Sams PUBLICATION

So you want to be a Ham

by Robert Hertzberg, K4JBI

so you want to be a HAM

by

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Preface

Ham radio is one of the greatest hobbies in the world. It is so widely practiced that it is recognized and licensed by practically every country in the world. Realizing its value to national security, the United States Army, Navy, and Air Force sponsor ham-radio organizations. It is encouraged by the electronics industry because of its importance to technical progress. Municipal officials everywhere have praised the contributions of ham radio to public service and disaster aid.

Thousands of new enthusiasts are attracted to ham radio each year. This book is intended to get beginners of all ages off to the right start in this fascinating hobby; it also serves as an invaluable reference for the old timer who has been "pounding brass" for years.

The entire field of amateur radio is encompassed in this volume —from the various types of licenses, and the requirements and procedures for obtaining them, to painless methods for learning the code. This book covers the value of kit building and the practical knowledge and experience gained in assembly. Completely updated, other chapters are devoted to receivers, transmitters, mobile equipment, test equipment, and antenna systems. In addition, such diversified subjects as operating procedures, the organization of amateur radio, and where and how to purchase equipment are included. The chapter on electronics as a career will be of particular value to young men.

ROBERT HERTZBERG K4JBI

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The Amateur Radio Game

It is late in the afternoon of a wintry day and you're killing time before supper. All you can find on TV is an old Western in which the "good guy" manages to coax nine or ten shots out of a six-shooter without reloading. For relief, you turn on the old all-wave console radio you have retained for just such emergencies. As the set warms up, a lot of grinding noise comes out of the speaker.

"Must be in one of the short-wave positions," you mutter to yourself. As you reach for the band switch, you are stopped by a loud, clear voice. "Hello VE8MA, VE8MA, Victor Easy 8 Mike Able. This is HH3DL, HH3DL, How How 3 Dog Love, answering. Thanks for the call, old man. You're coming in fine business in Haiti. The temperature here is about 80 and the fishing is fine, but I bet it's different up your way. Where are you located? Can't find you in the call book. VE8MA from HH3DL. Go ahead."

On the very same spot on the dial another voice pops out.

"HH3DL, HH3DL, this is VE8MA, VE8MA returning. All okay, but why did you have to tell us about your weather? We're located at a Canadian government weather station on Eureka Sound, Northwest Territory. You may have trouble finding this on a map, because we're only 600 miles from the North Pole, and brother, it's cold up here! We only get mail a couple of times a year, so we sure make good use of ham radio . . . ."

The voice fades away and a hodge-podge of others drifts in, but what you've heard sets you on your ears. How can a chap in Haiti carry on a conversation with someone on top of the world? What's "ham radio"? You twist the band-changing knob and as luck would have it you again encounter a mess of talking and whistling. Your attention is caught now by a female voice with an unmistakable southern drawl.

"Hello CQ, CQ, CQ. Calling any 75-meter amateur phone. This is W4XYZ, Washington 4 Xray Yokahama Zanzibar, W4XYZ, in Richmond, Virginia, calling and listening. Ov-er."

This limpid invitation brings startling results. The dial is crowded with anxious males calling W4XYZ and identifying themselves by various other strange combinations of letters and numbers.

"Hm, this is getting interesting," you say. "Wonder what she does now? "

Even while some lads are still calling her, Dixie Belle answers a lucky one in Philadelphia. During a back-and forth conversation lasting fifteen minutes, they exchange names, addresses, details of their sending and receiving equipment, etc., and are fast friends by the time they are cut off by interference by other stations similarly engaged. You hear every word on both sides, but curiously you don't feel that you've been eavesdropping because it's all been so cozy and congenial.

"Say, this is fun," you muse to yourself, as you go in to eat. "I'll have to look into it."

