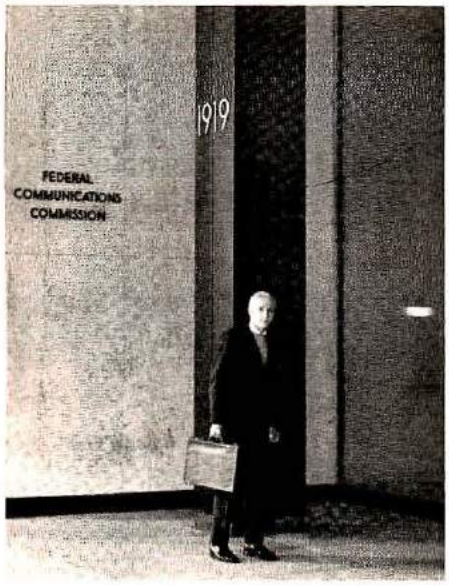
If hams abandon these objectives . . . in favor of others, then the service itself could no longer be justified on that basis.

I realize that a good spectrum management system would take a lot of effort on the part of the hams. First in developing the system, and then in making it work. It could go beyond vhf and uhf, into hf. It would meet some tough challenges. For example, W1AW transmits ARRL bulletins and code practice. Several channels are used for extended periods. I think they do it in a responsible way; they publish their schedules and frequencies in advance, and carry out an organized program designed to assist Amateurs. Most Amateurs apparently accept the program and concede the channel. A few others do not, and don't seem to be able to express themselves any better than venting their displeasure over the air. *That is not good spectrum management.* Another example of where Amateurs need better spectrum management is with some of the hf networks. They monopolize a channel over a very wide area, for whatever purpose they have, often for extended periods of time. Other hams, not part of the net, concede the channel and go on about their operating elsewhere, while a few challenge the net by making mishief on the channel. *That* is *not* good spectrum management. Sometimes one or both sides come to us and want the government to step in. That can be a very expensive undertaking, and one that gives Amateur Radio a black eye. Hams must develop better ways to work out these conflicts themselves, *off* the air.

HRH: Do you see the Commission taking any action on the commercialism issue in the near future?

John: That would depend upon a number of factors. Remember, I am talking about trends and what can be done about them. Amateur Radio is to be a service of self-training, intercommunication, and technical investigation carried on by Amateur Radio operators, that is, by persons interested in radio technique solely with a personal aim and without pecuniary interest. If hams abandon these objectives, as spelled out in Part 97.3 of the Rules, in favor of others, then the service itself could no longer be justified on that

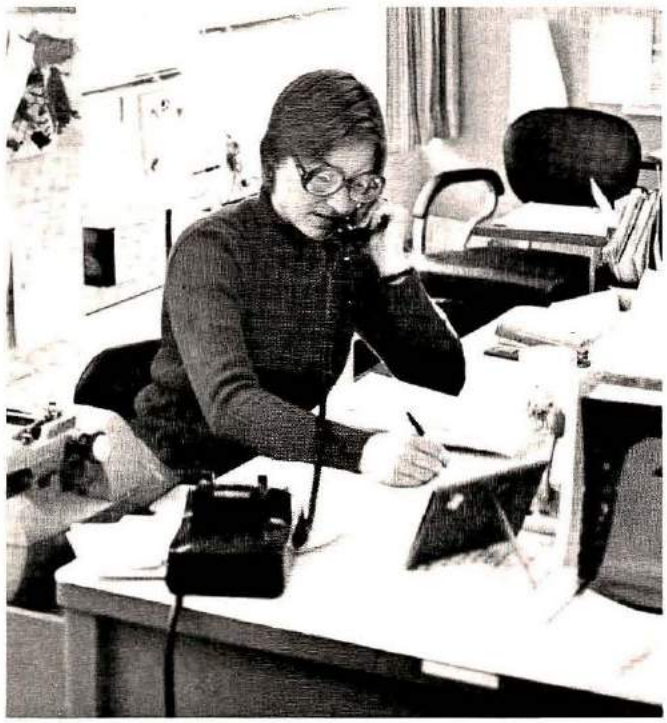
There it is, 1919 M Street, N.W. Skip Tenney, Publisher of *ham radio* and *Ham Radio Horizons* paused briefly to look our way before continuing to the meeting and interview with K3BNS.



basis. For example, if Amateurs use their frequencies for commercial local calls via autopatch, or long-distance business calls via phone patch, they're jeopardizing their own service. Other services will say, "Let us have these frequencies for commercial traffic since that's what they are being used for."

HRH: So far you've touched only on the negative side of Amateur Radio. What do you see as being positive in Amateur Radio today?

John: Taking the broader look at Amateur Radio, it is certainly meeting the objectives spelled out in Part 97.1 of the Rules. Probably much more than most people realize — including the hams themselves. There's no question that Amateurs are providing emergency communications — the floods in Idaho and Colorado and the earthquakes in Italy and Guatemala are very recent demonstrations of that. Amateur Radio is also advancing the radio art. It's also improving the participants' skills — just go to any hamfest and sit in on the technical sessions, or note the increasing participation of Amateurs in technical activities at IEEE meetings. They're growing in numbers, too, increasing the nation's pool of technically trained people. They must be doing things right in the field of international good will because the Amateur population is rising world-wide. Even before joining the Commission, I thought Amateurs should develop a more comprehensive award system that covered all five objectives of the Service. If properly designed, such a program could channel all Amateur activity into recognized productive directions, and provide hard data on what was being accomplished.



"Most of the contacts we have with Amateurs are in the form of complaints or requests to change the rules . . ." Gail Dinwiddie could probably write an interesting chapter about that! As John said in the first part of the interview, "We're trying to upgrade all our bulletins, issue more news releases and Public Notices, attend more affairs, where we can present our story and meet with people."

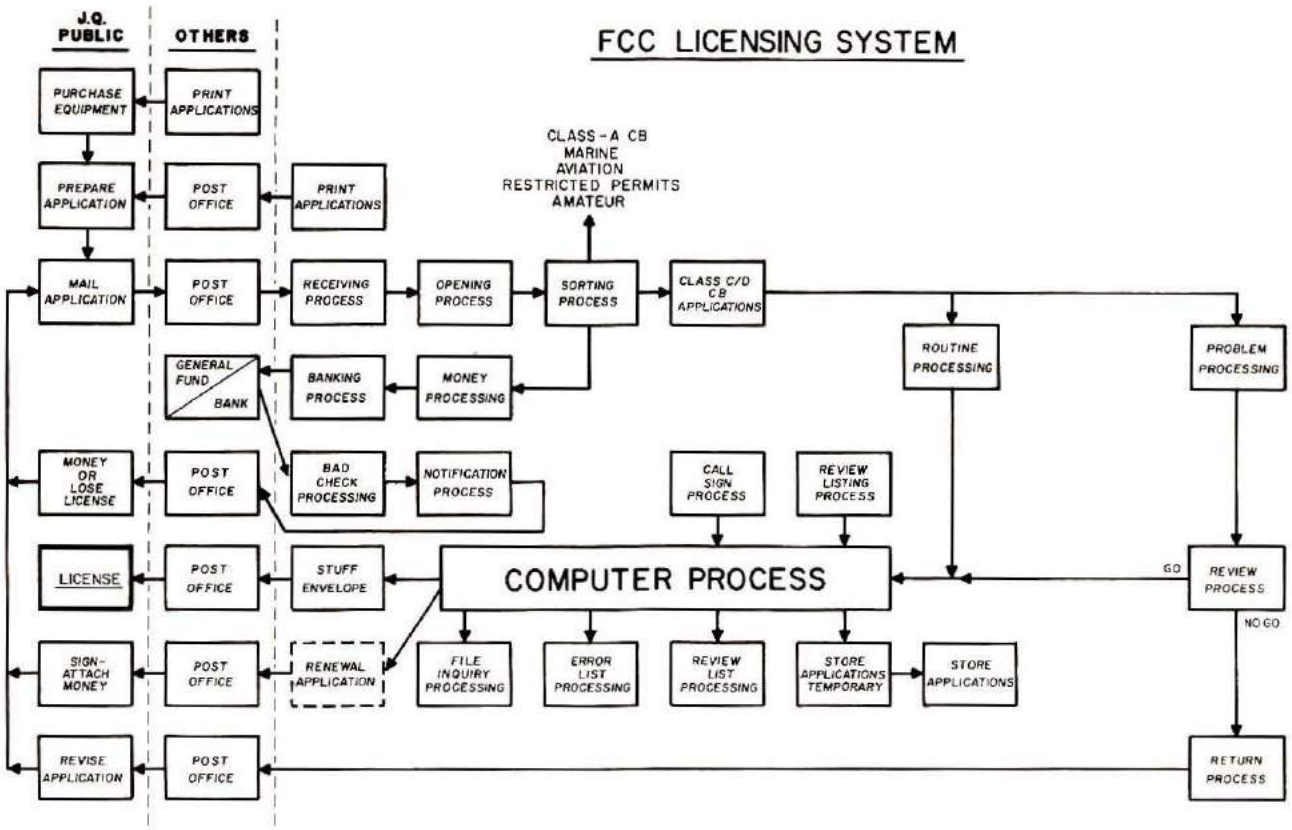
Most of the contacts we have with Amateurs are in the form of complaints or requests to change the Rules, or stories of wrong doings, so I don't think our viewpoint is the best one for a positive view. But I feel Amateur Radio is carrying on its heritage of appealing very strongly to the technically inclined. It continues to have an excellent reputation throughout most of the Commission for causing very little trouble, and for effective self-enforcement. From what I've observed at hamfests and conventions, I know Amateurs have some very enthusiastic, dedicated, resourceful, and talented people in their ranks.

HRH: We've heard a lot of talk that the day of the basement inventor is past and, with it, that the Amateur is no longer a significant contributor to the communications art. Most, if not all, "far out" electronics research is being done in expensively equipped commercial labs with highly sophisticated staffs. Do you think the Amateur is still capable of making significant technical contributions?

John: Yes, I do. Programs like OSCAR . . . people just can't get over the Amateur fraternity constructing and operating a pair of long-lived satellites.

Then amateurs got involved and soon were demonstrating very practically what repeaters really were capable of doing.

Amateurs are finding applications for microprocessor technology, making things simpler and more practical. Though it's true it is in the labs where much of the R&D work is being done, there are still a lot of areas where Amateurs do a great deal. The Amateur's *forte* is doing things pragmatically



This flow chart will provide some insight into the steps that must be carried through before a license can be issued. By comparison to this chart, the effort required to fill out an application form is minor. Even the shortest route — an application with no errors and a proper fee — must travel a lengthy road to get to that final box marked "License."

— repeaters are a good example. Commercial repeaters were around a long time before Amateurs got involved, but as soon as they did they were demonstrating what repeaters really were capable of doing!

HRH: Speaking of growth, what do you in the FCC project as the size of the United States' Amateur community in the next five or ten years?

John: We haven't come up with a way to project growth other than by extrapolation, and during the past few years the trend was headed downward — losing Amateurs at a rate of about 350 a month. Recently that trend has changed sharply upward. I was helping give exams at a hamfest recently, and the examiner remarked that Docket 20282, Restructuring, must have reminded hams about the importance of upgrading, since their office had been swamped with hams wanting to take the exams ever since the proposal came out.

The League's training program has spurred interest, as have the many individual club training programs. It's easier today to find a place to get help in getting an Amateur license than it ever has been before, and the quality of the training is improving. We can't overlook the spillover from CB, which has made people more aware of the interesting possibilities of two-way radio.

There's a very definite change in attitude, and it's not just because of WARC or the spectre of WARC . . .

There are a number of factors involved in Amateur Radio's growth, and we really don't know whether what we're seeing is for the long term or just a short-term burst.

HRH: Do you sense a change in attitude in the Amateur community itself toward potential hams? Just a few years ago it was quite common to hear a complaint from a would-be ham that local Amateurs or nearby ham clubs were indifferent or even negative toward his desire to become a ham.

John: There's a very definite change in attitude, and it's not just because of the World Administrative Radio Conference (WARC), or the spectre of WARC. That's part of it, of course, but hams as a whole — the active ones — are definitely more open to newcomers than they've ever been before. The phenomenal increase in club sponsored and operated Novice training programs proves that!

(To Be Continued)

TWO WATTS ON THE "ISLAND IN THE SUN"

BY DOUGLAS A. BLAKESLEE, W1KLK

A small radio goes a long way — physically and electronically — and we learn how to be a DX station.

DX! No other term in the ham vocabulary conjures up such visions: Faraway spots, pileups of stations calling the rarest of the rare, great DX contests. Until recently, for most of us, it was only a dream to think about changing places with an operator in some exotic location. Boeing started a change in 1957 with the introduction of the 707 jetliner. The world was opened to fast and easy travel. DXpeditions (amateurs traveling to rare locations and setting up a station) became a fad, then a way of life. At about the same time the transceiver — a complete radio station in a box — was introduced. Any amateur now has the opportunity, for the price of a ticket, to jet off to the place of his choice with his station under his arm.

New England in the winter can be cold, damp, dark, and otherwise miserable. On one such November evening, stuck in a traffic jam, I decided it was time for a vacation. Why not a DXpedition to one of those sunny spots in the Caribbean, say St. Thomas, KV4 land in ham lingo? That very night I called Barry Hyatt at Air/Marine Travel in Brewster, New York. While it may seem strange to call a travel agent some 100 miles away, Barry is one of the best in the business. After listening to my plans, he noted that what I wanted was a quiet spot with sun guaranteed — which would require going much farther south during December. Barbados was his suggestion. A quick check of the map showed an island 200 miles northeast of Venezuela, the outermost island in the Windward chain, ham radio prefix 8P6 in the countries list. Barry explained that the hotel rates would be lower but the air fare would be more, because of the longer distance involved. In

total, the cost would be approximately the same as going to St. Thomas in the Virgin Islands. I was convinced; after all, an 8P6 call is much more rare than is KV4.

In the traffic jam the next evening, I explained my personal DXpedition to Doug, W1CER (Now W1FB), while talking through a local two-meter repeater. After a few microseconds of reflection (perhaps while he looked at a thermometer outside his window), Doug said that he and his wife (W1CKK) would be interested in joining the adventure. After all, sun, fun, and ham radio are a tremendous combination. The idea has definite wife appeal with or without the radio.

Doug took charge of the equipment arrangements. He was wound up in QRP (low power) equipment at the time. I have the reputation of being a power nut, no doubt because of the articles that I have written about building kilowatt amplifiers. Doug suggested taking his Heath HW-7, a dipole antenna, and some spare parts. He demonstrated that it would all fit in a portable typewriter case. I admit, even after the fact, that I was skeptical that such a simple rig would be effective. But, from my years as F7DB in France, I know the phenomenonal power amplification that seems to take place when a DX callsign is used.

We're off

In just two weeks arrangements were completed, and we started. Perhaps in revenge, Mother Nature gave us a sendoff, New England style. Just as we left Hartford, a heavy wet snow started, and we slipped and slid all the way to Kennedy Airport. But, the driving problems were forgotten once we were airborne in a Pan Am 707 headed south.

It was late afternoon, Barbados time, when the plane settled down along the coral coast of a tiny island. From the window the land looked very lush and green in marked contrast to the black and white landscape we had left behind. Straight down, the many shades of purple and green of the Caribbean Sea, with coral reefs for accent, provided an inviting panorama. We could hardly wait to unpack our swimsuits. The big jet landed gracefully at Seawell Airport. The minute the cabin door was opened, we knew we were in another world. Close to sunset it was 85 degrees. As we walked to the terminal, it seemed the whole island had turned out to greet us. There was a sea of people, dressed in every color of the rainbow. To this day I don't know if they were out to greet some VIP or just to watch the planes arrive and depart.

The immigration procedures were simple and quickly dispensed with. We waited, and waited, in the main hall for our baggage. Slowly, a feeling of dread spread. Most of those who had gotten off the plane with us claimed their baggage and left. For us there was

There are many small and light-weight transceivers available to amateurs today. This HW-7, and the newer version, the HW-8 are not only fun to assemble, but also are easily carried about. With dimensions of approximately 4 by 9 by 8½ inches (10x23x21.5cm) and a weight of less than 5 pounds (2.25kg), the rig can be tucked into luggage or a typewriter case with room to spare for accessories as was done on this trip to the Island in the Sun.

After leaving the snow and ice of New England, not even the thrill of being a DX station could keep us from the beaches and sun (*photo courtesy Barbados Tourist Board*).

Sugar cane is the main occupation and product on the island. Evidence of growing, cutting, and transporting it can be seen everywhere (*photo courtesy Barbados Tourist Board*).

nothing — no clothes, no radio. Checking with Pan Am ground personnel, we found our baggage had probably gone to Trinidad, although they weren't sure. That's a good DX spot too, but not the one we had in mind. So, we spent an hour filling out missing baggage reports, a kindergarten show-and-tell exercise where you are shown line drawings of various bags and asked to point out what was yours — *was* being the right term. Trying to explain a Heath HW-7 CW transceiver in a typewriter case proved impossible, adding to the frustration.

Doug and I left the terminal severely depressed. We could make do on a Caribbean isle with no clothes — we had already agreed to buy new bathing suits and live in them — but to have no radio was unthinkable. My wife said, "Cheer up, things could be worse." And it was just so: Things got worse. Barry had arranged to have a car meet us. But, the fellow must have given up while we waited for the baggage, so we took the first available taxi. As we left, so did the masses, on foot and by car. We "flew" out of the airport gate, straight into another car. Without the crowds, it would have been a serious accident. Fortunately, there were too many people on the road for the taxi to really pick up speed. The damage was minor, but a long "discussion" ensued between the two drivers. The Bajan accent of the islanders is normally soft and pleasing to the ear. In this case the tone was reminiscent of two New York cabbies, even if we couldn't understand all of the words. Barbados is an English-speaking island — well, almost.

We're here

Finally out of the airport, we rode along in our taxi with the newly redecorated front end and side. The road was a winding lane that snaked out through fields of tall green sugar cane. Then, we circled through the outskirts of Bridgetown, the capital. First impressions were of very small wooden houses — of perhaps 400 square feet each — with gingerbread decoration, wooden shutters, and people. People everywhere: Leaning out of windows, walking in groups along the road, coming in and out of bars and stores at every intersection. Interspaced were rather elegant homes finished in white plaster, with tall, white, masonry fences surrounding them. In the dusk we thought we spotted a Mosley TA-33 beam antenna on one (later we learned it was the home of the local ham).

After a half hour of travel we were out of town and on the coast road; we entered the Parish of St. James. Barbados is divided into parishes after the fashion of the Church of England. With a quick right turn, we arrived at the Coconut Creek Club — another perfect choice by Barry Hyatt. The Club sits atop a coral bluff, a semicircle of cottages with a dining room, bar, and swimming pool at the center. The cottages are air conditioned, but the rest of the facilities are open air. The light tropical rains come straight down, so all you need is a roof over your head. A private sand beach, also semicircular, lies some 60 feet below the cliff. Coconut Creek is named for a wash which empties off at one side of the beach. There are no lakes, rivers, or streams on Barbados. Their version of a creek is an escape route for rain water which accumulates from infrequent heavy storms. Drinking water for the island is drawn up from natural storage in underground caverns. It takes approximately 9 months for the water to filter down through the coral substrate and become available for use.

We received a warm welcome from Owen and Jean Ellison, our hosts. After a short tour of the Club, we settled into our cottage near the edge of the cliff. Each room had a private balcony overlooking the ocean. Later, sitting by the

pool, we reflected over rum punches — standard island fare, courtesy of our hosts — that even without clothes or radio gear, it was a gorgeous evening. A slight breeze off the Caribbean caused a gentle sway among the trees and the huge flowering plants. We had another, and then another rum punch, soon forgetting about our itinerant radio which was on some island, somewhere.

The next morning we were treated to one of the second wonders of the world, a Club breakfast. Before retiring one fills out a long laundry list of possible treats which contains the traditional fare plus various island fruits and local delicacies such as flying fish. Then, you enter the time you want the feast delivered. At the chosen time, a waiter appears at the door with your order, which he sets up on the table out on the balcony. That first night my wife and I had checked off everything that looked interesting.

Breakfast arrived, pounds of it. In the bright morning sun, with the temperature already up to 80 degrees, it *was* a feast. With so much to eat, it was amusing to recall stories of other DXpeditions to barren rocks where cold beans were the fare for each meal. Dedication to ham radio is a fine thing, made ever so much easier after a good breakfast in a warm climate!

We immediately noted two species of creatures who had decided to join our meal. First, a few small birds flew in. They perched on the railing and waited for a few tidbits to be put out. They were followed by two small green lizards who seemed to have suction cups on their feet as they were able to scamper up and down the walls. Never having seen such ugly creatures before — there is no equivalent in New England — we were startled by their arrival. Gradually, we found that they were very tame and quite shy. However, they readily accepted some food when it was put on the railing. Our two little guests were nicknamed Harold and Tubby Tuba (the latter was quite overweight, even for a lizard — no doubt too much Club food).

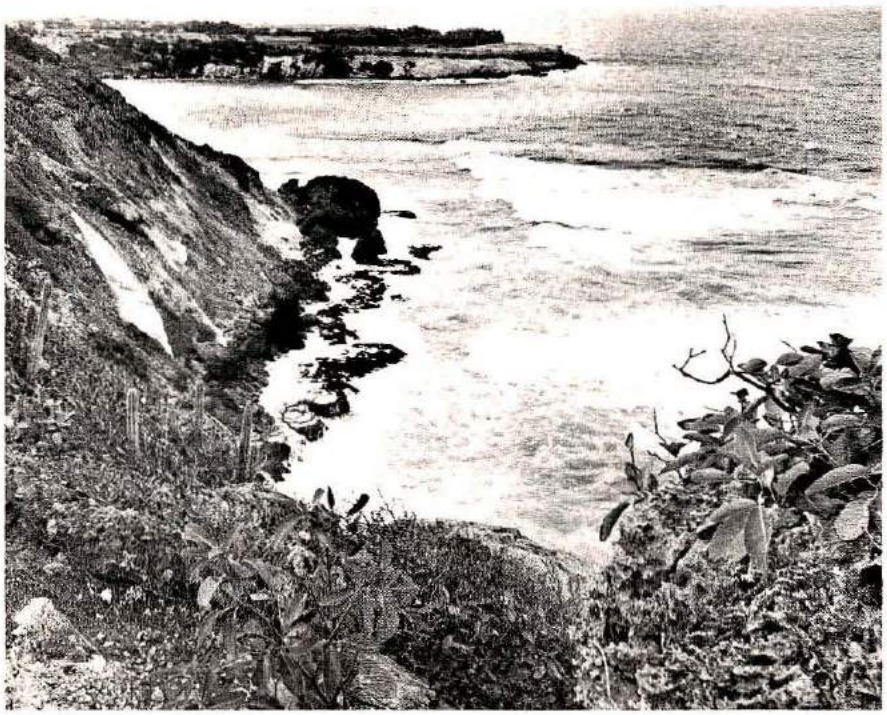
The dock area is always busy with pleasure craft and trading ships. Some interesting hours were spent on a cruise aboard the Jolly Roger (*photo courtesy Barbados Tourist Board*).

Much of our first full day, Sunday, was spent lazing about on the beach and inspecting the Club for possible antenna locations. Late in the afternoon, a truck arrived from Seawell with our clothes and the typewriter case (newly imported from Port-of-Spain). All of our earlier ugly comments about the moguls at Pan Am were withdrawn. Immediately the HW-7 was set up with a wire antenna thrown over the balcony. Signals from the Americas came pounding in. Our antenna discussions were revived in earnest, between spates of rum punches and monitoring all those beautiful ssb and CW signals.

To Bridgetown

Early on Monday morning, after a second of those breakfasts, we were off to Bridgetown in search of licenses. Following the Greyhound ad, we took the bus, which ranked as one of the unique experiences of the entire vacation. Ninety-five per cent of Barbados is black; we were the only whites on the bus. Everywhere on the island we were treated with kindness, including during our bus ride. As the vehicle lumbered along, the sights, sounds, and smells of the island surrounded us.

Bridgetown was a delight. Christmas crowds filled the narrow streets. Momentarily, we had forgotten that the holiday was so near. The raspy sound of "I'm dreaming of a Sunshine Christmas," played to the White Christmas tune, blared out of horn speakers on a large store. In the port area lay all manner of inter-island vessels; both ships and crew were picturesque sights for eye and camera. After some



At times the ham rig was turned off to allow exploration of the varied shoreline. Some of the rugged areas are in the marked contrast to the beaches (*photo courtesy Barbados Tourist Board*).

gawking about, Doug and I parted company from the girls — who went off to the stores with *BWI* clutched in hand. (Pronounced Bee Wee, the local currency is a leftover from the British West Indian Confederation.) We sought out Pat Toppin, 8P6AZ, for advice about obtaining licenses. The office of Pat's import/export business is down by the docks. He welcomed us warmly, told us what to do, and sent us off to the electrical inspector's office, in the Old Hospital Building. Current licensing procedure requires that you present a US document bearing your photograph, and your US Amateur license. The fee is $5, US. The licenses expires on December 31, and may be renewed by mail on January 1.

The licenses were issued in short order; 8P6EU for Doug and 8P6EV for me. In a sequence worthy of an old cops-and-robbers movie, Rollock, our taxi driver, was yelled at, urging full speed back to the Club.

What excitement! We raced to put up antennas, almost forgetting the girls. We climbed on top of the cottage and attached one end of our 20-meter dipole. The other end was connected to the top of a huge coral rock that was just off shore. Several guests and our hosts watched this operation; they were too polite to comment about the activities of the idiots from North America.

At last, CQ DE 8P6EV. The magic of the DX callsign entranced the 20-meter band. Suddenly, the whole world wanted to work 8P6, or so it seemed. Our life settled into a routine of beach, operating, and rum punches. The HW-7 did well. Heat was a problem, caused by the 50-Hz line voltage, so the cabinet of the power supply was removed. During the first night on the air, we had a schedule with W1FBY, who reported a snow and ice storm back in Connecticut. This report brought on a toast to all those people sliding about in the New England snow.

Off to tour the island

One day, as a break in the beach and radio routine, we set off to tour the island with faithful Rollock acting as guide and driver. Barbados is only approximately 166 square miles, most of that being sugar-cane fields. The population of a quarter million is packed into Bridgetown and a few small townships. The roads inland are very scenic — but wide enough for two cars in most places. The motorized vehicles on the roads were most impressive, many of them imported from Australia.

We drove up to one high point on the island, Farley Hill, some 1000 feet above sea level. Down a long sweeping drive bordered by royal palms, each 90 feet high, was the remains of a plantation mansion. The building had been destroyed by fire some years before. The plantation was where Harry Belafonte's "Island In The Sun" was filmed (before the fire). The movie produced a nickname that has stuck with the island; today the site is the island's first national park.

To a ham, it was an ideal radio spot. What were we doing down at sea level with low antennas? Oh, the DX that could have been worked from that hilltop with an antenna strung between those royal palms.

Rollock beckoned for us to follow him up through a grove of trees to the top of the hill. What we saw on the other side was perhaps the biggest shock of the trip. Until then we had spent all of our time on the

Caribbean side of the island, which appeared exactly the way the tourist brochures and films portray a tropical isle. Looking down on the Atlantic side was like looking into another world, which rather resembled the hills of Scotland. The coast was rocky and sparse of trees. For centuries the restless Atlantic has sent waves crashing into the shore, carving and rearranging. One large rock in the bay had been shaped like a human head, rather like the great stone heads of Easter Island.

The remainder of the afternoon was spent exploring the small farms and the coast line of the Atlantic side. There are scattered summer homes along the shore where Bridgetowners escape the heat of July and August. At dusk, we wandered through the graveyard of an old stone Episcopal church. In the center was an ancient sun dial set in a stone mount engraved with the date 1690. Looking over the sun dial, far below in a valley, was the white dome of the Cable and Wireless ground station for satellite communications. As the reds and oranges of the sunset played through the valley, we were left to reflect on time and space and the hardy Englishmen who settled Barbados three centuries before.

More hamming

Back at the rig, Doug and I took turns filling our log books. We operated at first on the porch outside his room. One morning we found two workmen replacing the palm roof of the table which sat on the outermost part of the cliff. As soon as the work was done, we moved our shack out under the palm roof. The new location featured natural air conditioning, a panoramic view of the coast, and an occasional glimpse, when not concentrating on CW, of bikini-clad surfers.

The keyer acted up from time to time. We weren't sure what was the trouble — perhaps the heat was getting to the integrated circuits. Suddenly, it was working fine. Tubby Tuba emerged from behind the rig, managing a lizard's smile. Lizards enjoy a diet of bugs, and evidently Tubby had taken care of whatever bug had been bothering the keyer. Next morning Tubby received an extra share of breakfast, which did nothing to improve his figure.

That evening we accepted an invitation to visit Pat Toppin. Although we were strangers just a few days before, we were welcomed as old friends. This special comradeship among hams of every nationality is one of the marvelous aspects of amateur radio. Set in the short hills above Bridgetown, Pat's home is an excellent radio location.

It seemed totally incongruous to be sitting on an open porch in a 75-degree temperatures talking about the hams of Barbados with a fully decorated Christmas tree behind us. Even though we had difficulty equating the tropical noises and warm winds with the holiday season, a good time was had by all. Pat described the cost of radio equipment which increases considerably in price when imported. Components are generally not available. And we thought we had problems getting parts for a project!

Upon returning to the Coconut Creek late that evening we were treated to another Caribbean spectacular. A storm far off in the Gulf of Mexico was kicking up the water. Breakers were rolling in, white mountains illuminated by the full moon as they raced across the bay. We sat on the porch and wondered at Nature's mighty display.

And home

As with every vacation, it was over all too soon. Rollock drove us to the airport. Yet we knew we had found a second home. The Ellisons asked us to return again. Our licenses could be renewed each year by mail; 8P6EU and 8P6EV were not to be silent keys.

New York was even worse than expected. The snow and cold that W1FBY had reported was everywhere. You notice a 65-degree drop in temperature. Waiting for our bags and the well traveled HW-7 at the Pan Am terminal, Doug and I looked at each other and said, simultaneously, "Where can you get a good rum punch around here?" **HRH**

At the keyer 8P6EU answers a station in Japan — not bad for two watts.

Exploring the 1750-Meter Band

At Frequencies Below the Broadcast Band a Little Power goes a Long Way, and Experience Teaches You What Can or Cannot be Done... and Why

BY KEN CORNELL, W21MB

The 1750-meter band may sound "far out" to an average ham who is oriented to high-frequency operation, but I am one of many experimenters who for years have been legally exploring the use of low-power transmitters and mini-antennas on frequencies between 160 and 190 kHz!

Subpart E of Part 15 of the FCC Regulations covers low-power communication devices. Section 15.201 deals with frequencies of operation which include [sub-section 15.201 (a)]: 10-490 kHz, 510-1600 kHz, and 26.97-27.27 MHz.

Section 15.202 governs the radiation limitation below 1600 kHz and states:

"A low-power communication device which operates on any frequency between 10 and 490 kHz or between 510 and 1600 kHz shall limit the radiation so that the field strength does not exceed the value specified in the following table:

Frequency (kHz)	Distance (feet)	Field Strength (μV/m)
10 to 490	1,000	$\frac{2400}{F(kHz)}$
510 to 1600	100	$\frac{24000}{F(kHz)}$

Section 15.203 specifies an alternative (to field-strength measurement) requirement for operation on frequencies between 160 and 190 kHz, and states:

"(a) The power input to the final radio frequency amplifier stage (exclusive of filament or heater power) does not exceed one watt.

(b) All emissions below 160 kHz or above 190 kHz are suppressed 20 dB or more below the unmodulated carrier.

(c) The total length of the transmission line plus the antenna does not exceed 50 feet."

One watt of input power may not sound very encouraging, yet many amateurs run less power to QRP rigs and enjoy success, particularly when their "flea-power" transmitters are connected to efficient antennas of one-quarter or one-half wavelength, or to directional antennas.

The 50-foot (15.2m) antenna restriction (including the transmission line) is tough to swallow, because even a quarter-wave antenna for 160 kHz would be over one-quarter of a mile long! In spite of the 50-foot antenna handicap, many CW contacts on 1750 meters have been made over distances of 100 to 300 miles (160-480 km). Single or double sideband, suppressed-carrier, voice transmissions show promise at 30-mile (48 km) distances and, on a-m, I would consider anything over 2 or 3 miles (3-5 km) real DX.

The receiver

The first requirement (to keep the horse before the cart) is a sensitive and selective receiver. Most of the better amateur communications receivers will meet this requirement but don't ordinarily cover the very low frequencies, so a logical next step is to use a communications receiver with a low-frequency converter. Many converters for low and very low frequencies have been described in various radio publications.[1]

The antenna

Since there are no restrictions governing the length or configuration of your *receiving* antenna, use one that will provide the best signal-to-noise ratio. This means that you should put it as high in the air and make it as long as possible, within reason. One of the major annoyances with low-frequency reception is man-made noise, *i.e.*, radio-frequency interference produced by such things as light dimmers, electrical appliances and the like. In many instances, such noise is confined to a particular neighborhood, location, or other limited area. Improvement of the signal-to-noise ratio

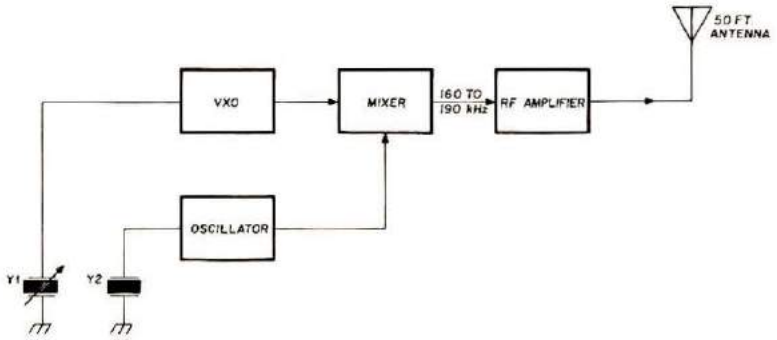


Fig. 1. Block diagram of a low-frequency transmitter, illustrating a method of using dual crystal oscillators to obtain a difference frequency of 160 to 190 kHz. Y1 and Y2 can have a fundamental frequency in the 6- or 8-MHz range with a separation of 160 to 190 kHz.

can often be made by the simple expedient of changing the location, height, configuration, or direction of your receiving antenna. Experimentation will be necessary to find the optimum combination.

If the transmitting antenna is to be used for receiving, its location is obviously very important and somewhat limited by the restrictions of *sub-part 15:203.*

I have had very good results with a loop antenna for receiving low frequency signals, specifically with the benefits of being able to rotate the loop to favor a wanted signal or "null out" a noise source.

The low-frequency transmitter can be crystal controlled or can be a self-excited oscillator type, with or without a power amplifier. A more sophisticated heterodyne oscillator configuration may be used for frequency control. The use of an oscillator alone, without a power amplifier, is not recommended because an oscillator is not as efficient as a combination oscillator-power amplifier. At low input-power levels, efficiency is paramount.

Crystal control of the fundamental transmitting frequency can be expensive because crystals covering the low frequencies needed are almost impossible to find on the surplus market, and new crystals — cut to order — cost $7.50 to $8.50 each. For this reason, a group of crystals covering the desired frequencies between 160 and 190 kHz can put a large dent in your pocketbook.

There is an alternative solution, however, to the problem of crystal control: two higher frequency crystals, separated by a frequency in the 160- to 190-kHz range can each be placed in an oscillator circuit, fed into a mixer and heterodyned to produce the desired difference frequency. The mixer-tube plate circuit is tuned to the desired operating frequency, and drives a power amplifier. My favorite transmitter uses this scheme of frequency control, but with a slight improvement: One of the two oscillators is a variable-frequency crystal oscillator which allows me to "swing" the crystal over a range of about 2 or 3 kHz. By swapping the crystals between my fixed oscillator and my variable-frequency crystal oscillator, I can obtain twice the excursion. I had an assortment of 6- and 8-MHz crystals left over from my "Gonset Communicator" days, and was able to use these for my heterodyne oscillator scheme. You can find inexpensive surplus crystals in the same frequency range. One source advertises three crystals for only $2.00. **Fig. 1** is a block diagram of my variable-frequency crystal heterodyne oscillator and transmitter.

A self-excited oscillator (vfo) can be quite frequency-stable in the 160- to 190-kHz frequency range if you use high-quality components and follow the recommended guidelines for stable vfo construction, paying particular attention to the details of mechanical construction. The balance of the transmitter can be of breadboard construction, because wire lead lengths are not particularly critical, within reason.

I have built many transmitters using a simple Hartley oscillator vfo circuit driving a power amplifier, and have enjoyed excellent results. This type of rig is probably one of the simplest you can construct, yet will permit you to move the frequency around in the band to suit your requirements.

Transverters

Another approach to low-frequency transmitter/receiver operation is a transverter; a combination transmitter and receiving converter that can be used with existing communications equipment. Many amateur rigs provide output for transverters that will extend their frequency coverage to bands not incorporated in the original design. Transverters for 2-, 6-,

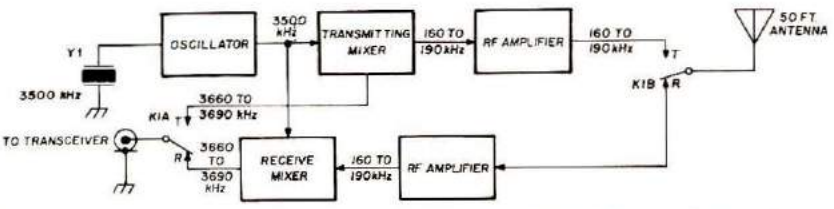


Fig. 2. Block diagram of low-frequency transverter using an 80-meter transceiver, as an example. This represents one simple way to begin experimenting in the 1750-meter band.

or 160-meter operation are common. **Fig. 2** is a block diagram of a low-frequency transverter.

Building a transmitter

Actually, I don't recall ever seeing a design for a low-power hf-band transmitter that could not be adapted to low-frequency use. Usually all that is required is to substitute components having the proper values of capacitance and inductance for resonant circuits such as oscillator and final amplifier tank circuits, and for rf chokes and bypass capacitors. A target range of values for tuned-circuit components in the 160- to 190-kHz range would be a variable capacitor of 300 to 400 pF and an inductor of 2 to 3 mH. Circuits requiring rf chokes should use values of not less than 10 mH, because the common 2.5 mH rf chokes are often self-resonant at these low frequencies. Bypass capacitors having values between 0.01 and 0.1 μF should be substituted for the common 0.001 μF capacitors found in high-frequency circuits.

Coils may be commercially available pie-wound, slug-tuned types with inductance values of 2 to 3 mH, or they may be fixed-value types such as 2.5 mH rf chokes. In some circuits it may be desirable to use coils having low-impedance taps, such as the J.W. Miller 9013 and 9014 types. I have even used a 2.5 mH pie-wound rf choke that I tapped between the first and second windings.

Coils for the final amplifier tank circuit and for the base-loaded antenna inductance can be wound on large-diameter forms such as oatmeal boxes, plastic pipe sections, plastic bottles, and the like. Forms having diameters of 3 to 4 inches (7.6-10.2cm), wound with about 250 turns of no. 24 AWG (0.5mm) wire, and resonated with about 350 pF of capacitance, should be satisfactory for most applications. It may be worthwhile to mention that it is always easier to remove turns than it is to add them after a coil has been wound. Therefore, wind your coils a bit "long" with some extra turns for later pruning. You may also want to add some taps to the tank coil to help obtain the best ratio of inductance to capacitance, hence greater efficiency.

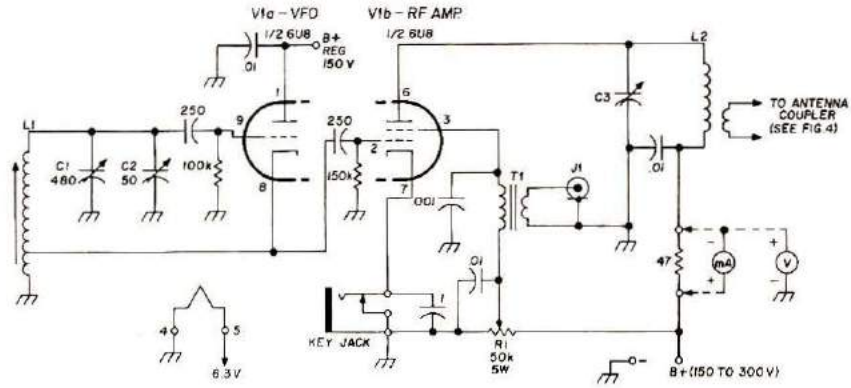


Fig. 3. A schematic diagram of a simple one-tube transmitter. This configuration uses a tube that has both a triode and a pentode within the same envelope. Types 6EA8, 6U8A would be suitable. T1 is a plate-to-voice coil output transformer that can be used to screen modulate the amplifier if desired. L1 should have a value of 2 to 3 mH. The cathode tap should be about ¼ of the turns up from ground end of L1. C1 can be a mica compression trimmer such as an Arco/Elmenco 466, or equal. C2 is for bandspread tuning, and I would suggest a capacitance of 50 pF. R1 is used to adjust the power input of the amplifier stage.

Simple one-tube transmitter

Fig. 3 shows a simple transmitter using a single dual-purpose tube of the triode-pentode type enclosed in one envelope. The triode section is used as a Hartley oscillator vfo, and the pentode section is used as a power amplifier. If desired, separate tubes can be substituted.

The circuit is straightforward, with one unique feature: R1 is a potentiometer for controlling the screen voltage, thereby allowing the plate-input power to be adjusted to exactly one watt. T1 is optional and may be included if a-m or controlled-carrier voice operation is desired. It is a plate-to-voice coil output transformer having its primary wired in series with the lead to the screen of the final amplifier tube. The output from a low-power audio amplifier can be connected to the voice coil winding of T1 to modulate the transmitter. R1 is then used to adjust the unmodulated carrier to a lower level where voice peaks will "kick it up" to the one-watt input power level. This is a simple form of double sideband a-m, and while the voice quality may leave something to be desired, it can be comfortably copied on a receiver with a bfo, or on a "sideband" receiver having a product detector.

The choice of voltage supplied to the final amplifier tube plate circuit to achieve the maximum allowable one-watt input power level is a matter of experimentation, but the following may be helpful: Years ago, I ran some tests with experimenters about 10 miles (16km) away, and we concurred that as long as resonance is maintained in the final-tank and antenna-loading coil circuits, light coupling to a final using high voltage and low current produced the best field strength and the strongest received signal.

Antennas for transmitting

Most experimenters seem to agree that the transmitting antenna should be a vertical, and have a saying: "If you can't light a neon bulb off the antenna, forget it!" To obtain this much rf voltage on a 50-foot (15m) vertical antenna, the

most common practice is to use a base loading coil and provide a good ground system, making the antenna a resonant electrical quarter-wavelength at the operating frequency. The ground system can consist of ground rods and radials, and a good base insulator must be used to isolate the antenna and loading coil from ground. Although 50 feet (15m) is the maximum length permitted for the combined antenna and transmission line, many experimenters have used 30- to 40-foot (19-12m) verticals with excellent results.

Coupling the antenna to the transmitter

Coupling must be as efficient as possible, but it is not recommended to connect the antenna directly to the "hot" end of the transmitter final tank coil, because harmonics generated by the transmitter might exceed the previously-mentioned field strength restrictions; few experimenters have the proper equipment to make accurate field-strength measurements.

A very effective coupling method is to place the loading coil and the transmitter in a weatherproof housing at the base of the antenna and inductively couple the final tank coil to the antenna base-loading coil. Any necessary power and control systems can be connected to the transmitter by cables from the operating position.

Link-coupling between two coils is preferably made by means of coaxial cable with its shield braid well-grounded at both ends, and the cable buried, to attenuate any possible harmonics. **Fig. 4** illustrates a link-coupling system.

Tuning the rig

Although some experimenters use a neon bulb for tune-up, it is not sensitive enough for the best results, and I highly recommend the use of a field strength meter. A field-strength meter incorporating a resonant tuned circuit covering the operating frequency is quite satisfactory, and can also be used to check the output frequency to be sure that the final amplifier is not acting as a doubler or tripler stage, should the wrong inductance or capacitance values have been used inadvertently. Without a field-strength meter, a condition of doubling or tripling in the final is hard to detect because the oscillator is still operating on the fundamental frequency and radiating enough energy to "fool" less sensitive instruments.

Summary

The information contained in this article is the result of many hours of experimentation by many builders, operators, and experimenters, but what might work for us may not work for you. I hope, however, that some of the basic guidelines I've covered will save new experimenters many hours of frustration.

To conclude, I'd like to say that the 1750-meter band is *not* a band for "loners." Try to interest some of your friends; they don't have to be licensed hams or CBers. Building and operating a low-frequency station is a good project for a radio club. The equipment is easy to build and tune, and when you think you've got things operating properly, it is very satisfying to be able to call a fellow experimenter on the land line — or see him in person — to check your progress. On your own private band there is little QRM and lots of fun. Good luck!

Metric Equivalents

Rather than break up the flow of the story with many parenthetical expressions, here are some metric equivalents to dimensions and measurements found in the text.

¼ mile	0.4 km
2 miles	3.2 km
3 miles	4.8 km
30 miles	48 km
100 miles	160 km
300 miles	482 km
30 feet	9 meters
40 feet	12 meters
50 feet	15 meters
100 feet	30 meters
1000 feet	304 meters
3 inches	76 mm
4 inches	101 mm

References

1. Ken Cornell, W2IMB, "Very Low Frequency Receiving Converter," *ham radio*, November, 1976, page 24.

2. James V. Hagan, WA4GHK, "A Crystal-Controlled Converter and Simple Transmitter for 1750-Meter Operation," *QST*, January, 1974, page 19.

3. William H. Fishback, W1IKU, "A V.L.F. Converter for Communications Receivers," *QST*, November, 1968; also see *Low and Medium Frequency Scrapbook*, 1976 Edition, by Ken Cornell, W2IMB, Communications Technology, Greenville, New Hampshire 03048.

HRH

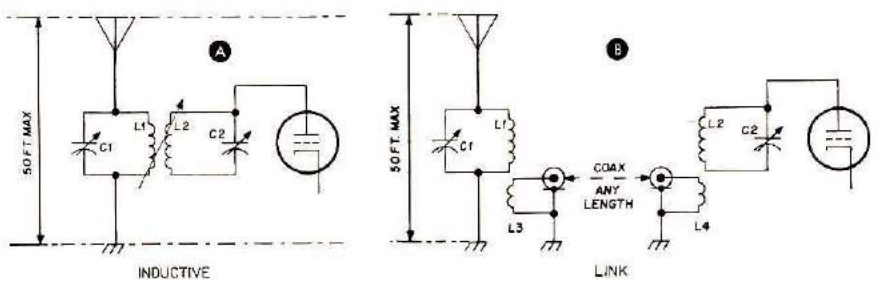


Fig. 4. Two methods of coupling the final rf tank circuit to the antenna are suggested. **A** is inductive coupled and **B** is link coupled — in any case the tuned circuit L1/C1 in series with the antenna to ground should be a resonant circuit at the operating frequency — L2/C2 in both cases is the resonant rf tank circuit of the transmitter.

Public Service... One Ham's Answer to the Portable Problem

PICON — the public interest, convenience, or necessity. With some ideas borrowed from backpackers and two-meter fm, a weighty problem has been solved

BY DICK JANSSON, WA1QLI

The first purpose of amateur radio, as stated by the FCC in section 97.1 (a) of the United States Amateur Regulations is: "Recognition and enhancement of the value of the amateur service to the public as a voluntary non-commercial communication service, particularly with respect to providing emergency communications."

Amateur radio means many things to many people and, to some, public service is the most important aspect to our hobby. Beyond this, however, *all* radio amateurs should have an awareness of public need and should be prepared to serve where possible and as necessary.

Because of their small size and versatility, two-meter fm transceivers are not only popular, but are ideally suited for emergency communication. Some fortunate hams have, in addition to their larger mobile stations, one or more small, hand-held, battery-operated units for the 146-MHz fm band. These units provide mobility far beyond that of an automobile-limited station, but for most hams there is a major drawback in owning two stations: financial resources.

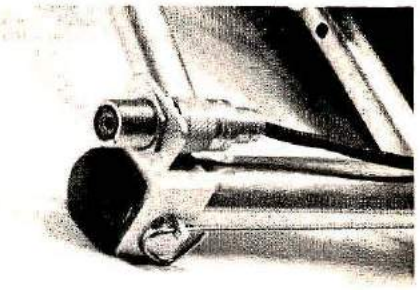
Hams who cannot afford both a hand-held rig and a mobile rig for two-meter fm often choose a mobile unit because of its usually greater power output and larger number of available crystal-controlled channels. I happen to be one of the latter group and own a Heathkit HW-202 transceiver which is a fine mobile rig but hardly a hand-held portable unit. Lacking the necessary "green stuff" to acquire a hand-held radio, but wanting to move further into public service operation, I decided to take another approach.

The photograph, showing WA1QLI wearing the backpack, illustrates my solution to the problem. I removed the pilot light from the HW-202 to reduce power consumption, but the major difference you will notice is that it is not mounted under the dashboard of my car! Instead, it is attached to a rigid backpack frame of the type intended for hikers and campers. A pair of rechargeable batteries and a whip antenna are also mounted on the frame with the transceiver, making a completely self-contained portable radio. Total weight of the assembly is only 17 pounds (7.7kg) but I was concerned initially with long usage because I have a particularly sensitive back; I wondered whether others might find the pack uncomfortable.

The unit was first tested successfully at a local county

fair in which amateurs provided support communication. Then, on the Fourth of July, 1976, the pack was used by the Amateur Radio Support Team at the Esplanade in Boston, Massachusetts, to help 400,000 people celebrate our nation's Bicentennial. This operation, in itself, is a story of public service operations. The activity called for wearing the pack for about ten hours, and I am pleased to say that there were no problems of fatigue on the part of the operator, or of run-down batteries, that would have detracted from the portable radio's usefulness and value. A recent brush with hurricane "Belle" further demonstrated the unit's versatility where it was readily moved at a moment's notice from mobile to base station and then to portable operations, serving the town of Wellesley, Massachusetts, with distinction.

If you're an enterprising amateur who might wish to duplicate this rig, or just borrow some details from it, here are some pointers. Don't skimp on the backpack frame. It must be comfortable to wear and should be made of metal, but it doesn't have to be the most expensive one available to meet these criteria. I used an *EMS Heliomaster* frame, medium size, made from TIG welded 6061-T6 aluminum alloy tubing.

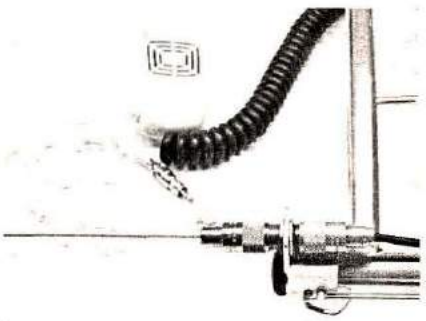


The antenna mounting bracket is made from a piece of aluminum angle stock which supports a chassis-type feed-through connector. The connector accepts PL-259 plugs at both ends.

WA1QLI wearing the backpack portable two-meter transceiver, complete with batteries and antenna. The entire assembly weighs only 17 pounds and permits operation for up to 24 hours.

When you mount your radio to the frame of the backpack, you won't want to chop a lot of holes in the frame — anymore than I did. Fortunately, the *Heliomaster* has a number of attachment pins on each side rail that can be used for mounting the transceiver, batteries, and antenna.

The close-up photograph illustrates the antenna mounting bracket made from extruded aluminum channel, or bent heavy sheet stock, secured to the top of one of the frame rails by means of one of the pins. The quarter-wave whip antenna is mounted on a chassis feedthrough connector, type UG-363/U, placed in a hole drilled or reamed in the aluminum mounting bracket, and secured in the usual manner. A PL-259 connector screws on to the feedthrough connector and provides a termination for one end of the coaxial cable leading to the rear apron of the transceiver,



The antenna is made from a piece of music wire inserted into a PL-259 plug that screws into one end of the feed-through connector. A portable radio-type earphone and microphone complete the station accessories.

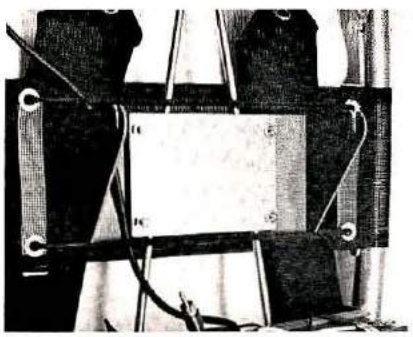
where another connector attaches the cable to the radio.

The antenna itself is made from a piece of 1/16-inch (1.5mm) diameter music wire soldered to the center pin of another PL-259 coaxial cable connector. A small spool of Lucite or similar dielectric material suitable as rf insulation is drilled and slipped over the music wire and down into the cable end of the PL-259, securing the wire in a mechanically strong arrangement. A small wood or plastic knob should be attached to the free end of the antenna wire to prevent skewering stray birds — or humans — passing by. A dab of epoxy should do the trick, or you might solder a blob of metal to the tip.

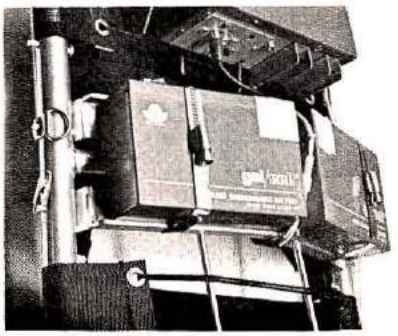
The HW-202 transceiver is very easily supported by obtaining a Heath gimbal bracket, part no. 204-1865-2, or by making a similar bracket from sheet aluminum. This bracket is attached to an aluminum backer plate with nuts and bolts to sandwich the frame braces between the two. This was the easiest part of the entire operation, and provides a very satisfactory arrangement.

Suitable support for the heavy batteries (good ones will not be light) must be chosen for security and light weight. Several configurations were tried before arriving at the one shown. Two L-shaped, extruded-aluminum angle brackets were formed with a shallow bend in the middle to allow for the curvature of the pack frame. A portion of the flange was cut away at each end of the bracket to permit bending right-angle tabs or legs for attachment to the frame side rails. The legs are drilled to receive a clevis pin that attaches the bracket to the pack frame, and are dimensioned to fit between the frame rails. The clevis pins are held in place with suitable clips or wire. The batteries are then clamped to the bracket with extra-large hose clamps, and the bracket mounted to the frame side rails. Depending upon the bracket dimensions, you will probably have to carefully drill an extra hole or two in the side rails.

Consideration must be given to the kind of equipment selected, and its power requirements, before deciding on the batteries most suitable for your application. In most instances, operations will be direct or through one or more repeaters, meaning that a synthesized rig will not be needed. If a crystal-controlled radio is chosen, current drain in the receive mode will normally be less than 100 mA. If a synthesized transceiver is used, however, current drain in the receive mode may be as much as one ampere or so. The impact on battery drain is obvious.



The transceiver is mounted on a gimbal bracket supplied by the manufacturer. The bracket is attached to a backer plate by means of nuts and bolts, with the "A"-shaped pack braces sandwiched and clamped between the bracket and backer plate. Neat and simple.



Two series-connected 6-volt, 7.5 ampere-hour batteries are attached by large hose clamps to a simple bent-aluminum bracket which is mounted to the pack-frame side rails with clevis pins. Note the fuse in the lead from the batteries to the transceiver.

The HW-202, less pilot lamp, draws about 70 mA in the squelched receive mode, and about 2.2 amperes when transmitting. If the radio is used in such a way that transmitting occupies only about 10 per cent of the entire duty cycle, the selection of 7.5 ampere-hour batteries will permit 24-hour operation per charge; considerably greater than what is available with most hand-held units! In my case, I used two 6-volt, 7.5 ampere-hour batteries connected in series to provide the power for the HW-202.

One final note connected with operation: Consider using a transceiver that you can control by touch or "feel," because it will be behind your head most of the time and it would be a nuisance to have to remove the pack just to change channels. In this respect, the pushbutton channel selector feature of the HW-202 is convenient. Also, the operator should have a small earphone of the type used with personal portable radios. When plugged into the external speaker jack of the transceiver, it permits public service operation in high-ambient-noise areas, it doesn't disturb the public, and it reduces battery drain. **HRH**

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YOUR STATION

From the Ground Up

Before you plug in your new radio there are some things you ought to know; some basic, fundamental things to improve the effectiveness of your operation and increase your peace of mind. Begin at ground zero.

BY JIM GRAY, W2EUQ

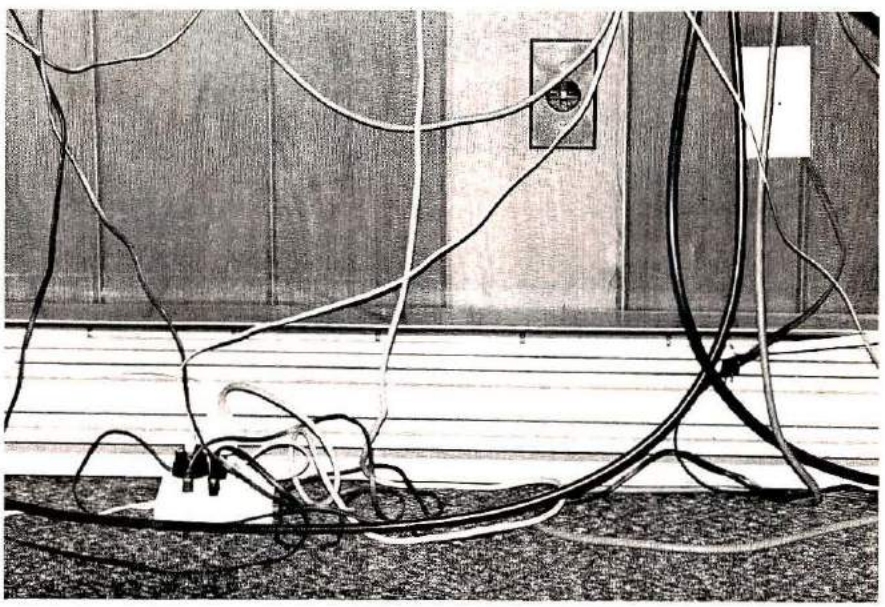
The ground system is one of the most important, yet one of the least understood, necessities for a successful radio station. Commercial stations have long understood the importance of good ground systems — both for dc and ac (rf) — and go to any lengths necessary to establish and maintain the best possible ground systems for station equipment and antennas. Amateur radio stations must also have good ground systems for safety and efficiency, but often do not — either due to the difficulty of providing a good ground in some locations, or due to the average ham's haste to put his station on the air. In some instances the licensed amateur radio operator just doesn't realize the importance of a good ground, and thinks that any old piece of wire attached to his transmitter and a copper-clad grounding stake is all that's needed. Such an assumption is wrong, and could be fatal. If you're a beginner, or even if you're an old timer, build your station from the ground up, and enjoy a long, happy and successful amateur career.

Why a Ground System?

Ground is a common reference point in electrical and electronic circuits, and ground potential means that no voltage exists between that reference point and the earth. In almost all cases, earth is taken to be "ground" both literally and figuratively, but the fact is that not all earth provides a good ground, in spite of Mr. Webster's definition. More about this later.

From the standpoint of safety in your station (we'll talk about another standpoint later) ground is very important. Like most other people, you probably want to live to a ripe old age, and a good ground will help you achieve this desire. Old-fashioned houses were wired with two-prong outlets for the ac line, one side called "hot" and the other called "ground" neutral — a misnomer. It is not really ground at all, which is why we have used quotation marks. Current enters the outlet on the "hot" side, flows through an appliance such as a toaster, an

"Rat's nest" is definitely *not* the way to wire your station. Each piece of ac-powered equipment is preferably connected to a separate wall outlet, or to plug-molding sold by electrical supply houses. Be neat, efficient, and safe!



electric iron, or your transmitter, and leaves by way of the "ground" neutral side of the ac line. The full current passed by the appliance exists in *both* prongs of the outlet. Many electrical appliances frequently, because of poor insulation and sometimes for other reasons, "leak" current between their internal electrical components and the metal cases surrounding them. This leakage current can be enough to do a great deal of damage to your nervous system and your carcass if it is allowed to flow through your body and back to real ground. The current might just prefer your short return path to ground instead of the longer one provided by the electric company through ground neutral. This is why you should never stand on wet earth, for example, and hold in your hands any kind of appliance, two-wire ac line cord, or other device connected to the ac supply. The same holds true if you are tempted to hold a "leaky" appliance in one hand and place the other on a faucet or other good conductor that might be a true ground potential. DON'T! Not any appliance, anytime, anywhere!

Contemporary or "modern" homes (**Figs. 2** and **3**) are usually wired in accordance with an up-to-date electrical code which specifies that a three-prong outlet system (**Fig. 4**) be provided for ac house wiring. Two of the prongs represent the hot wire and the ground neutral wire as before, but the third prong is directly connected to true ground (**Fig. 5A**). In the manner any appliance wired in accordance with the three-prong system would have its case at ground potential and thereby eliminate electrical shock hazard to the user — even if leakage current is present. Unfortunately, there are still many homes, laboratories, and businesses wired with old two-prong electrical outlets, and it is commonplace for people to use an adapter to convert a three-wire appliance to a two-wire outlet (**Fig. 5B**). If you must use such an adapter, be sure that the third — ground — lead or "pigtail" on the adapter is connected to true ground. The outlet box or metal enclosure is usually at ground potential, so it is common practice to fasten the spade lug at the end of the adapter's pigtail to the cover retaining screw of the electrical outlet box on the wall. Do this *first*, however, before connecting the appliance, and before plugging the adapter into the socket. Better still, have your home — or at least your shack — rewired to the three-prong system for peace of mind and safety.

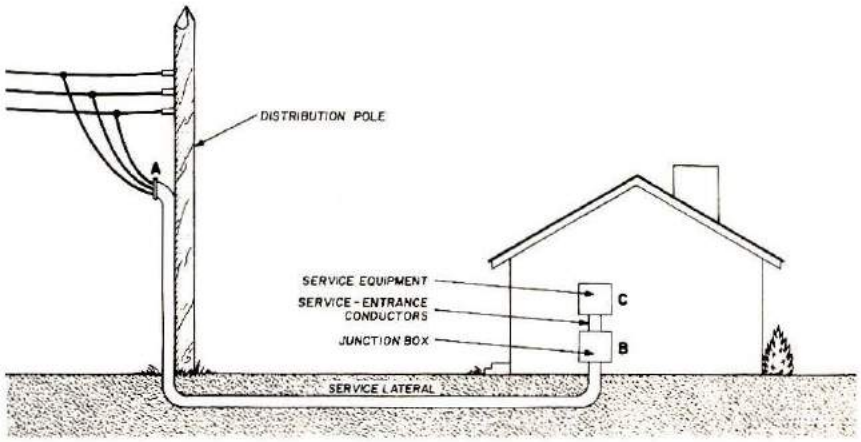


Fig 2. Illustrates an underground service "lateral" that extends between the distribution pole and the dwelling where a junction box serves as an interface between the lateral and the serviced equipment. Neater than overhead "drop" systems.

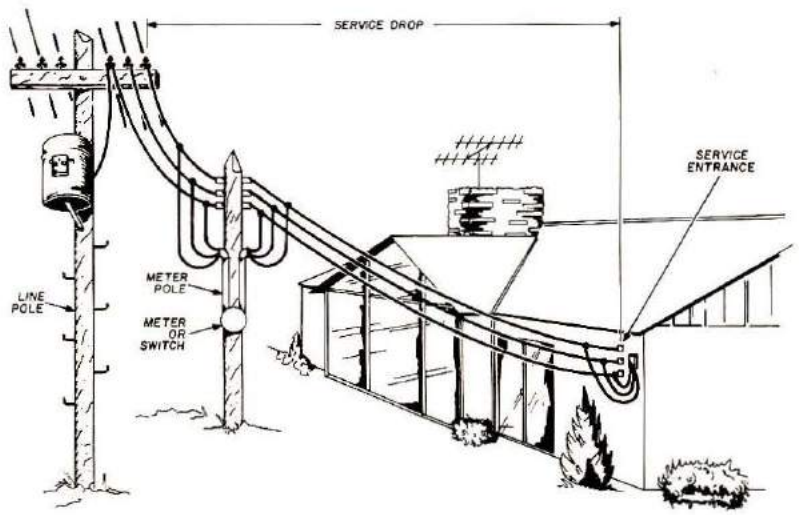


Fig. 1. Illustrates electrical service entry to a typical home. An overhead "drop" starts at the line pole transformer, extends to an intermediate pole near the house, and then runs to the house itself. Sometimes the meter is mounted on a pole as shown, and sometimes on the wall of the house.

Natural Ground — Back to Mother Earth

Perhaps the best true ground is not ground at all, but a salt water ocean or sea where electrical conductivity surpasses that of the earth, that is, common soil.

The next best ground is the earth (soil) itself — *if* it is mineral bearing, such as by virtue of containing large

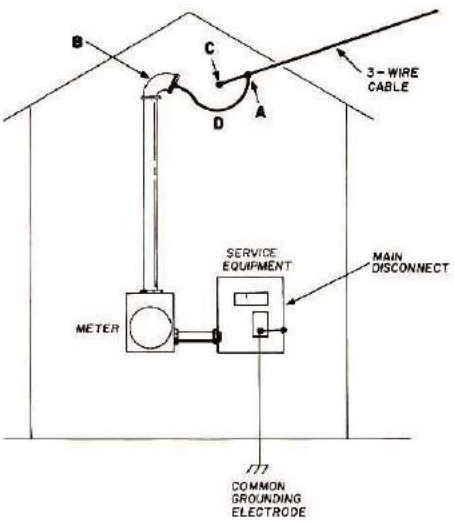


Fig. 3. Shows the more common overhead drop in greater detail. Note common grounding electrode attached to the main disconnect housing. Electrical junction **A**, protective "goose neck" **B**, strain relief tie-point **C**, and drip loop **D**.

deposits of electrically conductive metallic ore. Of about equal conductivity is soil in salt marshes near oceans and seas where the earth is moist and where the salt acts as a conductor of electrical energy.

The third-best type of earth ground is provided by soil moistened with fresh water, where an abundance of water near the surface keeps the soil damp at all times and where natural springs and artesian wells abound. Although fresh water does not ordinarily conduct electricity, leaching of minerals in the earth by fresh water often renders the soil sufficiently conductive to serve as satisfactory ground.

The poorest ground of all is dry, sandy and rocky soil of low mineral content far from natural water or moisture. Soil of this type is wonderful for drainage, but doesn't hold moisture long enough to stay moist or damp.

Blessed are the hams who live in areas where the ground conductivity is high, for their signals shall encompass the earth. Inasmuch as most radio amateurs are not so blessed, then it is necessary to simulate a good earth ground.

One way is to dig a shallow well, add a conductive mineral salt such as copper sulphate to the soil, and drive a long copper ground rod or stake into the earth, keeping it moistened at all times (**Fig. 6**). This expedient is quite satisfactory for a station ground.

Another method used by some amateurs is to make a well casing or pipe driven far into the earth serve as a ground by connecting a wire either directly to the pipe or casing at the well, or to a water pipe leading into the house from the well (**Fig.7**). One problem with this method, however, is the growing tendency among well drillers and water pump suppliers to use plastic instead of metal pipe between the house and the well.

Built-in lawn sprinkler systems serve as good grounds if you are lucky enough to have one of these covering several thousand square feet of lawn, just under the surface. You can attach your station ground wire to these pipes — if they are not plastic!

If you are building — or planning to build — a new home, it would be worthwhile to discuss the idea of building the ground system for your station right into the foundation of the structure. Copper wire may be encased in concrete with suitable conductors brought out where needed (**Fig. 8**).

Antennas and Ground

So far, we've just talked about *station* ground and how to find it for safely grounding the station equipment. There is another aspect to ground and the resistance it offers to the flow of electrical currents: Your antenna is as nearly dependent upon highly conductive ground as is the rest of your station. You can imagine that the electrons flow from your transmitter into your antenna, but what then? The antenna is part of a complete electrical circuit represented by the source of energy — your transmitter — the transmission line, the antenna, and the earth. The earth acts as the return part of the circuit for electron flow back to your transmitter. If the earth is highly conductive, with little resistance to the

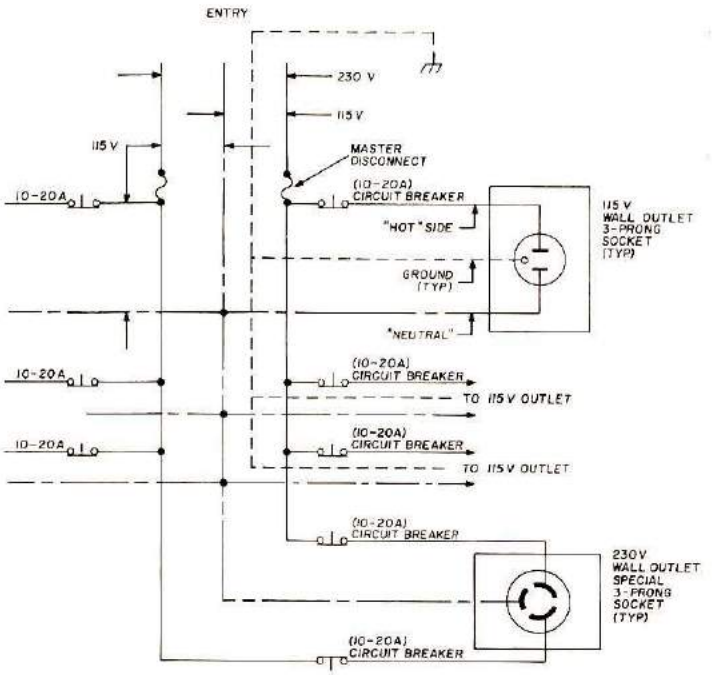


Fig. 4. Illustrates wiring from disconnect box at point of service entry to individual wall outlets. Note circuit breakers in each branch and master disconnect at point of entry. Both 115-volt and 230-volt service are provided.

flow, then only a small amount of power is absorbed by the earth while the rest is radiated. On the other hand, if the soil conductivity under and near the antenna is poor, a fair amount of your power will be lost in merely heating the soil for the worms.

Commercial broadcast stations have long recognized that power and money are interchangeable; wasted power means wasted money and — obeying an ancient dictum — waste not, want not. They install elaborate ground systems beneath and surrounding their antennas for hundreds, even thousands, of feet. These systems look like giant spider webs of copper wire and are buried just below the surface of the earth, centered at the base of the antenna tower (**Fig. 9A**). The wires are laid out like the spokes of a wheel, with one wire representing each degree of a circle, 360 in all. The wires are connected together at their common center, and to ground rods at their ends. Such a ground system is obviously expensive and time-consuming to install, but in the long run it pays off in a better signal and less wasted power.

If you live in an area where poor ground conductivity limits your station's effectiveness and weakens your signal, then it would be worthwhile to consider laying out your own "spiderweb" of ground wires either slightly under the soil or on top of the ground, if you can get away with it. Copper wire is best, but aluminum will do nearly as well. You can even use scrap wire, such as old chicken wire (**Fig. 9B**). The idea is to solder all the pieces together at several places to form a screen, or continuous mass, covering the largest area you can manage. This is most conveniently done before you put in a lawn, while building a new home, or re-landscaping an old one.

I once had the privilege of listening to a demonstration by a ham who had taken the trouble to install such a ground system under his dipole antenna and extending outwardly from it for several hundred feet in all directions. A large wire from the transmitter to this system was provided with a switch whereby he could cut the ground screen out at will, and ground his station directly to a stake. The effect was stupendous! Without the screen, his signal in my receiver dropped by at least three S-units every time he switched.

Moral: Drive as many ground stakes as you have energy, patience and money to install, and connect them to as large a ground screen as you can provide.

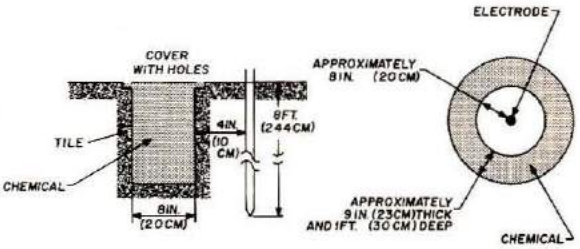


Fig. 6. A satisfactory ground may be provided by preparing a well and filling it with an electrically conductive chemical that must be kept moist or wet. Copper electrode should be replaced frequently due to erosion from chemical attack.

The Counterpoise

If the ground near your antenna is just too hard or rocky to even think of digging, try a counterpoise. This is an above-ground version of the spiderweb, where a screen is laid out above the earth — perhaps only a few inches — but insulated from it on wooden stakes and glass or porcelain insulators. The transmitter is connected to the counterpoise at the center, and usually to a ground stake at the same point. The counterpoise provides a good reflecting screen for the antenna and a low-resistance return path for antenna current. It is well to avoid an above-ground counterpoise in a populous neighborhood, but if you have plenty of land or a big vacant lot that is inaccessible to the usual kids and dogs, give it a try. Even one or two wires may be better than none.

Far-Field Effects

There's just one other factor that may be of interest, except that if you're not one of the blessed few, it won't be applicable to your station. Every antenna radiates energy into the space surrounding it, and some of this energy travels along the surface of the earth for a distance depending upon frequency and the nature of the ground. If the earth below the

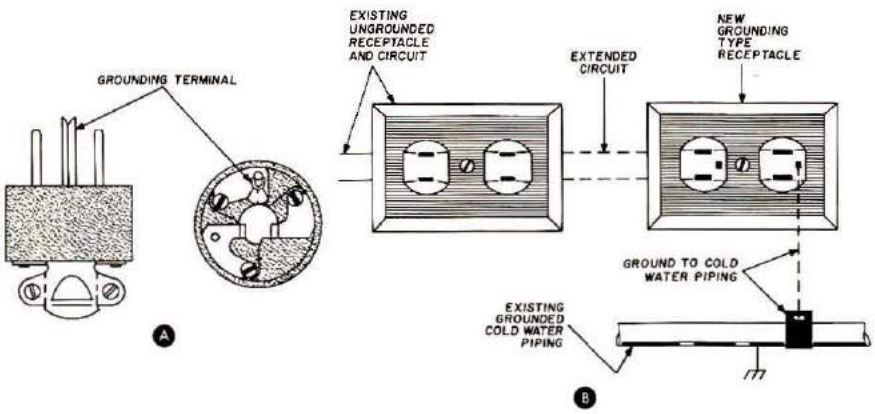


Fig. 5. Shows typical modern grounding type attachment plug **A**, with three prongs. Offset center prong is grounded. An older, two-wire system **B** without the grounding terminal may be converted to modern three-wire system and receptacle. Note attachment of the ground terminal to existing water pipe that is grounded. This system is better than using an adapter plug with a "pigtail."

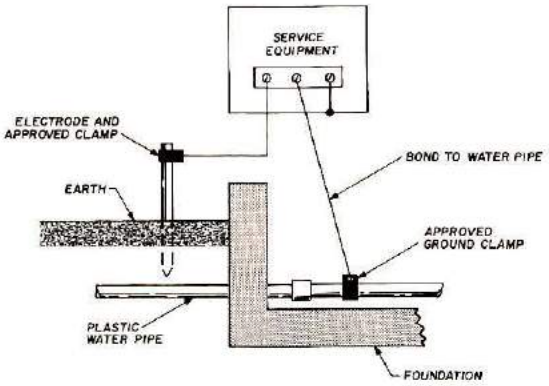


Fig. 7. Wiring system should be grounded inside to cold water pipe and outside to approved electrode, because of plastic pipe that acts as insulator. Typical of homes with pump-and-well water systems.

antenna for many wave-lengths around has poor conductivity, much of the radiated energy is absorbed. On the other hand, energy radiated by an antenna over highly conductive earth travels farther with less loss and — at the same time — is reflected skyward to combine with skywave, reinforcing it when in phase. This has the net effect of making your signal stronger, both close-in as well as at a distance.

Everything considered, there's no excuse for a poor ground system unless you prefer warming the worms to making lots of contacts.

Wires and Connections

When connecting your station to ground, it is a good idea to use the largest diameter wire you have available. For example, a good size would be equivalent to soft aluminum ground wire about one-eighth inch (3mm) in diameter. In fact, you can use the aluminum wire to connect the chassis of your receiver and transmitter together and to connect both to ground. The connections should be solid and tight, but aluminum is not easily soldered, so you will find a mechanical clamp helpful. If you connect the ground wire to a water pipe, be sure to scrape the surface of the pipe clean or use some abrasive material like sandpaper, steel wool, or the like to be sure of a good electrical contact. If you connect the aluminum wire to a copper pipe or ground stake, particularly outdoors where the joint is exposed to the weather, chances of an electrolytic reaction between the two dissimilar metals make it necessary to protect the joint by wrapping it with tape and coating it with a weather-proof or moisture-resistant compound such as silicone grease or bathtub caulk.

If you use copper for the ground wire, it can be soldered easily to a copper-clad stake or to a copper water pipe, but soldering is not usually necessary. A tight, clamped joint is usually satisfactory, but should be weather-proofed to prevent oxidation and high resistance.

Each piece of station equipment may — but need not — be connected to the ground wire. The important ones to connect to ground are transmitter, receiver, antenna coupler, and any ac-operated station accessory, such as a keyer. A good way to interconnect pieces of equipment is to use a ground "bus," that is, a single common wire strap or piece of copper pipe that runs along the back of the operating table. Each piece of station equipment to be grounded is attached by a short length of wire to the ground bus which, in turn, is connected to the ground rod or stake by a large-diameter wire or strap.

Some amateurs use copper or tinned-copper strap, of the kind that can be obtained by stripping lengths of old RG-8/U coaxial cable, to tie the equipment together and to ground. This has the advantage of flexibility, is easily soldered, readily available, and fairly inexpensive, while providing a large surface area.

Each piece of station equipment usually has a large stud or bolt protruding from the rear apron of the chassis for the purpose of a ground wire attachment. If not, one of the sheet-metal screws holding the chassis and cabinet together can be used for a ground wire attachment point. The wire is wrapped around the stud or bolt, a washer is placed over the wrap and a nut is used to secure everything in place. If braid or flexible strap is used, it is sometimes a good idea to "tin" a section of it with solder, punch a small hole in the tinned section and slip it over the stud or under the sheet-

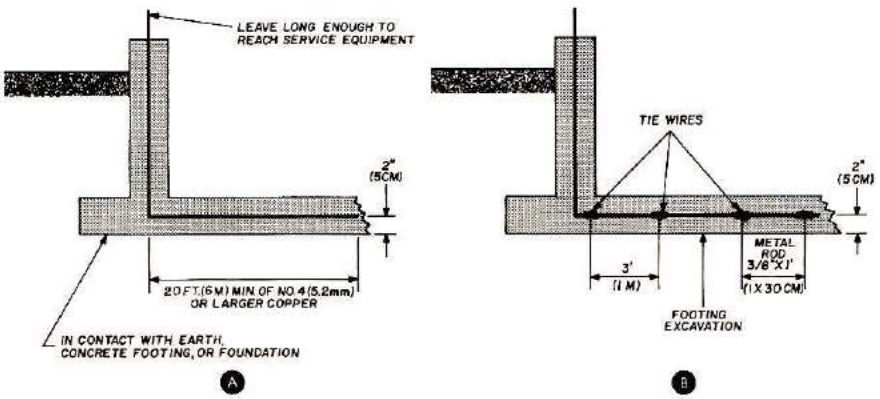


Fig. 8. When building a home, give some thought to placing ground wires in footing excavation and later filling with concrete **A.** Metal rods and tie-wires provide more ground contact area to improve effectiveness and lower resistance **B.** Use at least 20 feet (6m) of no. 4(5.2mm) copper conductor in the footing.

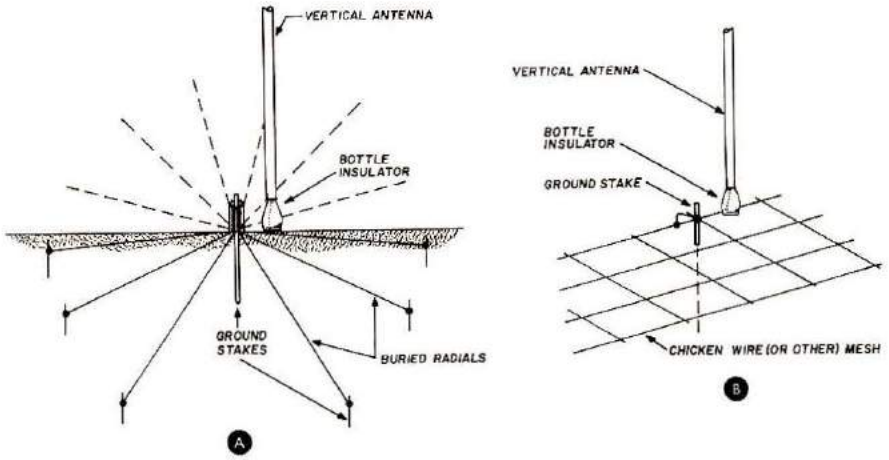


Fig. 9. Illustrates a simulated ground plane underneath the antenna, in this case a vertical. A radial system buried just beneath the surface is shown at **A**. Radial wires are connected together at center and to a ground stake driven as deep as possible. Ground stakes at ends of radials are optional. Where a buried system is impractical, place a mesh or grid of wires on top of the ground, as at **B**. Connect them to the ground stake at a point close to the base of the antenna. Shield braid of coaxial feedline should be soldered to ground stake.

metal screw. Also, you can use a variety of solder lugs to provide a convenient attachment fitting for the strap or wire.

Grounding the Antenna

If your antenna is fed with coaxial cable, an in-line lightning arrester can be used to provide a ground connection. This is merely a coaxial fitting having a built-in gap between a pair of spaced-apart points, with one point brought out to a screw terminal on the outside of the connector shell. Ordinary coaxial fittings screw into each end of the arrester, and the screw on the shell is attached to the ground wire. One popular type, manufactured by Cushcraft,* is called *Blitzbug*. If a static charge on the antenna builds up to the point where a lightning strike is imminent, the gap is jumped and the charge drained to ground.

Another useful accessory is a coaxial switch that can be used to switch the station to a number of different antennas, and, in one position, switch all antennas to ground; it is safe and simple.

If you use a single-wire feeder or an open-wire, double feedline between your transmitter or antenna tuner and the antenna, you can install a simple knife switch on the outside wall of your radio room near the entry point for the feedline. In one switch position, the antenna is connected to the station and in the other it is connected to ground. A single-pole, double throw or a double-pole, double-throw switch can be used for single-wire or twin-wire feedlines, respectively.

It is always desirable when grounding your station to use the shortest possible length of wire to minimize resistance and to prevent the wire length from becoming resonant at the operating frequency, a condition that can cause a transmitter tuning and matching problem when trying to load your antenna, and also create a source of unwanted radiation.

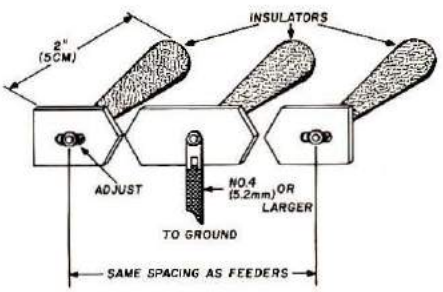
If you don't want to use the switch approach, it is possible to build your own lightning arrester gap from simple materials, as shown in **Fig.10.**

Voltages induced in radio equipment by nearby lightning can severely damage semiconductor devices. It is therefore always a good idea to disconnect the antenna from the station and ground the antenna long before an electrical storm strikes the vicinity of your home and station. A simple receiver-

Cushcraft Blitzbug® can be inserted in coaxial feedline to antenna. The shell is grounded to a good earth ground. Inside the "bug" is a gap that conducts high-voltage surges to ground without in any way interfering with transmission or reception.

*Cushcraft Corporation, 621 Hayward Street, Manchester, New Hampshire 03103.

Fig. 10. A simple but effective lightning arrester can be simply constructed from brass or copper strap material, about 8 inches (20cm) long by ½-inch (12.7mm) wide attached, as shown, to several stand-off or feedthrough-type ceramic insulators. Install the arrester outside the house on a wall or post near the point where the feedline enters the shack, and close to the ground. Heavy ground lead should be as short as possible and attached to a ground stake. The gap between the straps is adjusted so that arcing does not take place at normal transmitter power. Transmitter output is connected to feedline by way of conductors through centers of two outer insulators; ground through center of middle insulator.



protecting device is to connect a diode between the antenna terminal(s) and ground in such a way that the low "forward" resistance is between antenna and ground (**Fig. 11**). When a severe electrical surge comes in on the antenna feedline, the diode will conduct the electricity to ground and not to the rf coils and "front end" components of the receiver.

A large, high antenna will develop substantial voltages from static-electricity accumulation long before a storm, and it is therefore best not to wait until the storm is in progress before disconnecting and grounding the antenna. It is possible to get "zapped" by static charge alone if you touch the feedline with one hand and brush ground with any part of your body. Under no circumstances should you ever operate your radio station while a storm is in progress!

Disconnecting the AC Line

A very nice way to wire your station is to have a commercial "disconnect" box mounted to the operating bench, and the box itself connected to the power mains. A number of receptacles can then be run from the box and spaced along the bench or table behind the radio gear. Since the box is fused or provided with circuit breakers, you have some protection from overload. Best of all, when it becomes necessary to disconnect the station from the power lines, every piece of equipment "goes dead" when the main disconnect handle is pulled. In an emergency, this could save your life or the life of someone else.

Summary

Wire your station from the ground up, making sure you use modern three-wire outlets. Install a good ground system and connect all of your equipment to the ground by means of large-diameter wire or strap. If possible, use a single instant-disconnect means to remove power from all equipment simultaneously. Ground all antennas if there is an electrical storm in the vicinity, and don't wait until the storm hits, either! When a storm approaches, disconnect the entire station from the ac power mains. Never open a piece of equipment while voltage is applied to it, and don't use a "cheater" cord to circumvent safety interlocks. Don't ever become careless or so sure of yourself that you feel "casual" around electricity. It bites quickly and often permanently. Enjoy your operating — safely — from the ground up.

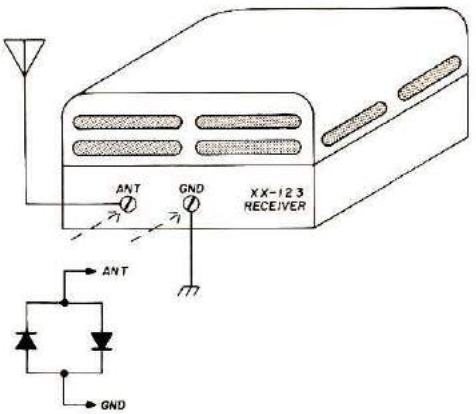


Fig. 11. Simple back-to-back diode arrangement protects receiver from lightning surge voltages by conducting them to ground, yet allows signals to enter receiver from feedline. Inexpensive diodes are satisfactory, and a few pennies spent here can save hundreds of dollars later.

Suggested Reading

The Radio Amateur's Handbook, 53rd edition, American Radio Relay League, Newington, Connecticut, 1976.

John E. Traister, *Residential Electrical Design*, Howard W. Sams & Co., Inc., Indianapolis, 1975.

Keith Henney, *Radio Engineering Handbook*, 5th edition, McGraw Hill Book Company, New York, 1959.

S. Hoenig and F. Payne, *How to Build and Use Electronic Devices Without Frustration, Pain, Mountains of Money, or an Engineering Degree*, Little Brown and Company, Boston, 1973.

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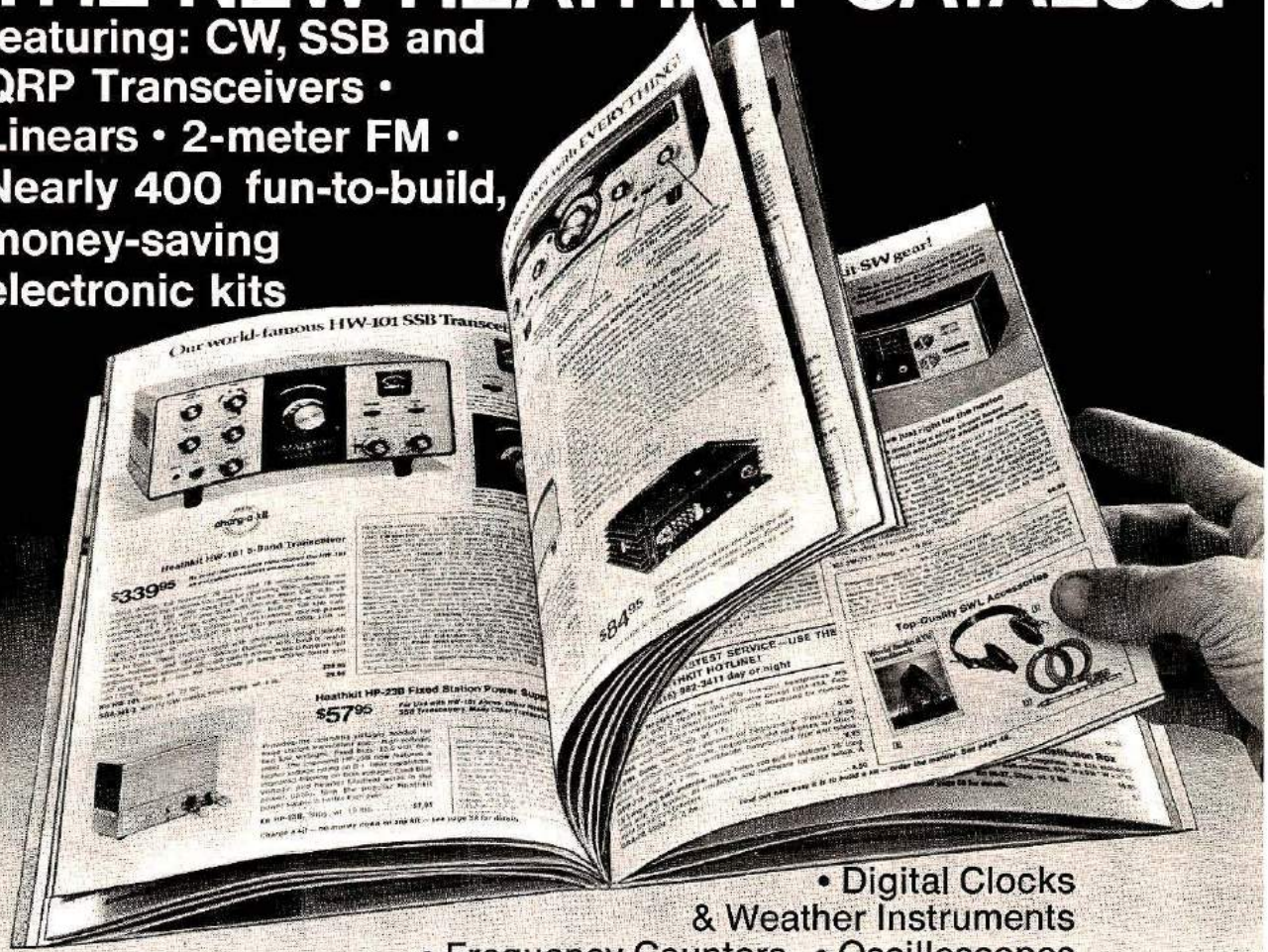

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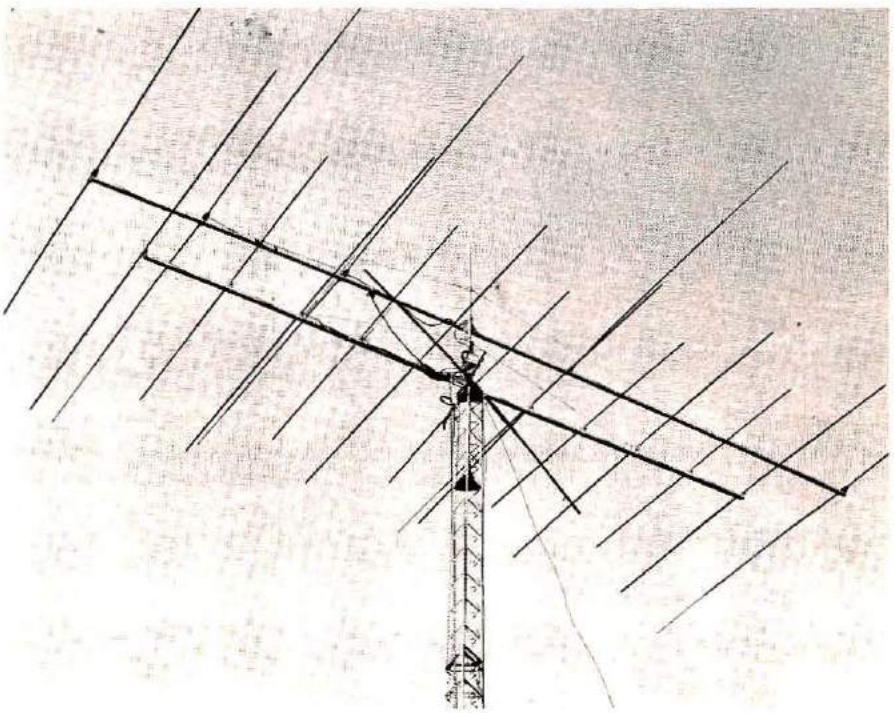
BY CHARLES CARROLL, W1GQO

To the beginner in amateur radio one of its more confusing aspects can be listening during a contest. The short, rapid-fire exchanges between operators may appear to the uninitiated to be an undecipherable jumble of information. The popularity of this type of activity is indicated by the fact that during most any weekend of the year contests can be found on various modes and many bands. By starting in the smaller ones, it may take a beginner only a few hours of operating to understand the exchanges and goals. Remember, whether it's your first contest exchange, some message traffic passed along, or a simple repeater contact, it always takes some time to practice and feel comfortable when learning new operating habits.

As more contest experience is gained, you will discover that this endeavor has many interesting facets within itself. In some ways it uses a little knowledge from many different areas. As an example, some repeaters have been installed just to allow various stations, members of the same club, to pass information. Check with a local contest operator and see which antenna he's using for 40 meters *this week*, and why. To a lesser extent, some operators have been known to change equipment between major events, seeking a way to gain a slight "edge." Find out why so many people pass through the San Juan airport, carrying radio equipment, just prior to the last full weekend in October. The answers to these questions indicate a few of the diverse areas that contesting can cover.

The basic goal in most contests is usually to contact as many different stations as possible in different areas, and thereby earn a good "score." Combinations of contacts are varied to suit the aims of the contest. There are generally at least three different pieces of information passed per contact: station callsign, report or signal strength, and location. The first two do not require much explanation; WA1KID/6 5NN (WA1KID is portable in the 6th call area, and is giving you an RST report of 599 — 5NN is a shorthand form). Information about your location will vary, depending upon the contest — "San Francisco" (for ARRL Sweepstakes), "Zone 3" (In the *CQ* World Wide DX), or "California" (for the ARRL DX Test). If you're planning a large effort in a contest, the type of exchange should be studied prior to starting time. It's not very productive to spend ten minutes trying to guess the correct exchange when, instead, you could have made fifteen to thirty contacts.

One of the towers at K6UD. This installation is a 70-foot crank-up tower supporting antennas for 10 through 40 meters. The top antenna is a five-element 20-meter monobander. Next is a 15- and 10-meter duoband antenna. The crossarm at the top of the tower supports wires that form a two-element quad for 40 meters (*photo by WA1KID*).



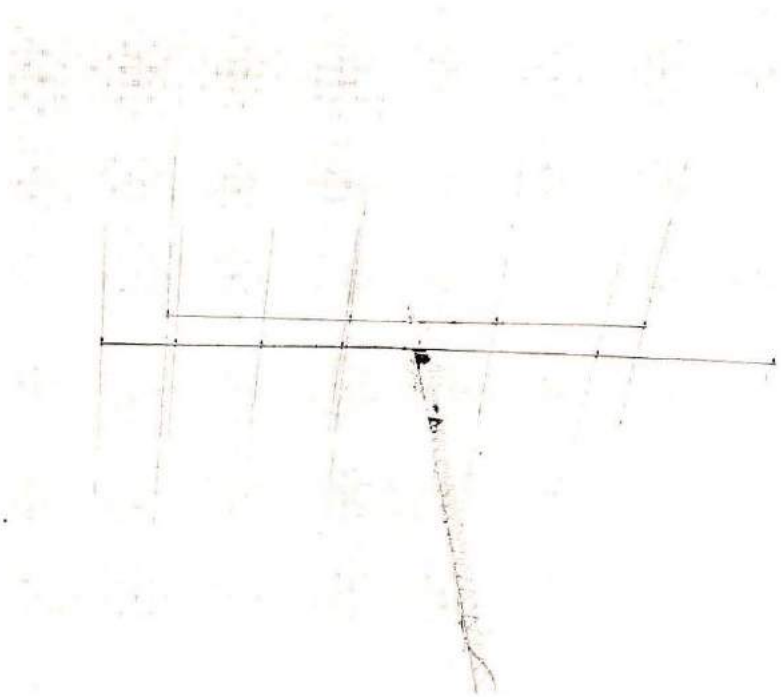
One of the "instincts" that must be developed is learning when to take times off. Some contests are just plain endurance events — you can operate as much of the allotted time as you desire. There are a few hardy souls who can operate the full 96 hours in the ARRL DX contest. But there is always a trade off between operating efficiency and the number of hours without sleep. You will have to learn to select the correct hours to sleep or rest. This type of knowledge is usually only gained with experience. Band conditions, your location and antennas, and even your competitor's performance, all play a part in deciding when *not* to operate.

In contrast to the no-time-limit contests are those that only allow a certain amount of operating time. The ARRL Sweepstakes is an excellent example. With the maximum operating time permitted being 24 out of a possible 30 hours, the proper selection of off times can be a real challenge and can make a real difference in how you "stack up." One rather well known contester always pushes hard in the beginning of the Sweepstakes. He knows that his closest competitor can be psyched out by hearing of a high contact total in the early parts of the contest (it makes him nervous and he makes mistakes). Also, be sure that you read or know the contest rules and time periods before you start; it could be embarrassing to stop operating some hours before ending time because you had it wrong.

Contest Calendar

Although you can generally find contest activity on a large number of weekends, the Winter period does seem to have more than its fair share. During the two-month period covering the last half of October through the first half of December there are six major contests. To be able to participate in all six events requires not only dedication but also an understanding wife and/or family.

Contest	Mode	Date	
Major			
CQ World-Wide	Phone and CW	October/November	Amateurs in any country can talk to amateurs in any other country
ARRL DX Contest	Phone and CW	February/March	U.S. and Canadian amateurs contact the DX countries; no DX to DX contacts
ARRL Sweepstakes	Phone and CW	November	U.S. and Canadian amateurs contact each other
Worked All European (WAE)	Phone and CW	August/September	Amateurs anywhere contact European countries
Specialized			
ARRL Field Day	Phone and CW	July	Stations set up in the field, using emergency power, to prepare for possible disaster operation
ARRL 160 Meter	Phone and CW	December	All contacts on the 160-meter band — world wide
Worked all Prefix (WPX)	Phone	March	Essentially the same format as the CQ Worldwide, but the emphasis is on different prefixes rather than on countries
Novice Roundup	CW	April	A major activity for Novices. Good for getting over "stage fright"
ARRL CD Parties	Phone and CW	October	Activity by stations that hold ARRL Official appointments
VHF Contest	Phone and CW	June, September, January	All contacts on bands above 50 MHz
Straight Key Night	CW	July 4, December 31/ January 1	
Regionalized			
There are many operating events in this category. Among the more popular are various state QSO parties; Bermuda contest; YU contest; ZL-VK contest; All-Asian; VE/W.			



Part of the installation at W6JZU supporting antennas for 40 and 20 meters (*photo by WA1KID*).

I've broken the contest listing down into three major groups. Though it is difficult to be precise, the total number of participants should be in the same categories. My apologies to those who feel I may have slighted them by misplacing or neglecting their favorite event. This article is too short and general to cover all of the events.

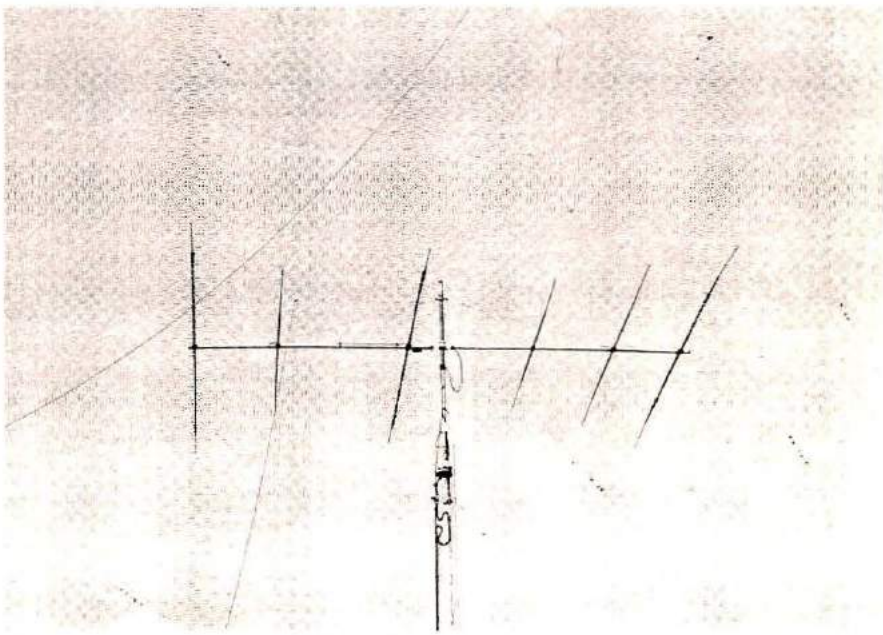
Rules and dates for these and many other contests can be found in various amateur-radio publications including the Contest Calendar in *CQ* Magazine and in the Operating Events section of *QST*. *HR Report* (published by *Ham Radio Magazine*) and *Ham Radio Horizons* also have a calendar that lists some of the more popular events. I have listed Field Day as a contest, but it is also a fun type of event. You get to share some great experiences with your friends, under conditions that simulate an emergency. The accumulation of points for score makes the event competitive and provides some pressure that makes Field Day an exercise in preparedness.

Stations and antennas

At this point you know basically what to send and when to send it. Now, with what? Probably the biggest variable in all of contesting is antennas and station equipment. Starting with the basic premise that your capabilities are ruled by the pocketbook (or your wife's budget), the equipment range can go from there. At the one end of the scale are the five-band transceivers — at the other you can progress up to a station with an individual transmitter, receiver, and amplifier for each band.

It is generally accepted that, as a minimum, if a transceiver is used it should have receiver incremental tuning (RIT). With the fixed offset between the transmitter and receiver frequency, the RIT allows you to transmit within the passband of another person's receiver while still being able to copy him in yours. The capabilities of the more expensive transceivers are certainly approaching the flexibility of separate units. With features like i-f shift, different filter selectivities, and RIT, the transceiver can be very useful as well as portable.

The separate transmitter and receiver does have much greater flexibility and usually has superior performance too. Combinations of antennas and transmitter/receivers are almost endless. You should remember that it takes a finite amount of



The short tower (60 feet) at W6PAA. The antenna is a six-element tribander (*photo by WA1KID*).

time to change bands. This time, multiplied by the number of band changes made during a contest, can be a significant amount of lost operating. This speaks well for having an uncomplicated station.

As to the number, height, and kinds of antennas — experience plays a large part. You might consider the antenna to be used with respect to the nature of the contest (DX or local). On the East coast, for example, during the ARRL Sweepstakes the emphasis appears to be on good 80- and 40-meter antennas due to the large and nearby population centers. In the same contest from the West coast, 40, 20, and 15 meters have the emphasis. Also, that big 20-meter DX array at 120 feet might be great into downtown Honolulu but the tribander at 60 feet would probably be better for Sweepstakes points. W6PAA shows this to good example in the photographs. He uses a combination of low and high antennas. Not to scare everyone off, it should be mentioned that WA1KID made some very creditable scores (top 10) with a three-band quad at 48 feet, and some wire antennas hidden among the trees at 70 feet. It certainly helps to have the resources, but it's more what you do with them that counts.

Depending on the contest, a station can be put into different classes; single operator and transmitter, multi-op single transmitter, multi-op and transmitters, or single band. Each class has its advantages and certainly some disadvantages. The beginner might find it more rewarding (and instructive) to participate in a multioperator effort. This gives you time to learn from experienced operators, under little pressure. The single operator is seemingly against the whole world. He's totally alone in his decisions and operating strategy. The multioperator stations are able to use the luxuries of repeaters and spotters. If your time is limited you will usually be able to participate in a multiop effort whereas a single-operator type of setup could be futile and frustrating.

The look of accomplishment as you beat out everyone to the new multiplier on the band. W1FLM is shown operating at the K1VTM multi-multi (*photo by K1THQ*)

One item that deserves mentioning is courtesy. This *is* competition and in the "heat of battle" tempers can get short. It's probably better to take a few minutes off than to sit and argue because someone disturbed your routine. For those people operating the club or multioperator stations, what you say may not directly reflect on you because it's not your call. It's entirely possible that you could be "not invited" for the next contest because of an inappropriate remark.

Contesting is really a large subject. This article is only intended to look at some of the basics. Nothing has been said of smaller (but important) points like memory keyers, tape loops, or Beverage antennas. A full discussion could take ten times this number of pages and then only cover half of all the tips, hints, and skills. Operating in one good contest season could enable you to learn 90 per cent of what you'll ever need to know. Oh, yes . . . as to the San Juan airport, most wives just wouldn't hold with the idea of your going on an overseas trip for a contest. Just tell her you're both going on a vacation to the Caribbean during the last weekend in October. (This just happens to be the CQ World Wide contest time and is the reason for the large amateur population in the airport). Anyway from here, in the pileups, it'll be 5NN NH DE W1GQO,QRZ?

HRH

TAKING THE MYSTERY OUT OF SINGLE SIDEBAND

A sideband receiver must have some special circuits to turn the signal into something you like to hear

BY THOMAS McMULLEN, W1SL

During the last session when we talked about ssb there was great to-do about getting rid of the carrier, and what the benefits were — chiefly the reduction of heterodyne tones and less interference. Well, now it's time to talk about receiving sideband, and I'm going to give you a little hint about how it is done: You have to put the carrier back.

Yep, that's right, after going to all that trouble to get rid of it, the receiver has to put it back if what you hear is to sound like what the guy at the other end is saying. But in order to paint a clear picture, I'll have to go back over some basic theory — like rectification of alternating current (ac). Radio-frequency waves *are* ac, and can be treated just like any other alternating current so long as you remember that the power is considerably lower than what comes out of your wall socket, and that the frequency is much, much, higher. For instance, if you have a house circuit that is protected with a 10-ampere fuse in a 120-volt circuit, you can use up to almost 1200 watts before the fuse goes away. By contrast, the voltage at the input to your receiver, even when you are listening to a guy on the other side of town who has a "bodacious" signal, is likely to be on the order of 0.002 volt! For the purpose of figuring how much power that is (so we'll not be comparing apples and bowling balls) let's assume that the input of your receiver is 75 ohms (some are and some are not). Going back to a law attributed to some guy named Ohm, we can see that Power = voltage squared divided by resistance:

$$0.002 \times 0.002 = 0.000004 \div 75 = 0.000000053333 \text{ watt}$$

That surely is not much power, so it has to be handled with care or you'll lose it. (I wish I had picked another example so it would come out even! Oh, well.)

So, back to the basics: Rectification. Detection in a receiver, such as the one you use to listen to your preferred music, is accomplished by simple rectification and filtering, just like a power supply. No, no, not fm, a-m (amplitude modulation) like I explained for the modulation process in the first place. Fm is a whole different bag of worms. In **Fig. 1** I have shown the resut of applying ac to a rectifier, and how a filter smooths the dc output. It is following the same principle that a power supply does — a diode allows current to pass in one direction only, and a capacitor stores the energy and eventually smooths the output to a somewhat constant level.

Now things get a bit more complicated when the ac has some form of amplitude modulation impressed on it. The main part (the carrier) is the largest, and most steady, but it is accompanied by the sidebands which are slightly different in frequency and are changing strength in accordance with the modulation (voice or tone).

Let's see if I can go through this slowly so you can follow. In **Fig. 1** I used an example of 10 volts ac applied to the rectifier to obtain a dc voltage of 4.5 V. (This time I'm using numbers that work out without all those 3s hanging off the end). It follows that if I increase the voltage to 20, then the dc output will also increase — in this case to 9 V. This follows well defined principles that can

be found in almost any basic electronics text. To sum up: The application of a varying ac voltage to a rectifier will produce a varying dc voltage at the output. Sound good so far? Right!

Okay, remember what I said about the carrier and its sidebands? It is a somewhat constant ac voltage accompanied by a varying ac voltage — which leads right to the point that the application of this voltage to a rectifier will *also* produce a varying dc voltage! This is shown in **Fig. 2**. There's a little trick here that I'll point out just so it will not sneak by unnoticed. The ac voltage (rf) is varying in amplitude *at an audio rate*. You can see in the drawing (**Fig. 2A**) that the lines inside the "envelope" are closely spaced, but that the envelope has the appearance of a double sine wave. This sine wave (modulation) is varying the height of the higher frequency component at the same rate as was applied to the modulator (2000 hertz if I remember correctly). It has exactly the same effect as if you had a potentiometer (voltage controller) hooked up to the rectifier and were turning the knob back and forth. It causes the dc output to vary at an audio rate: 2000 Hz.

Filtering? Um . . . yeah, I follow what you are asking. Doesn't the capacitor that filters (smooths) the output get rid of the audio? Nope! Not if you do it right. There is a little plotting and planning involved here, too. Somewhere I remember reading that capacitors have reactance (which is another way of saying that the resistance varies according to the frequency applied). Therefore it should be possible to find the right value of capacitance that would be a very low resistance for the high-frequency (rf) ac component, but has very little effect on the audio-frequency part. That's exactly what happens. A value of 0.05 μF has a reactance of 31 ohms at 100,000 Hz, but at 2000 Hz it appears to be 1600 ohms. The result is that the carrier is faced with what appears to be a near short-circuit and that is the end of that. The audio, on the other hand, looks at a much higher resistance and gets by without too much of a struggle. So, there, we've done it — removed the carrier and left the original audio to be amplified and applied to your ears.

No-carrier detection

Well, now that we have struggled through all that razzmatazz about detection of a signal that has a carrier attached to it, perhaps we can get into how to handle something that has no carrier. In one of the illustrations with the first part of this article, the sideband was finally isolated and standing all by itself at a frequency of 102,000 hertz. So let's assume that this signal finds its way to your receiver, and through the various amplifier stages inside it, and finally winds up at the detector (rectifier) just like any other ac voltage. There it is, 102,000 hertz, going into the diode, turning it on every half cycle, and dashing pell-mell into the filter at the output of the diode. The result? You get a dc-voltage output just like that shown in **Fig. 1B**! Not much percentage in that, is there? The object was to recover the audio that started this whole thing in the first place — the guy at the other end speaking into a microphone (or sending a 2000-Hz tone, to be true to our example).

Aha! Now is the time to put the carrier back in its rightful place. Look at **Fig. 3**. Seem familiar? It should because it is similar to **Fig. 1** in part one of this dissertation. If the carrier is placed just 2000 Hz below the upper sideband signal (and we will assume that we *are* talking about the upper sideband here), both important

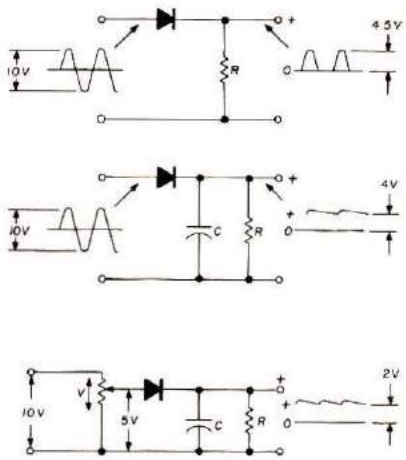


Fig. 1. The most common detector circuits in receivers are very similar to a rectifier that is used to turn ac to dc. In **A** the alternating current is applied to a rectifier, which conducts on the positive portion of the cycle. The output has no filtering (smoothing), so the resultant waveform is a series of "peaks" rising above the zero-voltage baseline. At **B** the same input waveform is applied, but the output circuit has a capacitor, **C**, to act as a smoothing filter. The waveform from this simple filter is dc with slight bumps on it where the capacitor is recharged by the rectifying action of the diode. At **C** the input amplitude is made variable, simulating a received signal that is varying in strength. The output is still "lumpy" dc, and its magnitude varies in proportion to the input.

elements are back in the picture again — a carrier at 100,000 hertz and a sideband at 102,000 hertz. The diode (rectifier) is also a neat little mixing (modulating) device, and as such proceeds to mix the two frequencies in fine shape. The sum product of the two (202,000 Hz) is very easily shunted out of the picture by the filter capacitor after the diode, which leaves the difference product — yep, 2000 Hz — to follow the same path out of the detector as did the audio component in the previous example (**Fig. 2B**).

Getting the carrier

How do you get a carrier if the station at the other end didn't send it? Had the answer right on the tip of my typewriter . . . you just include an

oscillator in the circuitry. If you make it just like the one at the transmitter end, it should provide the same carrier for your receiver as his did for the transmitter. Well, almost. You have to take into account the fact that most radio equipment is not that stable — temperature, voltage, adjustments — all of these can cause a given oscillator to be slightly different from one that is seemingly identical. Since we want the audio to be 2000 hertz and not 1980 or 2050 hertz, or whatever, the local carrier must be at the right spot with relation to the sideband. This is easily taken care of by making the oscillator variable over a small range. If the oscillator can be tuned from 99,000 to 101,000 hertz, then it is easy to see that somewhere between those two limits there is a spot where it is exactly right to hear the audio at its proper pitch. A smooth tuning control will make it duck soup . . . ah, very easy to tune in the signal by ear until it sounds right. This is especially true when you are listening to the human voice, since you have a general idea of what to expect.

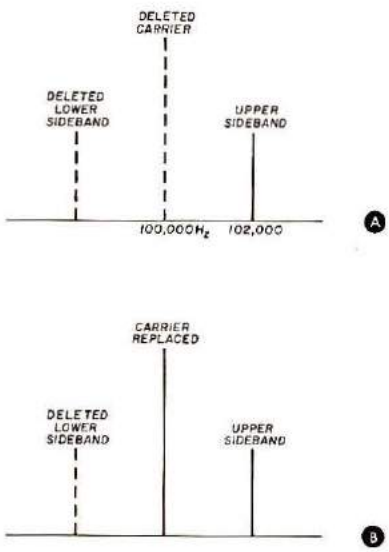


Fig. 3. To properly detect a sideband, the detector must "see" two components — the sideband which varies at an audio rate, and a carrier. The carrier must be generated with the proper frequency relationship to the sideband, as shown at **B**.

Placing the local carrier in the right spot also makes it easy to recover the voice range of frequencies — the lowest tones will be near the carrier and the higher ones will be farther away, just as they were in the transmitter example.

Remember the trick used to obtain either upper or lower sideband? The one about moving the carrier to one side or the other? It works here, too. Obviously if you placed the carrier on the wrong side of the voice sideband, and had the higher frequencies nearest the carrier, and the lower ones farther away, the voice would come out upside down (**Fig. 4**). I kid you not, that is what happens, and it sure sounds weird. Matter-of fact, that is one simple and basic form of speech scrambling. It was used by some businesses that have shortwave circuits for telephones to various places around the world. Don't think that you can go tuning around and "descramble" some hot conversations, though! They have added some other tricks to make life difficult for us snoops.

Of course it is not absolutely essential that the local carrier oscillator be variable in frequency — it can be crystal controlled, and many of them are. This makes switching from upper to lower sideband a snap — literally — by changing from one crystal to another. Incidentally, the oscillator that I have been talking about for generating the carrier is called the bfo (beat-frequency oscillator). It got that moniker in the early days of receiving Morse code signals, when it was used to beat against the signal to produce an audio tone. That's as good a term for it as any.

Detector types

So far, I have been talking about a rather simple diode type of detector, which will work for a-m, ssb, or CW. It does its job, but there

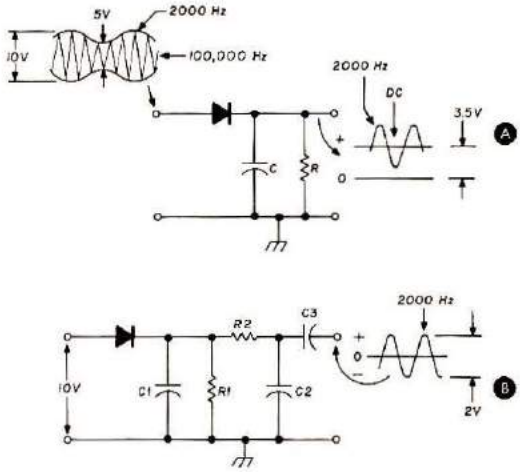


Fig. 2. When the input waveform to a rectifier (detector) is complex, the output waveform is also complex. The high-frequency part of the input is rectified and smoothed by **C**, which creates a dc component. The low-frequency portion of the input is passed through the rectifier, and, because the capacitor is not large enough to have an effect at the low frequency, causes an audio-rate variation of the dc level at the output. At **B** an additional filter consisting of R2 and C2, and an isolating capacitor, C3, removes the dc component and allows only the audio to pass. At this point the audio should be a reasonable duplicate of the audio that was transmitted by the other station.

are problems with it. One is that the amount of audio recovered is somewhat low; another is that the presence of the carrier, forcing a current flow through the diode, creates noise. Now, noise is something that you don't need, and inefficiency you can do without, too. Other people felt the same way, and developed a better detector. It's called a *product detector.* It is called that because it produces an output that is the product of two inputs. Describe it? Well, lets see . . .

Fig. 5 is a good place to start. There you see something that bears a striking resemblance to the diode detector used as an example before. Since there is no carrier being applied to the diode from the amplifier circuit, one must be fed to the diode from a local source. This source is called, appropriately enough, a carrier

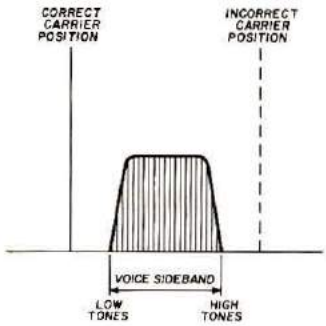


Fig. 4. When a band of frequencies, such as in a voice, are to be received, the frequency relationship is of prime importance. If the carrier is placed on the wrong side of the voice band, the voice will be inverted, causing the high and low tones to exchange places. This same relationship must be observed throughout the ssb system — transmitters as well as receivers.

generator. It is almost indistinguishable from the beat-frequency mentioned earlier. This is a crude type of ssb detector, but it does work. It requires better circuitry to give better performance, and **Fig. 6** shows an improved product detector. Here you make use of a principle that was touched on in the generation of ssb — the balanced modulator. The carrier is applied to the diodes through the transformer in such a manner that it virtually cancels itself after doing its job, which is to turn the diodes on and off at a very rapid rate. The sidebands, from the amplifier stage, are applied to the diodes in a way that allows them to beat (heterodyne) with the carrier, and the difference (product) is left over to be connected to an amplifier.

There are filtering capacitors connected with this type of detector, too, but they are not required to do nearly as much work because the amount of carrier left over after the detector is negligible. The product detector is great for ssb and CW, but is rather a nuisance for amplitude modulation because the local carrier must tussle with the carrier that is coming into your receiver along with the modulation. To properly receive a-m, you must adjust the carrier oscillator until it is exactly zero-beat (no frequency difference) with the incoming carrier. Two carriers tend to overwhelm the sidebands, and consequently the amount of audio recovered is lower than desired. However, it will work, so don't figure that you will never be able to listen to a-m again.

There are many other arrangements of product detectors, some involving specialized tubes, and a couple of recent ones that use a specialized (and very complicated) integrated circuit. No matter what the device, they all involve the same principle: Causing a mixing or heterodyning between the incoming sideband and the local carrier.

Amateur frequencies

Up until now, I have used the example of 100,000 hertz for the carrier frequency. That was mainly because it was a nice

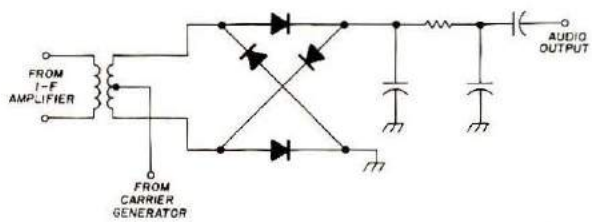


Fig. 6. An improved ssb detector makes use of the balanced modulator (mixer) type of circuit. Again, the i-f stage supplies the signal (after being amplified by previous stages) and the carrier generator provides a carrier with the proper frequency relationship to the sideband being received. This "balanced demodulator" is more efficient than the simple rectifier type.

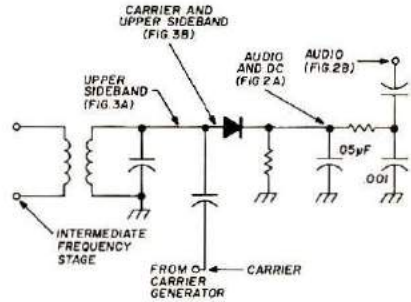


Fig. 5. A simple type of ssb detector is merely a rectifier circuit that obtains one signal from the i-f stage, and another from the carrier generator.

sounding number with a lot of zeroes that would impress people. It is also less than a billion, so no one could confuse it with a government spending program. Now, I'm afraid that we'll have to face life and journey into the real world. There are no amateur frequencies at 100,000 hertz. But you know that ssb works as much higher frequencies — you have heard them there. From 1.8 MHz (160 meters) to 30, or even 1296 MHz, amateurs are using ssb and enjoying it. Some equipment for 27-MHz CB use has ssb capabilities too. How does it get there?

Again, the good ole standby — heterodyne — comes to the rescue. This time I'll make use of the sum product of the mixing process. One of the fortunate results of this type of mixing is that things tend to stay right-side-up, so that the voices do not come out inverted as I mentioned earlier when I pointed out what happened if you put the carrier in the wrong place.

The amateur 21-MHz (15-meter) band is as good a place as any to start. Let's assume that you want to generate a sideband signal at a frequency of 21.4 MHz. That's twenty-one million, four-hundred thousand hertz, but there is no point in waving *that* many zeroes around! M is the abbreviation for million, and the term MHz is pronounced megahertz.

It will make things a lot easier if you keep the sideband that was generated at 102,000 Hz as a starting point to get to the higher frequency.

Fig. 7 shows what happens if two frequencies are added together in a mixing scheme. It is much the same as what happened earlier in generating a sideband signal, except that the frequencies are much different. You really don't need a drawing to figure this one out though — you can simply add up the numbers: 21.298 + 0.102 = 21.400 MHz. Simple enough! Oh, yeah — that 0.102 is the same as 102,000 hertz. Okay?

So, now you have the same sideband that you started out with at 102,000 hertz, and it is perfectly happy to be bouncing around up there at 21.4 MHz as an upper-sideband signal among the rest of the crowd. Problem is, how do you detect it? No, you cannot just feed it into an amplifier and product detector that are built to work at that frequency. Well, you could — in theory — but it is not so easy in practice. Remember I told you that the signal at the input of the receiver would be pretty weak, which means that you need some very good amplifiers to build it up to something useful. Amplifiers like that can be built, but there is a catch. You need a local carrier for the product detector, right? And it must be at a frequency of 21.398 MHz, right? (Remember that the sideband you want to hear is really a 2000-Hz tone in disguise, therefore the carrier must be 2000 Hz below it to be in the proper place: 21.4 − 0.002 = 21.398 MHz.) To make the product detector work properly, the carrier must be strong — from a half a volt to perhaps 2 or 3 volts. Here's the clinker — there is just no way that your amplifier is going to ignore that 2-volt carrier in the same box with it and amplify that 0.002-volt signal from across town! It's going to make like that proverbial snake that swallowed its own tail and lock itself up in a tight loop which is totally useless!

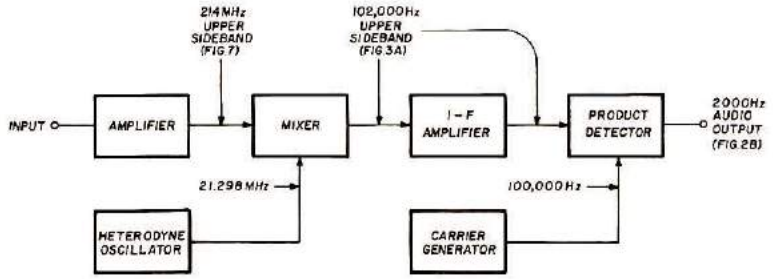


Fig. 8. A block diagram of the basic ssb receiver as set up to receive a signal at 21.4 MHz. Additional "niceties," such as variable tuning controls, automatic gain control (to keep the audio from being too loud), and audio amplifier circuits are not shown in the interest of clarity. For the waveforms and relationships involved at the various points in the circuit, refer to the figures indicated.

To the rescue

It may seem that this heterodyne guy is hogging the show at this point, but face it — he's indispensible. So, here we go again. Put an amplifier or two in the system, tuned to 21.4 MHz (**Fig. 8**). Okay, now the sideband signal is boosted up a bit, it is not so likely to get lost in a resistor or something. Next comes a mixer that is almost a duplicate of the one that was used to generate the 21-MHz signal before. It works with the same numbers too: 21.4 − 21.298 = 0.102 MHz, which is the same as the 102,000 hertz that we had in the first place (but it doesn't really *have* to be, modern receivers use frequencies from 50 kHz to 9, 10.7, or even 13 MHz). The next thing to do is build an amplifier that is tuned to 102,000 hertz, and that amplifier is called an *intermediate-frequency* amplifier (*i-f* for short).

At this point the sideband signal is considerably stronger than it was when it first came down the lead-in wire to your receiver terminals, and the i-f amplifier does not need such a terrific amount of gain. Now it is safe to turn on a carrier oscillator at a frequency of 100,000 Hz. With proper circuit design and good shielding in the receiver, this carrier will not bother the amplifier much, and will mix with the ssb signal to produce the 2000-Hz tone that you wanted all along.

An important thing to remember during all of this heterodyning process is that in order to preserve the original relationship between the sidebands and the carrier, you must keep the carrier in the right place.

Any time that any carrier is placed on the same side of the sideband as the higher audio tones, the product will come out upside down. See **Fig. 4**.

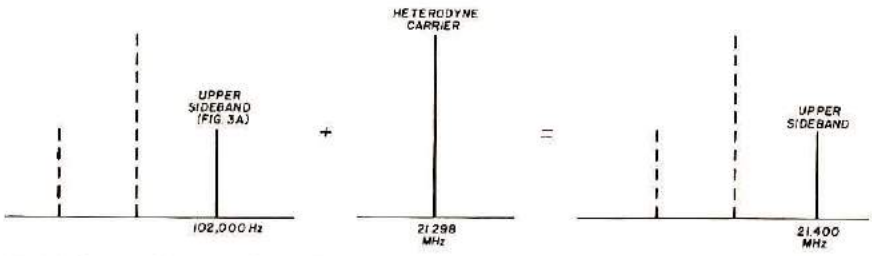


Fig. 7. Many ssb transmitters first generate the sideband signal at a lower frequency and then "translate" it to a desired ham band by one or more steps of mixing. Here you can see the addition process that will heterodyne the 102,000 hertz sideband signal up to the amateur 21-MHz band. The proper carrier-to-sideband relationship must be maintained, as explained in Fig. 4.

Because of internal design problems (or simply because the builder wanted to do it that way) some receivers allow this to happen. In some units the audio can be turned over again by means of a switch that automaticlly moves the local carrier to the other side of the sideband, in other receivers, you must flip a switch yourself to accomplish the same thing.

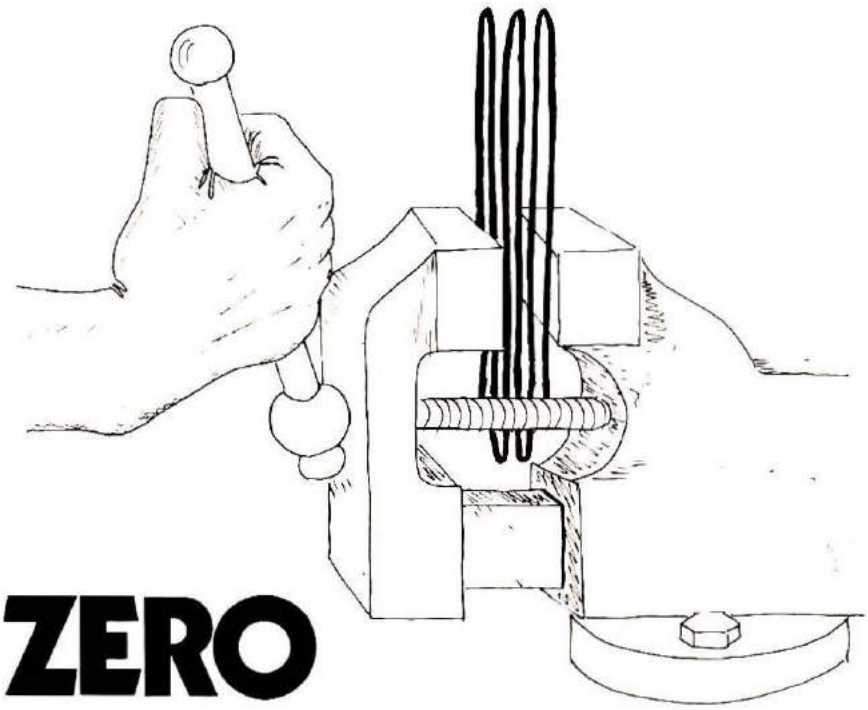
Improvements

There are a lot of tricks that can be put into receivers that will make life easier than with the overly simplified example that I have used here. F'r instance, a good filter is needed to be sure that you listen to only one sideband signal at a time (well . . . almost just one, the frequencies *are* crowded). The filters used can be identical to the ones used in the sideband generator that I told you about last time. In fact, most transceivers (transmitter and receiver in the same box) have some pretty nifty circuits in them so that they use the exact same filter for both creating the sideband and for receiving it. Many other parts of the circuitry can be shared equally between the transmitter and receiver, too, but you had better practice reading road maps before trying to follow the signal path through a present-day transceiver.

Another nice thing to have is called agc, for automatic gain control. This is a specialized rectifier circuit that senses how strong the signal is when it comes in, and by means of some tricky amplification, turns the volume control down (electronically) so that Mr. Loud-Guy on the next block doesn't take your head off when you are listening for a weak one.

As a closing note, I hope you are not fed up with Heterodyne, because he still figures in the plot in a couple of places. I haven't told you what he does in transmitters yet, but I will!

HRH



ZERO BANDWIDTH SSB

BY AGYLE KARRYER, B.S.E.E., PH.D

As amateur radio continues to gather adherents, certain of our bands seem to gather QRM in direct proportion to that increase. There is no denying the popularity of the 14-MHz phone band, for example. In fact, this area of our various allotted spectra is the one we usually think of the moment someone mentions that nasty phrase, "QRM."

With the advent of single-sideband transmission and its triumph over amplitude modulation, a decisive victory was, of course, won in the battle against interference; on the average, the bandwidth of our phone signals was halved. Still, ssb signals are characterized by a bandwidth running to 3 kHz. And today, with the burgeoning increase in the popularity of ssb, especially at 14 MHz, the spectre of QRM has raised its ugly head to the point where a decent conversation is all but impossible, especially on weekends.

As a frustrated single-sidebander I have, however, come up with an innovation which theoretically will allow at least a 300-per cent increase in the number of signals before QRM again becomes a problem.

The secret of the new scheme is to bring the bandwidth of the ssb signal down to practically zero. Impossible, you say? Flies in the face of all spectrum-occupancy theory? Not so. The system I use does just that: It brings the bandwidth down to all but zero — without eliminating the sidebands. This is accomplished simply by causing each sideband, normally displaced from the suppressed-carrier frequency by the amount of the audio-modulation frequency, to be moved to the frequency of the suppressed carrier. Therefore, the sideband does not extend out to the side, where so often it will occupy space in use by another station.

Placing of the sidebands at the suppressed-carrier frequency involves moving the frequency of the transmitter oscillator off to the side by the exact amount of hertz represented by the sideband, which in turn moves the sideband to the frequency formerly occupied by the suppressed carrier. If, for example, the speech frequency at a given instant is 2000 hertz, and you are using the upper

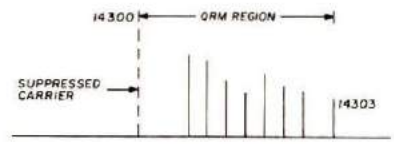


Fig. 1. A textbook presentation of a single-sideband suppressed-carrier signal, with the upper sideband transmitted.

sideband, the carrier will automatically be shifted 2000 hertz lower, thus bringing the sideband to the point normally filled by the carrier. This instantaneous movement of the transmitted signal is accomplished by sensing the frequency difference between the carrier and the sideband and allowing this difference to develop a bias voltage at the oscillator which will shift the carrier frequency by the desired amount.

Since voice frequencies during normal speech are continuously and rapidly changing — but at any given instant the signal is only one frequency — it will be seen that all of the various audio-frequency sidebands can be switched, as they occur, to the spot normally occupied by the suppressed carrier.

Fig. 1 shows a typical frequency disposition during conversation using today's normal ssb transmitter. Several sidebands are shown in the illustration, but it should be borne in mind, as mentioned above, that at any given instant only one of the sidebands will be present. To the listening ear, of course, the sidebands will appear to be present simultaneously. In fact, the figure shown is similar to the ones commonly appearing in texts illustrating ssb transmission.

A glance at **Fig. 2** shows the instantaneous case: The suppressed carrier and a single momentary sideband. In **Fig. 3**, however, my system has been put into operation and it will be seen that the suppressed carrier (which of course creates no QRM) has moved over by an

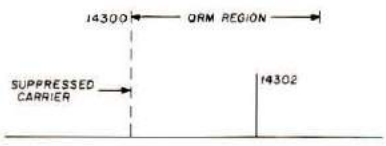


Fig. 2. For purpose of illustration, an instantaneous sample of the ssb spectra shows the suppressed carrier and a 2000 Hz sideband.

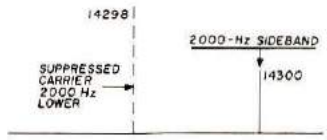


Fig. 3. The end result of the Zero-Bandwidth ssb system is to move the suppressed carrier lower in frequency. Thus the sidebands will all appear at the spot formerly occupied by the carrier. Since the carrier is suppressed, it will cause no interference to stations below its original frequency.

amount equal to the modulation frequency of the sideband. The sideband now occupies the spot originally held by the suppressed carrier. Since this will occur for each modulation frequency as it appears, it can be seen that the signal always remains at one frequency. Those ugly sidebands formerly sitting off to the side of the carrier and bothering adjacent stations are no longer there. The carrier is moving about, yes, but causes no QRM.

Right about now, if you are up on your theory, you are saying, "What about the receiver's oscillator? After all, it has to be spaced away from the incoming sideband to develop the mixing necessary for demodulation." I haven't forgotten this. In the arrangement presently in use, a biasing circuit similar to that in the transmitter causes the receiver oscillator to shift by the exact amount of the incoming sideband frequency. Thus, the necessary beat frequency is developed for demodulation. No problem.

Since I am still doing a considerable amount of research into the new system, with a view to simplifying the circuitry and creating adapters for the various ssb transceivers now in use, detailed information is being held for a future date. Present plans call for the details to appear in next April's *Ham Radio Horizons*.

HRH

The Call From CEDRO CANYON

BY A. DAVID MIDDELTON, W7ZC

The uniformed driver skillfully maneuvered the police car through the heavy traffic on Albuquerque's Central Avenue. Pulling into a left-turn lane, he waited for a gap in the heavy west-bound traffic.

"Just where is this electronics store, Tony?" inquired the driver, Sgt. Tom Melville, as he turned north on Truman avenue.

"Just on the north side of the branch post office, Tom. There it is ! See? The sign — ELECTRONICS — over the doorway?"

State Police Sgt. Tom Melville pulled past the store, stopped and backed into a parking space with a practiced hand. "I'll go in and get the gadget, Tony. You keep off that leg!" he admonished his companion.

"Sure. I'll stay put and keep an ear open for the squawk box," Tony Delgado replied, as he glanced down at his right leg, confined in a scuffed white plaster cast. "I'm not going to move around much with this thing on my leg." He smiled ruefully at his fellow officer. "Just ask for Mac, and tell him Tony sent you."

Tom Melville crossed the sidewalk, entered the door of the parts store, and disappeared from sight. State Policeman Delgado listened to the familiar voice of the state police radio dispatcher coming from the car's speaker. A faint smile flickered over the face of the young State Policeman, a battered face with deep scratches and some dark bruises marring his otherwise handsome appearance. Tony Delgado was about to do something that had haunted his dreams and kept him planning for a long time. Now it was to be accomplished!

Today was Tony Delgado's first day out of the house, where he had been laid up unwillingly for several weeks while a broken bone healed in his lower right leg. *The time at the hospital and home had not all been wasted*, thought Tony as he sat silently in the police car. *After all, I did get to see two All-Star baseball games!*

Tony was half asleep in the hot New Mexican air when the store door opened and out strode the police sergeant, with a cardboard carton heavy enough and large enough to require both arms. He grinned with pleasure. Right behind him came Roger MacDonald, the proprietor of the electronics parts store, and he, too, carried a box under one arm and a large envelope in the other hand.

"Hiya, Tony! How's the leg doing?" Macdonald asked as he placed his burdens in the back seat of the police car.

"Some people are lucky having a long vacation in the middle of the summer!"

"Sure good to see you, *Amigo*! The leg, oh — it itches inside the cast, but otherwise, no pain. Say, how about you putting your autograph on the cast? You'd be in good company." Officer Delgado stuck his leg out of the car toward his visitor.

MacDonald reached into his pocket and, pulling out a ballpoint pen, scrawled his name and amateur radio call on the plaster.

Delgado looked back at the rear seat. "What's the small box, Mac? And what's the envelope?"

Sgt. Melville answered before MacDonald could reply. "Your man Mac — you'd never guess! He threw in something extra — a loudspeaker!"

"I just wanted to help out, too. So I thought maybe the speaker unit might be welcome," said MacDonald, slightly embarrassed.

"Muy bueno, Mac." Tony lapsed into his boyhood tongue in his excitement. "I didn't know about *that* unit." He grew thoughtful. "My check, it is not enough for this too?"

"Ample, Tony, ample. The speaker unit is a gift from the store — all in a good cause, and don't you worry about it. The other packet has a few log books and several message pads in it also — a bit of a bonus."

"Let's go before the dispatcher finds something for us to do." The driver, Tom Melville, had placed his large carton in the back seat and climbed into the front. "Mac — thanks a lot! For everything!" Tony also shouted his thanks to MacDonald as the car pulled out of the parking space into the traffic.

"Better check in with Headquarters," suggested Melville as he turned the police car east on Central and headed through the thick traffic toward the mountains.

Officer Delgado took the microphone from the dashboard and called KKC686, State Police Headquarters. In terse police terms he requested permission to leave the city limits on a mission previously given "official sanction." Receiving an okay to the request, the two men sped swiftly out Central onto the open mesa. Ahead they could see the gap in the high mountain barrier where US 66

passes between the Sandia and Manzano ranges. Tony knew every inch of the highway and could almost have driven it blindfolded. It had been his beat — up until a few weeks ago. Then he was assigned State 10 south from US 66 at Tijeras, through the Cedro Canyon area.

The police car moved into new Interstate 40. The vegetation changed rapidly as they passed through Carnuel and Linda Vista, as the elevation increased. When they rounded the infamous curve known as Deadman's Pass, the temperature dropped sharply. The fresh, cool scent of piñon hung in the air.

"It's always good to get back into these mountains," said Tony. "This is another world from downtown Albuquerque, eh, Tom?"

"Yeah, you lucky guy — you used to patrol this area and now you have State 10 where it's even cooler and greener."

"Sure, but in winter — *muy frio* — very cold, *amigo*!" Tony grinned as he waved at a small boy sitting on a rock alongside the road. The car left 66 and headed out State 10.

The police car moved past the Forest Service Ranger Station and the men waved as they passed the ranger's teenage daughter. She was, as usual, out riding her horse in the afternoon sun. Tony asked his companion, "Do you know the ranger?"

"I've met him and visited in his office a few times, Tony. I've heard he's a great guy and a credit to the Forest Service."

"You bet! The ranger has been a good friend to me, *amigo*. Besides, he and his helper came on-the-double that day — when every hand helped!"

After a mile or two of slow twisting upgrade, State 10 begins to climb in earnest. The walls of Cedro Canyon are sheer, rising many hundreds of feet above the arroyo bottom and the narrow roadway that parallels the path of the normally dry creek. Occasionally there are open spots where the road straightens. The highway curves back sharply and heavily. The police car moved swiftly upward, holding tightly to the right-hand side of the center line.

After a few miles of winding and climbing the road suddenly opens into a flat stretch. Although the mountains still rise sharply on the east edge of the road, far below on the west is the bed of a dry arroyo. In many places the bottom of Cedro Canyon is not normally visible from a car on the roadway.

Tony spoke to the driver. "Slow down, Tom. You're about there."

The car reduced speed and came to a halt. "Here it is. See? The shoulder is still gouged out where the rock was! I'll get out now, Tom."

Slowly the disabled state

policeman moved his cast-bound leg out of the car and awkwardly swung his body to fit crutches beneath his armpits. "These sticks sure are a nuisance," he said with a frown, "but they *do* make it possible to get about!"

Delgado slowly moved the crutches and his one good leg to gain a spot on the very edge of the road.

"Be careful, Tony. We don't want to have to pull you out of there the second time!" Tom Melville warned the becrutched policeman.

Tony paid no attention to his companion. He stared down into the deep canyon. Sgt. Melville moved over and joined Tony. He, too, peered down the mountainside. There, far below them, jammed between several huge boulders was the tortured steel skeleton of what had been a gleaming piece of fine automotive machinery. The wreckage appeared to have been wracked by a severe explosion, followed by a fire. Only the barest outlines of a few letters on the rear of the car gave an inkling of its original identity, letters which at one time had spelled out STATE POLICE. There was little resemblance between the wrecked car in the canyon and the sleek, trim police vehicle sitting on the right-of-way.

"Man — you're a lucky guy! This is my *second* view of your wreck, Tony, and I hope never to see another one like it!"

Tony was silent, deep in his private thoughts. Finally, he turned slowly on his crutches and faced up Cedro Canyon and looked up the steep wall of the mountain. There, far up the rugged slope, he could see the glint of the bright afternoon sun on a window. Only the barest outlines of the cabin structure itself were visible from that distance.

Tony stood quietly looking up at the cabin for several minutes, then took another look at the wreck in the canyon. "*Si, amigo.* How lucky I am. Thanks be to God! I am indeed the fortunate one! Let us go, Tom, we still have far to go." Slowly they returned to the waiting police car.

The car moved back onto the roadway, still climbing, as the canyon narrowed. Neither man spoke until Tony instructed the driver to turn at the dirt road on the left.

The driver obeyed without comment. The police car and its two occupants bounced and jiggled as the dirt road roughened and twisted its way up the face of the mountain. Sharp rises and hairpin curves slowed the car as it moved steadily upward.

The narrow road widened into a small flat space with a few trees. At the far end, a slab-sided cabin stood among piñon trees. The tiny house seemed nearly engulfed by the huge glass picture window that faced down Cedro Canyon. A hand in the window waved a greeting as the police car slowed to a stop and Melville climbed out and moved around the car to assist his passenger.

Unsteadily, Tony hobbled along on his crutches toward the cabin. Tom, reaching into the back seat of the car, brought out the larger of the two cartons. "Okay, Tony — let's go!"

The trimly uniformed State Policemen went slowly up the path to the cabin, where by now they could see a teenage boy sitting in a wheelchair at the doorway, one arm holding open a screen door.

Tony Delgado had been waiting a long time for this moment. This meeting had been on his mind since that fateful day last spring when he first learned of this lad. The boy in the wheelchair had never seen Tony until this moment, but the officers had been quickly recognized as "old friends."

This was indeed a strange way to start a friendship; a friendship that was, until now, a one-sided affair where one person is not even aware of the other's existence until there comes a moment where their two lives are joined by an event such as happened on that day in Cedro Canyon.

The boy in the cabin doorway, Louis Manning, had two hobbies. First, he was an ardent radio amateur and had been operating on the air for almost a year, ever since he had successfully passed the government examination for a Novice license. Second only to his ham radio work, young Manning thrilled over his ability to view the world outside the tiny cabin by means of his four-inch telescope.

Some people might think that Louis Manning, a teenage wheelchair polio victim, was imprisoned in those four walls of a cabin, perched high and remote on a mountain, where he lived with his mother. And lonely, too, for Mrs. Manning was gone all day, working in a highway restaurant down below on U.S. 66.

Far from feeling like a lonely prisoner, Louis had many friends and he felt free to roam the world and the space around it. Despite the lack of neighbors or even a telephone,

and though he missed his mother, he had many things to keep him busy and to occupy his mind.

By ham radio, he could *talk* directly with other amateur stations scattered over the entire world by means of radiotelegraphy. By eye he could peer far into the heavens with his telescope. He could roam visible outer space at will. His telescope brought into his room happenings in the immediate outside world, a look at a short strip of State Highway 10 far below his perch. A view not shared by anyone, since the Manning cabin home was the only one in this area.

Even though Louis was confined to a wheelchair, he was an honor student and was completing his second-year equivalent of high school by mail. Louis was an ardent student of radio and electronics. He spent time each day studying radio text books and technical magazines. He then applied this knowledge, in rapt fascination, toward building his amateur radio equipment.

First, Louis had built simple but efficient pieces of gear — a two-tube receiver on which he had listened to the world of short-wave radio. Concentrating on the amateur bands, Louis learned the intricate technique of "hamming," and learned the code through the steady use of an inexpensive set of code-lesson records. He then improved his operating skill by regularly listening to the code practice sessions transmitted by W1AW, Headquarters station of the amateur's own organization, the American Radio Relay League, in faraway Newington, Connecticut. By studying simplified text books and the *License Manual* (another ARRL feature) Louis learned sufficient theory and regulations to pass, on his first attempt, the examination for a Novice license.*

Louis Manning had progressed from a two-tube receiver to a pair of war-surplus receivers, one for 3.5 and one for 7- megahertz coverage.The former unit Louis augmented by the use of a converter he painstakingly built from *Handbook* plans. This combination permitted the reception of signals on the 21 MHz band on the stable lower frequency of 3.5 MHz. Such conversion made distant daytime reception much better and gave Louis the equivalent of a receiver costing many times more than his initial investment.

He had also assembled his own transmitter, a Heathkit DX40, which he could use as a Novice on the 3.5-, 7- and 21-MHz Novice bands. Later he would use it on all the frequencies allotted to amateurs when he obtained his General-class Amateur License.

Louis had also studied basic astronomy and was an advanced amateur astronomer through his constant application of hard-earned book knowledge and judicious use of his telescope. Do-it-yourself kits are not confined to hi-fi or ham radio units. Telescopes can also be built in home workshops even by beginners, and this Louis had done, assembling a four-inch telescope from a mail-order kit. His scope, plus a two-dollar basic astronomy book,[1] had literally opened up a new world for the house-bound polio victim.

After studying the skies for some time, Louis turned his telescope to the immediate world around him where he found a new freedom in intimate looks at the woods and rocks, where birds and animals fed, played, fought, and rested.

*This examination consists of a few regulatory laws, some basic radio theory and requires the demonstrated reception and transmission, by key, of a code-speed of five words per minute.

Then one day Louis discovered a new, steady source of entertainment — the close-up study of a stretch of highway and canyon in sight far below him on State 10. His small vista was not confined to the highway, but by virtue of his height above the road, included a look-see down into the canyon itself.

It was indeed lucky for State Policeman Tony Delgado that Louis Manning *had* discovered this view into the canyon for thereupon hung Tony's very life!

Let us look back a few weeks and see what happened up in cool, green Cedro Canyon, on a beautiful spring day. It was late morning when Louis Manning finished his written high-school lessons for the day. Tomorrow his mother would mail his work to his extension course teacher in Albuquerque where the papers would be graded.

Louis was not worried about the lessons or anything, except for one little thing, and that had nothing to do with school. He had tried to explain it to his mother before she left that morning but she only partly understood his complaint. Only another active radio amateur could have shared Louis' woe — *the band was erratic*. About all his mother got out of this statement was the fact that too many sun spots, or maybe it was the total lack of them, were upsetting shortwave radio, and that this condition might prevent Louis from talking to as many stations as he desired. It might even prevent him from working anyone at all!

To Louis, this seemed a low blow. (What he did not know, being a relatively new operator, was that this sort of erratic activity has plagued all radio operators for years and that there was nothing he, or anyone, could do about it).

Louis rolled his wheelchair from his typewriter stand, where he always studied and typed out his school work, over

to a small radio operating table. There sat his receiver, his transmitter, and a telegraph key. Under a glass sheet (a salvaged car windshield) Louis had placed a group of helpful operating hints clipped from the ARRL manual, *The Ham Radio Operating Guide*[2]. There were lists of Q-signals which are an internationally recognized series of three-letter groups having the same meaning in every language. In addition there was a mimeographed sheet of members' names, addresses, and calls of the Albuquerque chapter of the Caravan Club, a mobile group. Included in this list were telephone numbers of official agencies with whom amateurs in the Caravan Club cooperated in times of emergency drills. Although Louis was not eligible to be a Caravan Club member, a friend, W5UOZ, who did belong, had given him the list, and it made Louis feel as though he were one of this outstanding ham group.

Louis' operating table was neat and orderly. All controls were convenient for his use, seated as he must be in his wheelchair. He switched on the receiver and while it was warming up began to make an entry in his log book. He grimaced as he noted that yesterday he had only talked to a few U.S. stations, no DX station, and no new country! But — all operating was grist for his mill — the mill of experience that must grind ever so slowly to bring a radio operator, or anyone else, up to the peak of perfection in any endeavor.

Louis tuned slowly across the band. He could have used any one of three amateur bands as a Novice. Being in remote New Mexico, Louis had learned the hard way that useful summer daytime operation was confined to the 7- and the 21-MHz bands if he desired to make contacts. The segment allotted to Novices in the 3.5-MHz band was very poor in New Mexico during the daylight hours.

Louis had progressed to the point where working mostly other Novices was old-hat. Although Louis had never put it into words, he had learned that so many Novices and even some ex-Novices on the 7-MHz band were very poor operators. Their poor "fists" and sloppy operating techniques often made contacting these hams a chore, instead of a delight to Louis. He had really *worked* at learning to be an amateur! He had an operating skill far above the normal Novice or even a new General class amateur.

But what a difference on 21 MHz where Novices could talk to stations just about anywhere in the world! In fact, Louis had talked two-way with other amateurs in over sixty foreign countries. *Only a few more to go*, thought Louis, *and I can get my* DXCC certificate. *It takes only 100 countries confirmed*! Louis already had QSL cards from 52 countries. He counted them daily!

So Louis had his "rig," as hams call their equipment, all tuned up on the 21-MHz band. He *could* change to the 3.5- or 7-Mhz bands by plugging in different crystals, a type of quartz that controls the frequencies of some transmitters. But he chose to remain on the band where he could easily talk to stations *all over* the U.S., as well as with foreign stations, providing the band was "open," as hams call it.

The face of young Manning looked gloomy and provoked as he tuned across the dial, carefully listening to each signal as he stopped momentarily to catch a bit of their conversation, a call sign, or both.

Mother always said there would be days like this! But she never said there were so many, thought Louis as he went back and forth across the dial searching for someone he could work without having to go to the trouble to change bands. He did not hear much of anything. After several tries, he sent out a CQ, an inquiry call which is a ham's plaintive cry, "Please talk to me — somebody — anybody — anywhere!" He signed his call proudly and distinctly — and then listened — senses alerted for any possible answer.

Louis tuned around his frequency but there was no answering call for him. Being a skillful operator and one who had faith in his equipment and in his own positive thinking, he took another look away from his own frequency and across the band. This time he struck pay dirt! A Novice, WX2GUM, was calling him, or at least Louis thought he was calling him. The WX2 was not as good an operator as Manning and he was very slow at the code. He even made an error in Louis' callsign! However, this was nothing new to Louis, who had traveled this road himself, not so long ago.

The station in New Mexico replied to the Novice whose WX2 call placed him in the New York area. The two Novices exchanged signal reports, their names, their locations. WX2GUM operated in Long Branch, New Jersey, and he was amazed at hooking up with someone in New Mexico and repeatedly said so. Furthermore, he pleaded with Louis, saying — "PLEASE QSL HR NEED NEW MEXICO." Louis had heard this cry many times, because there are relatively few New Mexican stations active on the bands, and their QSL cards are therefore scarce and highly prized.

Louis grinned as he noted in his log book, "First New Mex." He mentally noted how often this had happened since he went on the air. Hardly a day passed but that Louis was urgently requested to send a card — to help somebody get a WAS — Worked All States award issued by the ARRL. Louis already had this award, including, he pointed with pride — both Hawaii *and* Alaska! signifying that he had

confirmed contacts with all 50 states.

Louis was trying to copy the New Jersey amateur's mail address when the bottom fell out of the band. WX2GUM's signals dropped down into the noise level — and the short contact ended.

Louis was not surprised but he was disappointed as this meant that he would have but few nibbles on his well-baited line today. *Oh, well*, he thought, *maybe the band will open up after awhile.*

The Cedro Canyon amateur settled himself more comfortably in his wheelchair and turned up the volume control on his receiver so that he could hear extremely weak signals on the band. Only a vast silence greeted him on 21-MHz. There was nothing to be heard but the normal tube hiss and a faint power line noise that was one of Louis' pet peeves. The 21-MHz band *was* dead and that was that!

In a period like this Louis turned from ham radio to his second love — his telescope. It was all set up on a rugged stand in front of the picture window fronting the cabin. Rolling his chair over to the scope, Louis turned it from the sky position towards the ground and carefully focused it on a pair of ground squirrels frisking about on a rock some distance away.

Louis Manning had learned much about the small animal life that roamed, almost unobserved by the naked eye, in his field of vision from the cabin window. He had spotted many different bird species, various assorted small beasties, plus several types of lizards. With all his nature study, Louis had still another intriguing subject for his telescopic eye. That was a glance at the cars rolling along the highway on the fairly open strip of State 10 that passed his line of vision from the cabin window.

Usually Louis trained the telescope to catch sight of the up-canyon cars since the drivers were on his side of the car, where he could see their faces. License plates were easily identified. Car types required study. But Louis had plenty of time, and he had the patience. He had learned how to scan the road for *anything* of interest.

Louis found, from his steady observation, that some drivers were sloppy in their driving habits! These people got a low rating from Louis! At the other end of the scale were the State Policemen who, without any knowledge that they were being closely observed by a telescope manned by a lad up on a mountainside, drove skillfully, with absolute confidence in their own and their car's capabilities. Louis Manning had often remarked to his mother about his "policemen pals" and of their passing along far away but where, with the scope, they were almost in his lap!

State 10 is not a highly-traveled road on weekdays. Other times it loads up with a steady stream of picnickers and sightseers who drive to and from the Pine Flats Forest area about five miles further south. During the week, often a woodcutter from Escabosa or Chilili would rumble downhill with a top-heavy load of cut fire logs — always topped by a dog or two hanging on precariously but loving every inch of their hectic windblown ride.

Louis did not see this on the northbound vehicles. When these same trucks came back empty after delivering wood in Albuquerque, there would usually be a few *muchachos* riding in the back of the truck. Some of these local kids had visited Louis and, after learning of his telescope watching, always waved as they passed even though they could not see any return signal from Louis.

If there had been any envy in Louis' heart, it would have been toward the State Policemen. Louis knew about their work, its danger, their training, and the possibility of an exciting incident lurking perhaps around the next curve or in the next call to come in over their car's police-system radio.

There was something in the mobility, the freedom, and the very manner in which these State Policemen handled themselves and their shiny swift cars, sitting there so relaxed but always alert at the wheel. Too often, Louis had noted, southbound police vehicles were driven fast, red light flashing on top of the car and a siren screeching as they opened the way for a gleaming white ambulance following closely behind the police car, enroute to the scene of an accident on one of the treacherous curves further out State 10. Fortunately, such tragedies were usually confined to Saturday, Sunday, and holidays while the schedule of routine patrol cars passing was normal on weekdays.

By observation Louis had noted that a police car went past about once every two hours during daylight. The police car would go up Cedro Canyon. Then about an hour later, Louis would see it return downhill. Louis also knew that this was the tour of duty for these officers — from far out on State 10 northward to the junction of this road and U.S. 66, at Tijeras.

A few days before, Louis had seen a new face behind the wheel of the police car as it moved toward Chilili south on the highway. Louis told his mother about the new man. She already knew who he was. Tony Delgado, she told her son, was a newcomer to Cedro Canyon. He had just been reassigned from Santa Fe.

Delgado was an efficient officer, well liked by both his fellow policemen and the citizens. A native New Mexican, he had grown up in Santa Fe, and had played on the varsity football squad at the University of New Mexico. Mrs. Manning said her New Mexican friends

had referred to Tony Delgado as "*Un muy buen hombre yavado con la gente.*" This was their quaint way of saying that Tony was a very good man with the people. A high tribute for a policeman — or any man!

The boy in the cabin window could scan a short stretch of highway where, at the right-hand edge of his view, there was a mileage post. Louis used this post to focus his telescope since the black numeral 5 stood out clearly against the post's white background. It was just five miles from that point to the junction where Highway 10 joined U.S. 66.

Louis zeroed in his scope on his piece of highway. Two cars went by downhill toward Albuquerque. There was a lull in the traffic. Then a sports car climbed the opposite way toward Chilili. Louis smiled as he watched the young couple snuggling tightly together, the boy driving with only one hand, and not paying much attention to his driving either, Louis observed. Then for several minutes there was no traffic in either direction.

Louis Manning swung the telescope to the right section area of view just as a police car came within the view through his eyepiece. Louis caught a glimpse of the driver's face. *Yes*, he thought, *there's Tony Delgado — the new man.* Louis panned the telescope slowly to keep the car and the friendly face of the policeman in view. Louis pushed the scope ahead to "lead" the car. At that instant he was terrified to see a large boulder appear on the road, as if from nowhere. He realized that the huge rock came from his side of the road, which was an almost vertical cliff!

The boulder bounced twice, rolled obliquely in front of the oncoming police car, and slammed into the right front end of the vehicle. The driver could not have had warning of the falling rock, nor could he have had time for any evasive action. Young Manning's eye was glued to the eyepiece as he watched helplessly. The police car swerved sharply to the right, hung on the graveled shoulder of the road for a split second, then plunged over the side.

The driver had no opportunity to jump. Louis saw the police car strike a pile of huge boulders. He almost felt the sickening shock as the car turned end over end and continued to roll down the steep slope. It seemed to Louis that the car would never stop falling! From where he was sitting, the action appeared to be right in the room with him! He kept his eye to the telescope by holding the eyepiece tight with his right hand. His left hand gripped the wheelchair arm tightly. The boy in the wheelchair was nearly overcome at the scene he was witnessing.

Now the highway was completely free of traffic. No welcome car rolled into sight from either direction. *If someone did come by*, thought Louis, *they could not see the wreck!* He was the only one who knew of the crash, he and his new "friend" Tony Delgado, who by now was either dead or unconscious.

There was no movement anywhere in or around the car. The policeman had unwillingly ridden his car to the bottom of the canyon where it now stood on its nose, upsidedown.

The car wheels still slowly turned. Louis could see the gold letters STATE POLICE across the rear of the white body. He read the license number "88".

For a minute or two, which seemed more like hours, the boy sat frozen, unable to comprehend what had happened. Then his brain started working! There was no telephone in the cabin. It would take him a long time to wheel his chair over the rough private shelf road to the highway and then perhaps an even longer time to flag down somebody. It was possible that no one would come along for hours! These and similar thoughts raced through Louis' mind as he quickly surveyed the situation. He took a last look through his telescope. Conditions had not changed. All was quiet down at the wreck. There was no motion. Even the car's wheels had finally stopped.

Louis turned his chair and rolled over to his radio operating table and snapped on the switches. Suddenly he realized that even this line of communication might not hold up — for had not the band been dead a few minutes ago? Louis knew that it would take him several precious minutes to change bands and tune up on the 7-MHz Novice band and still more valuable time to raise another station before he could get word of the fate of State Police car 88 and its driver to the outside.

Maybe, thought Louis, *all I can get will be some slowpoke who can't even copy his own call!*

Louis tuned the band looking for someone calling CQ. There were a few scattered signals, but no CQs. However, he was encouraged by hearing a few stations busily chatting. He had feared the band might be completely out. If so, it would probably be useless even to try a contact. *I've got to try*, thought Louis anxiously, *it just might open up!*

Louis snapped on his transmitter and, for the first time in his life, he sent out the amateur's SOS — by transmitting QRRR QRRR QRRR de WN5WLO. Clearly and distinctly, Louis Manning formed each Morse letter of his urgent plea, hoping that anyone listening would catch the call without error and without delay. Three times Louis repeated this QRRR. He listened on his own frequency. No answering call came through the headphones as Louis slowly tuned across the band. *I'll try again*, Louis muttered to himself, *somebody's just got to hear me!*

QRRR QRRR QRRR de WN5WLO — sent the operator in Cedro

Canyon. He listened. . . .WLO WN5WLO DE W2ZI AR. He had an answer! The incoming signal was loud, and with cleancut sending! The skillful handling of the key plus the two-letter call sign told Louis that he had contacted not another Novice, but a highly skilled old-time operator located in New Jersey. Louis had read about W2ZI and his famous Ham Radio Museum in Trenton. Louis replied to the distant station —

W2ZI DE WN5WLO QRRR HERE POLICE CAR 88 WRECKED IN CANYON NEAR ME — NO TELEPHONE — CAN YOU QSP INFORMATION ALBUQUERQUE? W2ZI DE WN5WLO.

Louis listened and his spirits rose as W2ZI replied in crisp code —

GIVE DETAILS — WILL TELEPHONE — BK.

Louis now knew that the expert ham operator at the other end had not wasted a moment asking questions. Louis understood that W2ZI would relay via a long distance telephone call as soon as he received full information from Cedro Canyon!

Young Manning looked down at the roster under the glass top on his small operating desk. There it was — STATE POLICE — ALBUQUERQUE. He sent to W2ZI.

AREA 505 255 1601 — STATE POLICE CAR 88 WRECKED AT FIVE MILE POST STATE TEN SOUTH — NO SIGN OF LIFE IN WRECKED CAR — URGENT ACTION NEEDED.

The earphones whistled with code as the New Jersey operator snapped back —

R R TELEPHONING NOW — QRX.

Now Louis felt better! How lucky to catch a skilled operator who didn't ask a lot of unnecessary questions or even ask for repeats! All Louis could do now was to standby, or QRX, for action by W2ZI and the New Mexico State Police headquarters.

The Novice ham operator did not have long to wait. He heard W2ZI say —

INFO PASSED STATE POLICE DISPATCHER ALBUQUERQUE — ASSISTANCE ON WAY FROM US66 PATROL CAR — NAME HERE ED QTH TRENTON.

Louis replied thanking W2ZI for prompt action and his swift appraisal of the emergency. W2ZI replied stating that he has caught the very last of Louis' QRRR as he was idly tuning across the 21-MHz band.

I KNOW ABOUT POLICE CARS OM — said W2ZI — AM RETIRED CHIEF ENGINEER NEW JERSEY STATE POLICE RADIO SYSTEM.

The eastern signal faded down quickly and disappeared, almost caught in the middle of a word. Louis was stunned by the silence! He called W2ZI again and again but there was no reply. The band had died again, after opening up just long enough to permit the exchange of the information. As a final gesture Louis sent SORRY ED QSB BAND DIED 73 WN5WL0 SK. He signed off.

Louis turned from his radio operating table and wheeled himself over to the window. He placed his eye to the telescope still trained on the wrecked car far below. Where there had been only the motionless and mangled police car at his last look, now Louis was horrified to see smoke rising from the wreck. Suddenly a small tongue of flame rose from the midst of the wreckage! No motion of any kind. Just the ominous sight of groping fingers of flame growing steadily larger as they spread around the car.

As Louis surveyed the scene he heard the whining scream of a siren echoing through the canyon, growing louder by the second. A police car, red light flashing on top, roared into view and stopped by the mileage post. The car door burst open and a uniformed policeman jumped out, ran to the edge of the roadway, and looked down. By now flames were shooting high in the air. The officer whirled around and reached into the car, withdrawing a large red fire extinguisher. Darting to the edge he started down the canyon wall. Louis could easily see it was tough going, since the many rocks were great obstacles to a man in a desperate hurry.

The policeman had climbed but half-way down to the wreck when Louis saw a green pick-up truck pull up behind the parked police car; two men got out. Louis Manning knew that truck! It belonged at the Sandia Ranger Station at Tijeras and the older man was Ranger Ronson. The young man must be one of his helpers.

Louis watched as the men moved swiftly to the side of the road and peered down. Louis saw the ranger's lips move as he shouted to the other man who ran to the side of the green pickup and grabbed a backpack fire extinguisher and a smaller hand type. Without delay these men went over the edge.

It's like a silent movie, thought Louis as he watched the action below, *only this time it's for real — These are no stunt men*!

Louis saw the policeman had reached the wreck and was struggling to get the door open. It was jammed. He cracked the carbon dioxide fire extinguisher and the "snow" billowed into the open window of the car. He set down the extinguisher and was struggling with the car door when the forest ranger reached the wreck in a bone-shaking slide. Together the two men wrenched at the door. It seemed to the anxious boy in the cabin that they would never get it open! Suddenly the lock gave way, the door flew open, throwing the rescue pair on their backs. The men scrambled to their feet just as the other Forest Service man arrived.

Through his telescope, Louis could clearly see the expressions on their faces as the men fought desperately to free the pinioned officer from the trap inside the car. "Snow" again spurted out of the carbon dioxide extinguisher as the younger man aimed the black

funnel nozzle into the car and at the unconscious body inside. With almost superhuman effort, the men lifted Officer Delgado from the flame-filled car. His black uniform was burning in spots, but these flames were quickly put out by the carbon-dioxide snow. Carefully and expertly the men moved the police officer away from the wreck and lowered him to the ground.

Flames shot higher all around the car by the time the men had moved the unconscious Delgado to a point of safety on the graveled arroyo bed.

Without warning, the car was wracked by a terrific explosion which Louis *felt* as well as heard, seconds later, at the cabin. Instantly, the wreck was enveloped in a ball of flame following the explosion of the car's gasoline tank.

Tony Delgado had been pulled out of his wrecked police car in the last remaining seconds! Louis still had seen no sign of life in the officer since he had been moved, and he had no way of knowing if the officer had even survived the end-over-end roll and the wreck.

Louis Manning watched as the Forest Service aide climbed back up to his truck, entered the cab, obtained a first aid kit, and then returned downhill to the side of the stricken policeman.

Louis did not recognize the State Police officer who had come so quickly to the aid of his unfortunate co-worker. He saw from a glimpse of stripes on the officer's arm that this officer held the rank of Sergeant. Manning marvelled at the skill at which the Sergeant and the forest ranger worked over the prone body of Tony Delgado, whose right leg lay bent in an abnormal position.

The young radio amateur was watching closely when he saw a slight motion in the arms of his "friend Tony." "He's alive!" shouted young Manning out loud, without remembering that there was no one to hear his cry of joy.

Policeman Delgado was indeed alive! He made a feeble attempt to raise himself on his arms, was promptly put back flat on the ground by Ranger Ronson as the other State Policeman carefully placed a small log as a pillow under his head.

Ranger Ronson said something to his aide who promptly left the wreck scene again and came up the steep slope to the green pickup. Expertly turning the truck in the narrow roadway, the young aide took off down the canyon, apparently toward the ranger station.

Louis summed up the situation that now confronted the rescue team. He knew that the police-car radio would not reach Albuquerque from where the car was parked on State10. FM radio is sometimes rather tricky in the mountains. Louis knew that there were "dead spots" in that area that killed the high frequencies used by the two-way police radio system. The Forest Service man probably had left the scene to telephone for an ambulance.

While Tony Delgado lay quietly, his right leg still bent at that strange angle, the police sergeant and the Forest Service ranger administered First Aid to the numerous bruises and cuts on the injured officer's face and arms. Through his telescope Louis could see the shine of the burn ointment being applied to a few spots on the arms of the officer, after his shirt had been cut off.

Time sped rapidly by. Louis, engrossed in the rescue scene below, saw private cars come along and stop. Men got out and looked down over the cliff at the scene in the canyon. The police sergeant shouted something and one car drove off toward Albuquerque. The driver of a Jeep, a stalwart looking young man in jeans and riding boots, slowly made his way down to the arroyo.

Louis had been correct in his deductions. In a few minutes another siren was heard screaming through the canyon. A long white ambulance appeared, drove past the parked vehicles, and pulled to a stop. Two grim-faced attendants climbed out and ran to the back door. One man pulled out a collapsed stretcher as the other grabbed a medical bag. The ambulance crew scrambled down over the rocks with their awkward loads and reached the bottom without mishap.

Swiftly these trained paramedics went to work. The boy watched as they skillfully and delicately examined the injured police officer. One of the men readied a hypodermic needle, and deftly injected a shot of liquid into Tony's arm. Within moments the officer stopped moving about and lay still. He appeared to Louis to be unconscious.

Then the medical men went to work on the officer's more severe injuries. His trouser leg was cut off and a temporary wire splint placed on the broken leg. Louis marveled at how carefully the officer was lifted from the ground onto the assembled stretcher sitting on its squat legs.

The boy could now see that still more trouble was ahead for the rescue party. The slope where the police car had been forced over was too steep to climb with a loaded stretcher. The men held a short conference during which the ranger pointed downstream. The ambulance driver climbed up the cliff to the roadway and cautiously turned his long vehicle around and headed it slowly down canyon. Strong hands gripped the stretcher as the four men began to carry the injured man down the arroyo, heading for a spot where they could get back onto the road by a less steep ascent.

Everyone was now out of Louis' view. Only the still-burning wreck in the canyon, the parked pickup truck, and

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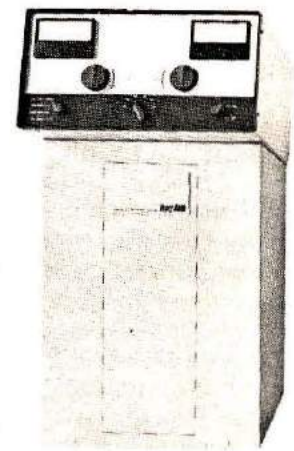

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cars remained. Louis Manning continued his watch through the telescope.

Fortunately, the carry must not have been a long one. In a few minutes the forest ranger and his aide trudged back up the arroyo to the wreck. They retrieved the fire extinguishers and the first aid kit and slowly climbed to the road, where they deposited their items of burden in the proper locations. They were soon joined by the citizen who had stopped to help and the other police officer, who walked back up the road to their vehicles parked on the shoulder. Louis realized that these men had assisted the ambulance men with the uphill carry and then, when the ambulance had left for town, were returning to their vehicles.

None of the men looked Louis' way. No one seemed to have any idea that the entire proceedings were being watched by anyone, not even by a boy with a telescope behind a large picture window far up on the mountain.

Ranger Ronson and his helper placed a wire tow-rope around the huge boulder and snaked it a few feet closer to the edge of the cliff. Then they pushed the rock with their car's front bumper until the offending boulder rolled off the right-of-way, to tumble crazily down on the rocks below. The men gathered around the Forest Service truck for a short chat and then returned to their cars and left the scene at milepost 5 in Cedro Canyon.

Only the smoking wreckage of the police car, the empty road and the white 5-mile marker post remained in Louis' eyepiece view. Louis almost believed he could have imagined the whole thing. But the tortured wreck of a police car was too real to ignore!

Louis felt tense with stored-up excitement and he sat back in his wheelchair for a few minutes. Rolling himself to the refrigerator, he took out a tall glass of orange juice, a cold apple, and a hunk of cheese. The events of the past few minutes had left him hungry. Somehow he had missed his lunch!

After he had eaten the snack, he rolled his chair over to the radio operating desk and tuned over the band. It was still in bad shape — only a few weak signals could be heard. Somehow he did not feel like moving to the 7-MHz band. The thought of mere routine QSOs had little appeal after the exciting past hour.

Well, he thought, *I'll write a note to W2ZI and tell him that his telephone call brought results*. It was so like Louis to give the other fellow the credit.

Louis wheeled over to his typewriter stand and typed out a short letter reporting on the event and the result of the QRRR QSO. Louis neatly filled out a QSL card covering the contact and put note and card in an envelope. He accurately entered all this data in his log book including the QRRR call and its results, in brief, concise wording. (Such records are required by FCC regulations and Louis took pride in keeping a legible, complete log of his operating at WN5WLO).

Late that afternoon Mrs. Manning returned from her work at the busy restaurant on U.S. 66 and, as usual, this evening she had much to tell her son. She liked to collect bits of "outside" talk to pass on to her son.

"Did you hear several sirens up here about noon, Louis?" she asked. "There was a bad accident somewhere up here on our highway!"

"Yes, Mother, I heard them and I saw them, too," Louis replied.

The boy paused as his mother said, "A rock rolled down the hill and knocked a police car off the road into the canyon. The car caught fire," she continued. "Some men came into the restaurant this afternoon and told us about the wreck. As they described it, Tony Delgado was pinned in the wreck but another policeman and the Forest Rangers pulled him out just before the car exploded!"

"What nobody could figure out," she went on breathlessly, "was who reported the accident? There was no one on the road when the police car got there. Which way was the accident from here, Louis, up or down the road?"

"Mother, I guess you didn't hear me. I *saw* the accident!" Louis repeated.

"With your telescope, I'll bet." Mrs. Manning had been so pleased when her son had put together the scope kit that helped broaden his world.

"But did you see anyone down on the road who could have reported the accident? The grapevine said something about a telephoned report of the accident," Mrs. Manning inquired.

"No, Mother. I guess no one else knew about it. Just me . . ."

"You?" questioned Mrs. Manning. "But the phone call? You couldn't have made that. I wonder who did," mumbled Mrs. Manning as much to herself as to her son.

"Guess I did sorta make it — in a way, Mother," admitted the radio amateur. "I passed the word to Ed and he made the call to the Albuquerque State Police Headquarters."

"Who's Ed? I don't remember you mentioning any ham in Albuquerque named Ed."

"This was Ed Raser, W2ZI, Mother. He lives in Trenton, New Jersey, and he was with the State Police Radio there. *Wow* — what an operator!" Louis rattled on. "Look, Mother, you go right on fixing supper and I'll tell you all about it — okay?"

So Mrs. Manning heard a first-hand account of the events of that noon-day episode. Although Louis didn't elaborate on his part in the rescue of the police officer, Mrs. Manning realized that her son must have

More details? Ad Check page 78.

been an important link in the chain of events leading to the saving of the life of a policeman.

Next day at the restaurant counter Mrs. Manning could not help but overhear the buzz of conversation concerning the accident, the timely arrival of the police and the Forest Service rescuers — and how they had pulled Officer Tony Delgado from the wreck just before the car's gas tank exploded.

She heard several versions of the story, but one point everyone mentioned, and still a detail that mystified everybody, was *the telephone call*. No one seemed to know who had made it! The civilian switchboard operator at the State Police Headquarters had stated that a man called in, reported the accident, and urged that immediate action be taken. The car's number 88 checked with that of the Cedro Canyon patrol car. The operator said the man gave his name as Ed Blazer or Fraser or something like that. In the press of the emergency, the Headquarters operator had not made more effort to get the name of the man.

Mrs. Manning, although highly proud of her son's quick thinking and his ability to initiate the rescue action, kept silent during the next few days. The accident and the timely rescue were the topic of chatter during the coffee-break stops by truckers and State Policemen patroling U.S. 66. Officer Tony Delgado was reported to be doing fine in St. Joseph's Hospital. Although he had a broken leg and bad burns, he was coming along satisfactorily and would be out of the hospital in about a month.

The daily events of school study, his ham radio activity and the telescopic nature study occupied Louis Manning. Soon the accident-rescue episode dimmed in his memory.

Then one day a QSL card came from W2ZI. For a day or two Louis relived the 21-MHz contact and the skillful handling of his QRRR call by old timer Ed Raser, in Trenton.

Several weeks later one of the State Police patrol cars stopped outside the restaurant where Mrs. Manning worked. The husky officer got out of the car, came inside, and slid his long legs over a stool. When Mrs. Manning came to serve him he said, "Just a cuppa java and a sugar donut, Annie — and the answers to some questions, please."

Mrs. Annie Manning filled a big mug with coffee, passed the officer the cream and sugar, and then asked, "What have I done now? Parked by a fireplug? I'll go peacefully, sergeant." She smiled across the counter to Police Sergeant Tom Melville, who was one of the "regulars" along this busy highway.

"Isn't your boy, Louis, a radio amateur?"

"Sure, Tom. He has a Novice license. Why? Has he been getting into Dr. Block's TV set again? I thought that interference was all licked. Besides, what's the State Police interested in *him* for, anyway?"

Mrs. Manning mentally recalled an unfortunate incident some time past when Louis first got on the air. His signals had been reportedly interfering with a TV channel. A neighbor, Dr. Block, down the road, had really been upset about it! Louis had put a filter or something on his transmitter. She knew that Dr. Block's TV service man, also a radio ham, put some gadget on the offended TV set. Thereafter Dr. Block had made no further complaints about Louis' radio transmissions.

"No, Annie," replied the officer, "nothing like that at all. Did he tell you he had seen the wreck of Officer Delgado's car?"

"Sure, he told me about it," Mrs. Manning said proudly. "He saw the rock knock Tony's car off the road. Louis got on his radio and passed the word to somebody who made a telephone call to your headquarters. How did you know it was Louis?"

"We *didn't* know till yesterday. Our Chief Radio operator got a letter from a man in New Jersey named Ed Raser, who was at one time the head of the New Jersey State Police Radio System. There is," he continued, "a national organization of Police Communication Officers and, of course, our man belongs to it. Well, this Mr. Raser, who is also an amateur operator, wrote to our station in connection with some Association business. In his letter he inquired about the officer's condition. Mr. Raser said that he had learned of Tony's wreck by radio during a contact with an operator out here in Cedro Canyon."

"But how did you know it was my Louis?" inquired Mrs. Manning as the officer took a bite of his donut and sip of the coffee, which had now cooled to suit his taste.

"The New Jersey man said that the operator's name was Louis Manning and he mentioned his call letters, too. You're the only Mannings living in Cedro Canyon. We put two and two together and came up with your boy. We know now how the emergency call reached us," he went on. "Our telephone switchboard operator, after reading the letter, recalled that it was he, Raser, who had placed the call. But because there was no operator on the line, our switchboard man thought it was a local call!" The policeman halted to finish his coffee and donut.

Mrs. Manning beamed with pride. "Oh, Tom, I'm *so* glad the State Police found out my boy helped! He didn't want me to say anything about it. He said it was just lucky that he had been looking out the window."

"Lucky for Tony, he means, Annie," retorted the police

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sergeant. "That's why I'm here. Tony wants to meet your son to personally thank him for his work on that day." Sgt. Tom Melville continued, "I'd like to meet Louis too, Annie. Too bad he's tied to that wheelchair . . . "

Mrs. Manning broke in, "Yes, sometimes I think of that — but he seems to know more of what goes on in the outside world than I do — and he has a wonderful time with his radio and his telescope."

"That's what we heard, Annie. Say, another thing — did you ever hear Louis say that he needed some new piece of radio equipment? Or is he satisfied with what he has already?"

"Louis is awful proud of his radio equipment. He either rebuilt or made it from a kit. But to tell you the truth, Tom, lately I did notice that he has been poring over an advertisement for some new receiver. He said that its 'specs' were just what he had been looking for. Whatever that meant."

"Could you find out the name of this gadget? Without Louis knowing, that is?" inquired the officer hopefully.

"Sure, I guess so, Tom. But — say — what is this?"

"Never you mind, Annie. So long, I'll see you tomorrow about this time." The officer strode out of the restaurant and resumed his highway patrolling, leaving a bewildered but pleased woman back at the restaurant.

That night, after Louis had gone to bed, Mrs. Manning went to his radio table. There lay the latest copy of *ham radio* magazine. It was not so easy for her to find the correct page, as the edges of the magazine were dog-eared from use. However, the corner of one page was turned down. It was a full-page advertisement for a new receiver. She made a note of the manufacturer's name.

The next day Sgt. Melville came in the restaurant right on schedule. After having his coffee he called to Mrs. Manning.

"By the way — did you get the name of that receiver?"

Mrs. Manning then told him how she had found out what he wanted to know. She gave him the receiver name and type. The police sergeant jotted down the information in his notebook, thanked Mrs. Manning, and left the restaurant.

Mrs. Manning soon forgot the officer's strange request in the busy days that followed. The officer did not again mention the matter although he came in frequently on his patrol route along U.S. 66.

Several weeks later, two trimly uniformed men, one a sergeant, and the other a patrolman, went slowly up the path to the Manning cabin, where they saw a teenage boy sitting in a wheelchair at the doorway, one arm holding open a screen door.

"Hello, Tony and Tom," cried Louis happily, "come right on in!"

Officer Delgado held open the door while Sgt. Melville, entered sideways, handicapped as he was with the big box. Both men greeted the boy warmly. In the excitement of meeting his visitors, the boy did not notice the carton. Sgt. Melville placed the box on a table as Louis invited the men to sit down and make themselves comfortable. Instead, the boy was surprised when both men walked over to the picture window and stood staring down the mountainside.

"I'd like to have a look through your telescope. Okay?" the officer on crutches asked, "Will you aim it at the wreck for me?"

"Sure, it'll take just a minute."

The boy rolled his chair over to the window, skillfully focused the scope and turned to the officer standing beside him.

"There it is — what's left of it!"

Tony Delgado took a long look at the remains of what had been his sleek police cruiser. "*Gracias a Dios, no me maté*," he murmured. (Thanks to God, I was not killed). There was a thoughtful look in his eyes. He stood aside and his officer-companion moved in and he, too, took a careful look.

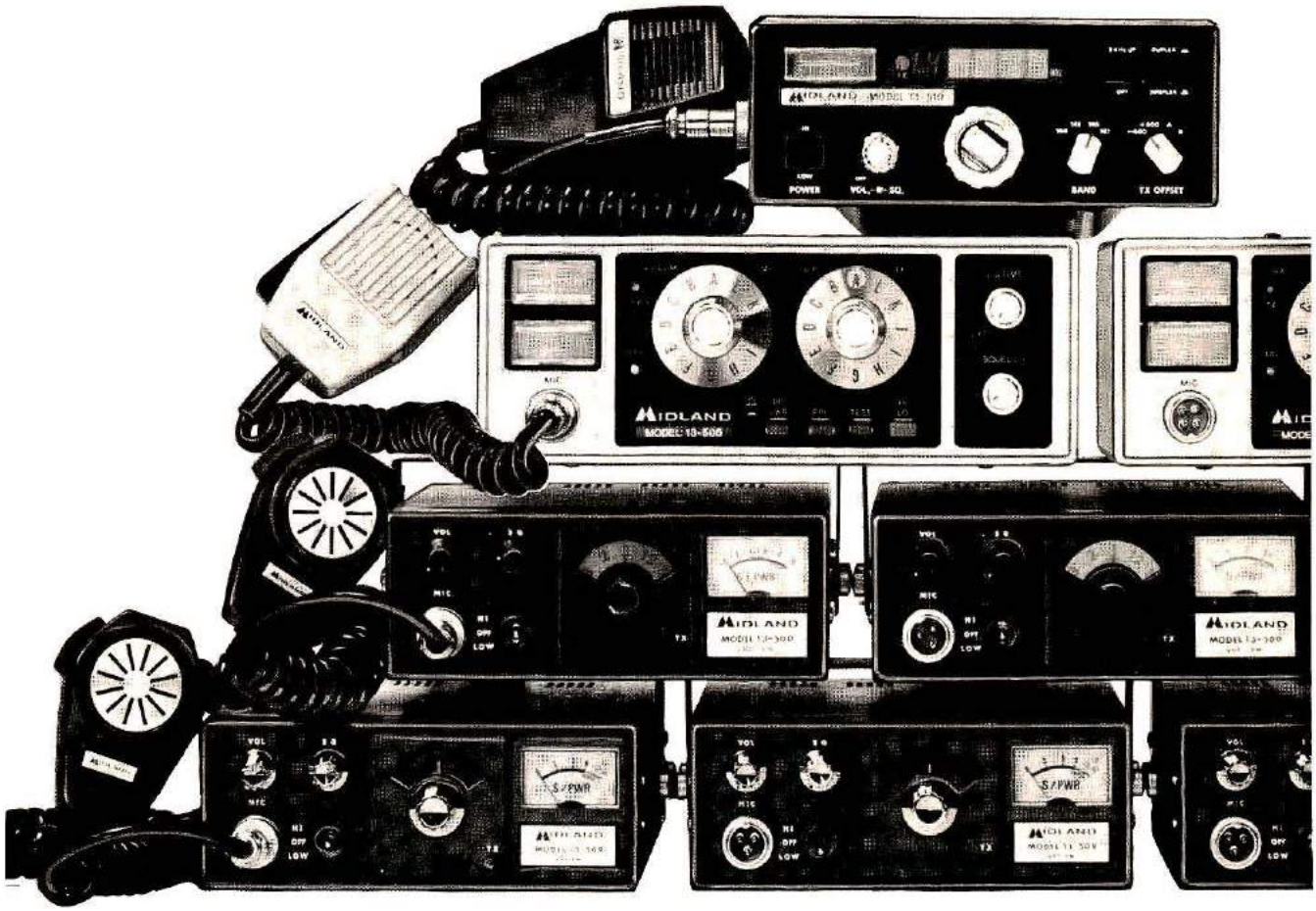
Sgt. Melville turned to Tony and said, "That was a narrow squeak, Tony, I'd hate to even think what *could* have happened down there."

"Lucky for me, I did not have long to think about it, *amigos*!" the becrutched officer stated. "Thanks to Louis here and to his telescope and his radio!" Delgado grinned at the boy, as he continued, "We came up here to meet you and to hear the whole story right from the beginning, Louis."

Thus began a session in which the radio amateur described, in detail, how he happened to be looking at the road. He told what he had seen and the action he had taken that resulted in the eventual rescue.

Both Sgt. Melville and Officer Delgado repeatedly interrupted the boy as they inquired into details not quite clear to them, particularly details in connection with the amateur radio contact. Louis explained in concise, non-technical terms what ham radio was all about, and how it worked. He spoke about the "dead band" and other technical features of the contact. The police officers soon grasped the basic principles and were thrilled with the idea that this youngster, with such a small layout could actually talk all over the country and even to foreign countries. Louis proudly brought out his QSL card album and showed them his highly prized cards. In addition, he displayed the various awards he had acquired.

Although both of the men used police radio daily in their



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The third row lines up Midland's basic 2-Meter mobile—Model 13-500. This popular 12-channel, 15-watt transceiver has a complete multiple FET front end couple with high-Q helicalized cavity resonators. Despite its small size (2¼" h. x 6⅜" w. x 8⅞" d.), it's designed for exceptional service and serviceability.

At the bottom is Model 13-509, Midland's "220" mobile. With 12-channel capacity, crystal controlled, it shares the compact size and receiver features of the 13-500 above, while delivering 10 watts output power (switchable to 1 watt when you want it).

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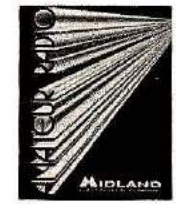

More details? Ad Check page 78.

work, their technical knowledge of radio was, as is normal, limited. The only type of "radio operating" they understood was how to turn on a TV or broadcast receiver to a pre-set position just to be entertained. Tony Delgado did admit to being able to manipulate a tape recorder, while Sgt. Tom Melville said he was real hip with a hi-fi fm tuner, *if* it had pushbuttons. This brought a laugh to the young radio amateur as he showed the men his efficient homebuilt equipment.

Louis got out a jug of apple cider and a bag of donuts. The three sat, talked, nibbled, and sipped. The time slipped away. The boy sensed their genuine interest in what he was telling them. Tony, especially, poured questions at the radio amateur, pressing him for information on how to get started in hamming, and kept insisting that he, Tony, was not smart enough to get a license!

Louis showed the officers several of the QSL cards he had received from "kids," some of whom were less than ten years old! He also pointed out the excellent record of many of the YL (women) operators who had scored heavily against men in all phases of ham radio competition! The officers were impressed with these facts and both granted that if "kids" and "girls" could learn ham radio *they* surely should be able to master the code and the ham theory and eventually get amateur licenses!

"Louis, please put your call letters on my leg cast." Tony stuck out his leg cast.

Louis carefully printed his call and name on the plaster cast and noting another ham call, he asked, "Why, here is Roger MacDonald's call. Do you know Roger?"

"I just met him today. Say — that reminds me, Tom, we almost forgot the other reason why we came up here. Where are those boxes?"

Sgt. Melville went to where he had deposited the big carton, brought it over to the radio table, and grinned at Louis. "It's your party, you open it."

"Yes, Louis, you do the honors. Just get a look at what's inside this carton! Tom, would you please bring the other stuff from the car?"

Melville rose from his chair and strode out to the police car as Louis Manning struggled to open the heavy corrugated box. The boy was hard at it, pulling out the form-fitting foam insert, when the officer returned.

The men watched and Melville offered a hand to pull the big item of equipment from the box. Louis Manning looked at Tony and said with delight — "Wow, it's a *Kenwood 599A receiver*. What's it for, Tony? Are you going into the ham game too?"

"Well, maybe, Louis. But this is for you, *amigo*! You see, you practically gave me back my life when I was lying there in my car unconscious. I'd like you to have this receiver. That is, if you can use it. How about it?"

"Use it!" Tony, I've almost twisted the dials off the advertisement ever since it came out in the magazines a couple of months ago. "Why," — "the boy's eyes sparkled with delight, "I've never even heard a receiver as good as this one!"

Tony asked, "Tom, how about the small box?"

"Louis, Roger MacDonald at the store sent this companion speaker for you. And he threw in a packet of log books and some message blanks, too." Sgt. Melville reached down and picked up the smaller box and the wrapped package of supplies and put them on the table.

Louis Manning was almost beside himself with joy. Now he had a truly modern, efficient, complete receiver on his operating table — for real!

The police officers watched as Louis plugged in the cables and attached the wires to the receiver and speaker. In a few minutes the receiver was hooked up and the *on* switch thrown. The officers kept silent and let Louis handle his new equipment for the first time. Fondly and yet with expert fingers, Louis manipulated the various controls. The cabin echoed with bursts of crisp radio telegraph code signals.

Then, realizing that his visitors could not read radio code, Louis politely excused himself and changed bands. He tuned in on the 14-MHz amateur voice band where he knew there were many phone signals to be heard. The boy stopped tuning as he hit on a loud clear voice signal. The three listened.

By chance, Manning had tuned in on a two-way contact between a YL (young lady) operator, W6NAZ, and a station on a floating ice-island in the Arctic! Lenore was putting through a phone patch between a GI, stationed on a remote icy dot in the Arctic, (which was not even on a map), and his wife in Los Angeles. The couple were talking away over this phone patch almost as though they were talking over a wire telephone circuit, which was of course, impossible, due to the location of the GI. The officers listened intently.

"Why, I saw this lady amateur on TV on *This is Your Life*!" Sgt. Melville exclaimed.

Tony asked, "Can you do this thing, this phone patch?"

"Not now, Tony, But when I get my General license and if I operate on phone I could get patched through — but — we have no telephone here so I can't patch a second person through my rig."

"Louis, if you had been able to use phone on your transmitter, you could have called Headquarters directly from here, by going through some station who could make a patch for you. Am I right?"

"Sure! I could have done that — but since I couldn't I let W2ZI make the telephone call. It was almost as quick!"

"It was fast enough, Louis," retorted Tony Delgado firmly. "Fast enough to get Tom and the Forest Service on the job."

That brought a question to Louis. "Now, let me ask something. How did it happen that Ranger Ronson and his helper got here almost as fast as you did, Tom?"

"Our dispatcher at Headquarters, after radioing me where I was patrolling on U.S. 66, put through a call to the Sandia Ranger Station at Tijeras. The dispatcher knew that Ranger Ronson or some of his men would roll out right away at the first sign of such a call. He knew they might even reach the wreck *before* a police car could! You see, Louis, we policemen work very closely with the Forest Service folks. It works both ways, too — I'm glad to tell you!"

Louis Manning's hands were not idle. His fingers manipulated the controls and he quickly learned how to operate them. He was eager to learn all about his new receiver.

Sgt. Tom Melville looked at his watch and snorted, "Man, we've got to get moving. The Lieutenant didn't give us permission to stay off patrol *all* afternoon!" He rose. "Let's get rolling, Tony."

Young Louis Manning looked at his friend Tony and back at the receiver. For once in his life he was almost speechless, but his young heart was full of thankfulness for the unexpected and kind act of the police officer. Finally he said, "Tony, this is the finest thing I ever owned! I just don't know how to thank you!"

The officer with the plaster cast got slowly to his feet as he placed his crutches under his arms. "Louis, *amigo*, it is I who should thank you."

Tom Melville turned to go out the door, and Louis cried out, "Come back — often — both of you! And many thanks for the log books and message blanks, too!"

Tony Delgado reached the door and called back over his shoulder — "I'll be back Louis. I want you to help me get a license. How about it?"

"Anytime, Tony! I'll be right here. I don't want to *ever* leave this receiver! I'll be sure glad to help you all I can!"

As the men went out the door Melville looked back at the radio amateur, who in these few seconds had returned to his new receiver, and was busily tuning the dial. All else was forgotten in the delight of a new and wondrous piece of equipment.

Thus ended phase two of a friendship which was destined to grow — a friendship founded on a boy's ability to act and react in time of another person's dire need, and nurtured by the inherent desire of a police officer to express his sincere gratitude to the boy who had given him back his very life.

"*Gracias a Dios*," Tony Delgado murmured reverently, "*que suerte la mia*!" To which Sgt. Melville replied softly, "Yes my friend, you are a lucky man — and a grateful one, too."

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HRH

Introduction to the Propagation of Radio Waves

The transmission and reception of radio signals takes place by two basic modes — direct wave and sky-wave propagation. In this article you will learn the fundamentals of what, how, why, when and where to gain understanding

BY OAK OKLESHEN, W9RX

When you transmit or receive a radio signal by way of your station antenna, you may wonder how and why it all happens? Very simply, you can look at your antenna as a conversion device that transforms electrical energy from your transmitter into radio waves capable of travelling through space without wires. You can also look at your antenna as a device that converts radio waves from space into electrical energy that can be used by your receiver. Whether transmitting or receiving a signal, your antenna behaves in much the same way, only in reverse.

The transmitted wave leaves the antenna and travels by one or both of two basic methods. It can travel by *direct wave* — line of sight — or by *sky wave* — first by line of sight until it strikes ionized regions of gases in the earth's upper atmosphere, and then back to earth by reflection. These regions of ionized gases in the upper atmosphere are collectively called the *ionosphere*.

Until satellite and moonbounce communication became a reality, the direct wave was always called *ground* wave; but now the definition must be broadened to include any category that does not involve reflection from the ionosphere.

You can think of these two basic methods this way: Direct-wave transmission includes any method by which a radio wave travels from one point to another without making use of the ionosphere, and skywave transmission is any method by which a radio wave travels from one point to another by means of the ionosphere. Skywave transmission of radio signals is therefore referred to as *ionospheric propagation*.

Direct-wave transmission is easiest to understand, but to understand skywave transmission, it will be necessary to study the ionosphere in some detail. Future issues of *Ham Radio Horizons* will explore the subject of ionospheric propagation because it is still the most useful means for transmitting and receiving radio signals over long distances in the high frequency (hf) amateur bands with elementary equipment. Only frequencies between about 1.8 MHz (160-meter band) and 30 MHz (10 meter band) can be consistently transmitted via the ionosphere. Although the very high frequency (vhf) bands will occasionally make use of ionospheric propagation, the conditions under which this happens are very special and quite rare. Nevertheless, you will find presented here some explanation of how and when these special conditions may occur.

To begin, let's review what happens to the strength of radio signals as they travel along their skywave path from here to there. Compare a radio antenna with an ordinary light bulb. Just as the bulb is a source of light, the antenna is a source of radio energy. The farther away from the bulb you travel, the dimmer it appears, and the farther away from the antenna you travel, the weaker the signal seems. This is due to a law of physics called the *inverse square law* which says that the strength of a radio wave (or light) is inversely proportional to the square of the distance from the source. Let's see what this means in simple numbers. If you travel away from the antenna a distance of one mile (1.6km) and record the signal strength and then move two miles (3.2km) away from the antenna and measure the signal again, it will be only one-fourth as strong. Twice the distance — one-fourth the strength; four times the distance — one-sixteenth the strength; and so on. Each time, the strength is divided by the distance squared. This holds true under "ideal," that is, perfect conditions without taking any other factors into account. Nature is seldom "ideal," however, and usually many other factors must be considered. So it is with the transmission of radio signals by ground wave or skywave. Sometimes the signal is much stronger at the received end,

and sometimes it is much weaker, than the inverse square law would predict. Here's why.

When a ground wave signal is transmitted away from the antenna, part of it is usually absorbed by the surface of the earth or by objects in the signal's path. Sometimes just the opposite occurs, and a signal is "ducted," just as if it were passing through a tunnel or tube, being prevented from spreading out in all directions. In vhf propagation, a signal can be naturally ducted or tunneled by the effects of certain weather patterns and conditions in the lower part of the earth's atmosphere called the *troposphere*. The troposphere exists from the surface of the earth up to a distance of about six miles (10km). In another example — manmade this time — a signal is confined within a metal tube called a waveguide and is artificially conducted from its source to the point where it is received. This is something like a heater duct from your furnace conducting heat around your house, or a water pipe conducting water from its source to the point where it is used. Light is ducted in a laser beam because it is produced in such a way that it does not spread out like light from an ordinary bulb. Laser beams have been reflected from the moon using small amounts of power that, if used by an ordinary light source, would never even reach the lunar surface.

Radio antennas can be made to avoid the inverse square law to some extent by concentrating the radio waves in a narrow beam, thereby preventing them from spreading out as much as they normally would. Such antennas are called *beam* antennas, and many are used for TV and fm reception. You may have one . . . or more.

These are some of the reasons that the inverse square law does not always hold true in practice: Natural conditions occasionally "get around" the law, and manmade conditions can be provided to avoid it.

The Ionosphere

You have already learned that skywave propagation relies on the upper regions of the earth's atmosphere called the ionosphere. There is nothing very mysterious about this part of the atmosphere, except that it does have the ability to reflect radio signals. Do you wonder why that happens to only a part of the atmosphere? **Fig. 1** is a rough sketch showing only one region of the ionosphere for simplicity. Actually, there are three separate regions, or thick layers, called the D, E, and F ionized regions. Several short explanations are certainly in order. First, what happened to the A, B, and C regions? Simple; the discoverers thought that there might be other, lower, layers but weren't sure, and they didn't want to take a chance. Later, it was found out that lower layers did not exist, but the original names stuck.

Secondly, why are the layers there and how do they reflect radio signals? Amateur radio operators sometimes think of the ionosphere as being there for the exclusive purpose of aiding amateur communication, but this is really only a fringe benefit. The real reason for the existence of the ionosphere is because the sun emits ultraviolet and X-radiation, together with visible light. The ionosphere "traps" most of the undesirable or harmful radiation, allowing heat and light — necessary for life — to filter through. The trapped energy works on the gases in the upper part of the atmosphere, bombarding the molecules of oxygen, nitrogen, and some helium, causing them to *ionize*.

In their normal, quiet state, these gases have regular and predictable atomic and molecular structures. Each atom has a nucleus (positive charge) surrounded by orbital electrons (negative charge). These are the same electrons that flow in an ordinary electric current, except that they are tightly bound to atomic nuclei. When these atoms are struck by ultraviolet and X-rays, however, the electrons are driven farther away from their nuclei than normal, and the molecules, which are made up of strings, clumps and chains of atoms, become ionized. The nucleus of each atom no longer sees its orbital electrons close enough to remain neutral, so it separates into a positively charged entity called an ion and several negatively charged electrons.

If enough atoms are bombarded in this manner, the molecules are affected and

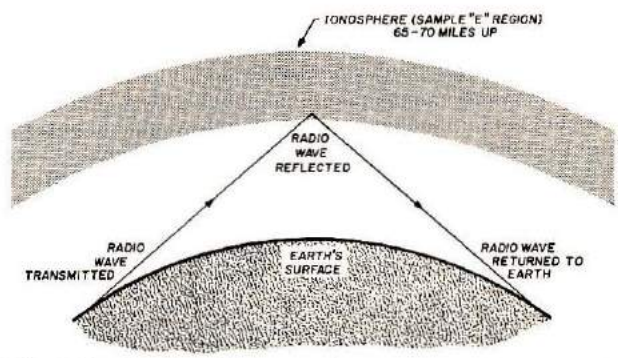

Fig. 1. A radio signal (sky wave) leaves the earth and travels to the ionosphere where it is reflected and returned to earth at a distant point. Although the ionosphere consists of several layers at different heights, the "E" layer is representative. The "D" layer is lower and the "F" layer is higher than the "E" layer, but all contribute to *ionospheric propagation*.

separation takes place. The gases are no longer in their normal state, but instead, become "clouds" of oppositely-charged particles from which radio waves are easily reflected. If the sun were to disappear for a day or two, the separated positive and negative particles would recombine, and typical atoms and molecules of the same gases would soon reform. Not all of the electrons return "home" however, and some of them remain free, particularly those of the oxygen atoms. Oxygen, stripped of its customary number of electrons, becomes *ozone*, which forms its own layer in the upper atmosphere. The ozone layer also shelters life on earth from harmful radiation.

As an illustration, a similar effect takes place on earth in an ordinary neon sign. Neon gas enclosed in a glass tube with an electrode at each end is excited by placing an electrical voltage across the tube, causing current to flow through the gas. Orbital electrons surrounding the nuclei of the neon atoms are driven farther away from the nuclei. When they try to "fall back" and return to their original positions, the released energy is given off as red-orange light, and the gas is said to be excited. It is possible that, if the ionosphere were pure neon, around-the-clock neon lighting from the sky would be visible all over the earth.

Continuous ionization and de-ionization takes place in the earth's atmosphere, with the ionosphere absorbing the sun's harmful rays. At night, less ionization takes place than during the day, causing the reflecting mirror for radio waves to become less reflective.

In future articles you'll read about the individual regions of the ionosphere in more detail, what happens to them, and how each affects radio communications in its own unusual way. **HRH**

More details? Ad Check page 78.

DX forecaster

April, 1977

Good news, DXers — the word is out; bottomed out, that is. Sunspot cycle 20 reached its lowest point in July or August 1976, and since then has started its upward turn. Conditions last fall on 15 meters gave some indication that this was the case in spite of being partly masked by the effects of mini-flares on the sun that helped propagation along through September, October, and into November.

The best DX band for April will be 20 meters for daylight and early evening hours. For a few hours after sunset optimum propagation conditions will be shared between 20 and 40 meters, with 20 gradually fading to nothing and 40 remaining favorable until sunrise. Fifteen meters will not be quite as good as it was in the fall and winter, but a few openings into Europe and the Pacific can be expected. Most of the strong openings will be trans-equatorial into South and Central America, and occasionally Africa. Best times to listen will be in the afternoon, local time. Ten meters will be sparsely populated except for rare occasions when a good north-south path will open. Eastern USA and mid-USA stations can expect South and Central Americans to pop through, while stations on the west coast ought to point their beams toward the South Pacific when any sign of activity appears on ten. *Top banders* might want to look for some DX in the dark hours and up until local sunrise. Also, check 80 meters for the fun of it, because some good DX signals will appear as welcome surprises on both bands.

Long path propagation to the populous areas of the world can be expected during April and into May, so once in awhile swing your beam 180° to its normal direction. Particularly good times to try this will be during twilight at both ends of the path, when propagation of signals in a north-south direction along the terminator is heavily favored.

As you know, April showers bring increased atmospheric noise, and static will be rearing its ugly head more often. This will be less of a problem on the higher bands but 40 and 80 meters will often be useless for DX because the signals — although present — will be swamped by noise.

On the vhf bands, the Lyrid meteor shower in late April will provide some fun by way of meteor scatter propagation. Increased sporadic-E openings will activate 6 and 10 meters for short skip opportunities. Eight-to-Noon and Five-to-Nine local time will be the best hours to listen. On ten meters, the short skip distances can be expected to vary from a short-short of 700 miles or so to a long-short of about 1500 miles.

Propagation special

Two major solar events will take place in April: A lunar eclipse on the 8th, and an annular solar eclipse on the 18th!

Propagation conditions may be affected by ionospheric disturbances on these dates, with the more prominent effects centered on the 8th. Expect April 8th through 10th to be disturbed, however. Conditions will be getting back toward normal for about one week, and then will be increasingly disturbed again beginning around the 15th or 16th and peaking on the 17th or 18th.

Considering all of the factors that may affect the earth's weather (atmosphere) and ionosphere, you should also be on the lookout for unusual weather conditions following the peak ionospheric disturbances by a day or so — in other words, around April 10th and 20th.

Keep a sharp lookout for rapid changes in the solar index and geomagnetic flux data as reported by WWV — particularly as the 8th and 18th approach — and be guided by what you hear.

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 per cent or as few as 25 per cent of the days, with an average of 50 per cent being the rule.

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

For convenience, Greenwich Mean Time (GMT) is given adjacent the left-hand edge of the chart. The four major United States time zones are given beside the area column, with corresponding local times listed.

GMT	PST	WESTERN USA ↑	↗	→	↘	↓	↙	←	↖	MST	MID USA ↑	↗	→	↘	↓	↙	←	↖	CST	EST	EASTERN USA ↑	↗	→	↘	↓	↙	←	↖
0000	4:00	—	—	20	20	—	15	15	—	5:00	—	20	20	—	—	15	—	—	6:00	7:00	20	20	—	20	20	—	15	—
0100	5:00	—	—	20	20	15	15	15	—	6:00	—	—	20	—	20	15	20	—	7:00	8:00	20	—	—	—	20	—	—	20
0200	6:00	—	—	—	20	20	15	15	—	7:00	20	—	20	—	20	15	20	—	8:00	9:00	20	—	—	—	40	—	—	20
0300	7:00	20	—	—	20	20	15	15	—	8:00	20	—	—	—	20	20	20	20	9:00	10:00	20	80*	40	—	40	—	—	20
0400	8:00	20	—	—	20	20	15	15	—	9:00	20	—	—	—	20	20	—	20	10:00	11:00	—	80*	40	40	40	—	—	—
0500	9:00	20	40	—	—	20	20	20	20	10:00	—	—	—	40	—	20	—	20	11:00	12:00	—	80*	40	40	40	—	—	—
0600	10:00	20	40	—	40	20	20	20	20	11:00	—	—	—	80*	—	20	—	—	12:00	1:00	—	40	40	40	40	—	—	—
0700	11:00	—	40	—	40	—	20	20	20	12:00	—	—	—	80*	—	20	—	—	1:00	2:00	—	80	40	40	80*	—	—	—
0800	12:00	—	—	—	40	—	20	20	—	1:00	—	—	—	80*	—	—	—	—	2:00	3:00	—	—	—	—	80*	40	80	80
0900	1:00	—	—	—	40	—	40	20	—	2:00	—	—	—	80*	—	—	—	—	3:00	4:00	—	—	—	—	80*	40	40	40
1000	2:00	—	—	—	40	—	40	20	—	3:00	—	—	—	80	—	—	—	—	4:00	5:00	40	—	—	—	—	40	40	40
1100	3:00	—	—	—	—	40	40	40	40	4:00	—	—	—	—	—	—	—	—	5:00	6:00	—	—	—	—	—	40	40	40
1200	4:00	—	—	—	—	—	40	40	40	5:00	—	—	—	—	—	—	—	40	6:00	7:00	—	—	—	—	—	—	—	—
1300	5:00	—	—	—	—	—	40	40	40	6:00	—	—	—	—	—	—	—	40	7:00	8:00	—	—	—	—	20	20	—	20
1400	6:00	—	—	—	—	—	40	40	40	7:00	—	—	—	—	—	—	—	—	8:00	9:00	—	—	—	—	20	20	20	20
1500	7:00	—	—	—	—	—	40	—	—	8:00	—	—	—	20	—	—	20	20	9:00	10:00	—	—	—	—	20	20	20	20
1600	8:00	—	—	—	20	—	—	—	20	9:00	—	20	—	20	—	—	20	20	10:00	11:00	—	20	—	—	—	20	—	20
1700	9:00	20	20	—	20	—	—	—	20	10:00	—	—	—	20	—	—	20	20	11:00	12:00	—	20	—	—	—	20	—	—
1800	10:00	20	20	—	20	—	—	—	20	11:00	—	—	—	20	—	—	20	—	12:00	1:00	—	20	15	—	15	—	—	—
1900	11:00	20	20	—	15	—	—	—	—	12:00	—	—	15	20	—	—	20	—	1:00	2:00	—	20	15	15	15*	—	—	—
2000	12:00	—	—	—	15	—	—	—	20	1:00	—	20	—	15	—	—	—	—	2:00	3:00	—	20	20*	15	15*	—	—	—
2100	1:00	—	20	—	20	—	—	—	20	2:00	—	20	—	15	—	—	—	—	3:00	4:00	—	20	20*	20	15*	—	—	20
2200	2:00	—	20	20	15	—	—	—	—	3:00	—	20	20	15	—	—	—	—	4:00	5:00	—	20	20	20	15	15	15	20
2300	3:00	—	20	20	20	—	15	—	—	4:00	—	20	—	15	—	15	—	—	5:00	6:00	—	20	20	20	20	15	15	20
	APRIL	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

April 1977

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
*All International events such as contests are shown on the GMT days on which they take place even though they may actually begin on the evening of the preceding day in North America			Special Event Station ZS1CTF will commemorate the Cape Town South Africa Festival during the month of April 1977, operating from 1800-2200Z daily, around the clock on weekends, all bands 10 through 80, plus OSCAR and VHF frequencies		1	Columbus ARC Hamfest — Fine Arts Building Fairgrounds — Columbus, GA — K4JNL or K3MTY — 2-3 Tennessee QSO Party — CW & Phone — By Tennessee Council of Amateur Radio Clubs 2100Z Sat - 0500Z Sun — 1400-2200Z Sun W4OGG QRP ARC International QSO Party — 2000Z Sat - 0200Z Mon — W5TVW* Zero District QSO Party — By Mississippi Valley Radio Club 2000Z Sat - 0200Z Mon* 2
Greater Baltimore Hamboree — Calvert Hall College — Goucher Boulevard & LaSalle Rd — Towson, MD — W3WVC SE Michigan ARA Hamfest — S. Lake High School — Nine Mile Rd & Mack Ave St. Clair Shores, MI — WB8PRJ Six Meter Ground Wave Contest — 0300-0700Z — K9DTB* 3	4	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) 5	West Coast Qualifying Run 6	7	8	9
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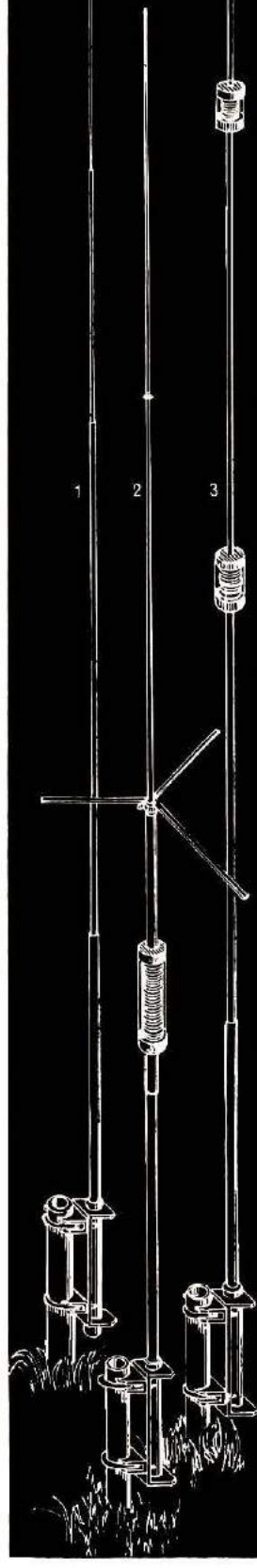

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UNWANTED SIDEBAND SUPPRESSION: Better than −40 dB
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AF RESPONSE: 400 to 2600 Hz (−6 dB)
AUDIO INPUT SENSITIVITY: 0.25μV for 10 dB (S+N)/N
SELECTIVITY: SSB, 2.4 kHz (−6 dB), 4.4 kHz (−60 dB). CW 0.5 kHz (−6 dB), 1.5 kHz (−60 dB) (with accessory filter)
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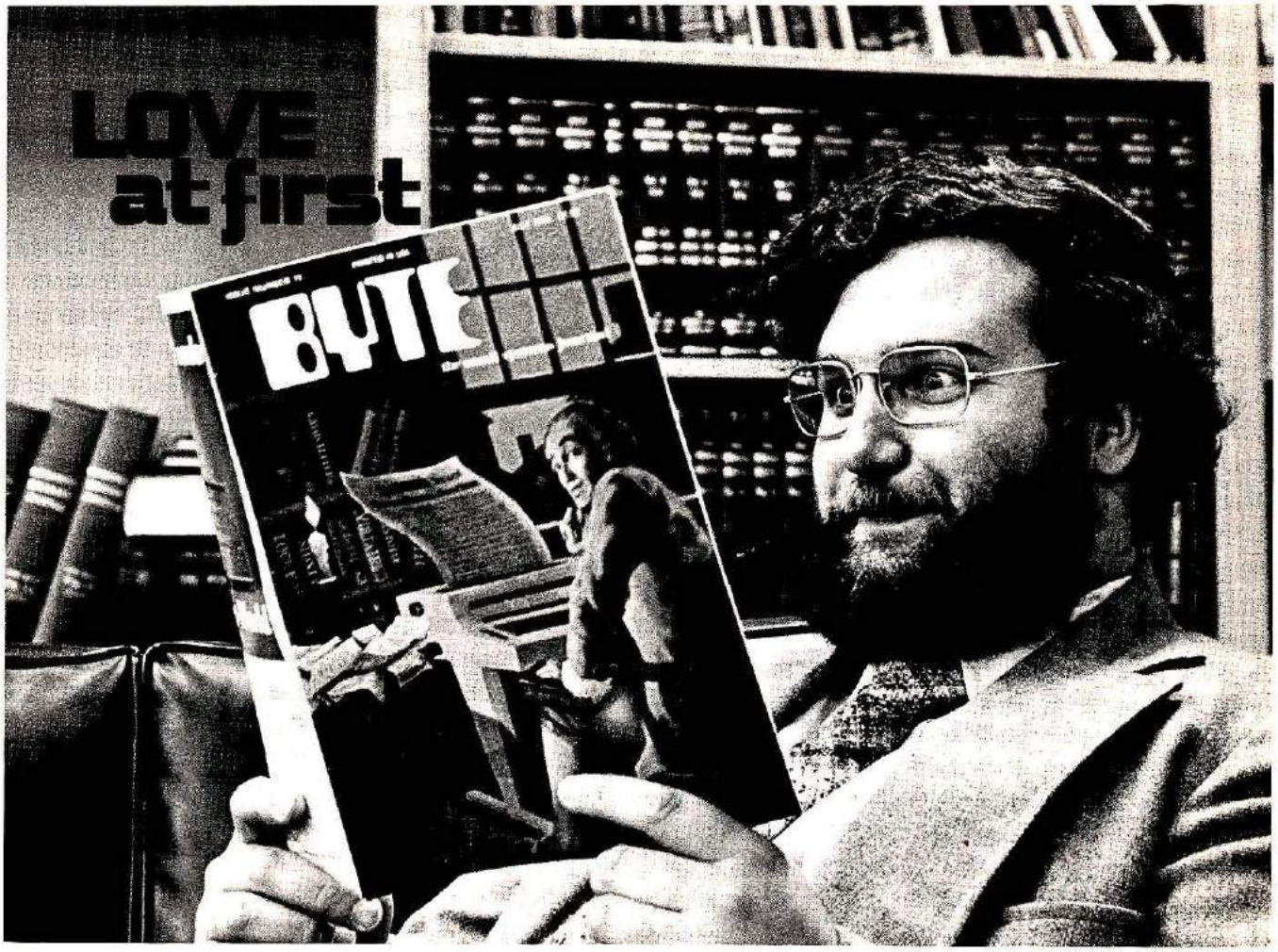

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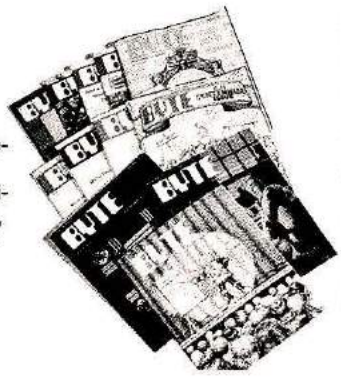

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