The next day you are full of questions, to which you might or might not get answers from your friends. How does a man get himself on the air with his own transmitting station? Who issues the licenses and those tricky call letters mentioned by the operators you heard? How much do they cost? What's the age requirement How much does equipment cost? You don't realize it quite yet, but *the bug has bitten,* and you are on the way to becoming a *ham!*

WHAT'S A "HAM"?

One of the first things you learn is that amateur radio operators rarely call themselves that; they are *hams.* In other fields of activity, particularly the theater, calling a man a "ham" is likely to get you a swift right to the jaw, but in radio circles the term is one of distinction. Practicing this great hobby are doctors, lawyers, and Indian chiefs; generals, admirals, and lowly seamen; corporation presidents, bus drivers, and grocery clerks; retired octogenarians and boys whose voices haven't changed yet; grandmothers and teenage girls; even the king of an Asiatic country and a one-time candidate for the presidency of the United States. All are proud to be "hams." The origin of the word is a complete mystery, even to hams who have been hams for fifty years and more.

Amateur radio is almost as old as radio itself. Intrigued by the possibilities of communication through space, electrical experimenters at the turn of the last century emulated Marconi by building crude but successful receivers and transmitters. By 1910 there were several hundred such "wireless amateurs" in the United States alone, and others in Europe.

The technical contributions to the art made by amateurs, and their right to maintain private stations for experimental and non-commercial purposes, were recognized and affirmed in the first Federal legislation regulating radio communication passed by Congress in 1912. A licensing procedure was set up, and certain restrictions were imposed on amateur operation to prevent interference with vital ship-to-shore communication. Power was limited to one kilowatt, and the maximum wavelength to 200 meters. (This is now the bottom edge of the regular broadcast band.) The wavelengths in general use during this period ran from 600 meters and upward. Many technicians thought that anything as short as 200 meters was useless, and that the poor hams would soon die off because they'd be unable to communicate with each other. The hams promptly proceeded to prove otherwise, and today receive full credit for the extraordinary development of short-wave radio as we now know it.

FCC LICENSES

Radio laws were first administered by the Department of Commerce, then by the Federal Radio Commission, and now by the all-encompassing Federal Communications Commission (FCC). The government attitude toward hams has consistently been paternalistic and protective; hence, ham radio as a hobby has had a steady and ever-increasing growth.

No license of any kind is needed for short-wave receivers, any more so than for broadcast or television sets. However, you must have an FCC Amateur Radio License to operate transmitting equipment for communicating with other amateurs, regardless of how small or low-powered it is. There's no limit on the number of transmitters you can own and use under a single license—you can fill a whole basement with them, put one in your car, boat or airplane, carry one on your back, and have still others at a camp or cottage.

All ham licenses are issued without cost.

Eligibility for Licenses

Any citizen or national of the United States is eligible for a ham license, or "ticket." Get this: *any* citizen, man or boy, woman or girl, healthy or disabled. Age is no bar. The only requirements are the ability to send and receive the International Morse Code, a knowledge of a few technical fundamentals, and a familiarity with FCC regulations. In 1948, two brothers aged eleven and nine, respectively, both passed the FCC examination. They were Ken

William Lattig, W9FZE, and Lowell Kay Lattig, W9FZJ. Probably the outstanding junior of all time was Jean Hudson, who in 1934 or thereabouts flabbergasted FCC inspectors by copying 20 words per minute. She was then just eight years old! At the time Jean and the Lattig boys got their tickets the examination was much more difficult than it is now.

Michael Homenick, WA2PAO, Flushing, N. Y., was scarcely 15 when he obtained his general-class license in 1961. From this neat, compact "shack" in a corner of the basement, he has worked stations all over the world. His equipment is modest: Drake 2-B receiver, Heath DX-40 transmitter and Heath VFO (from kits), and home-brewed modulator for phone transmission. Table is four feet wide; shelf provides extra space.

The inauguration of the relatively easier "novice" and "technician" licenses in 1951 enabled many would-be hams to qualify for licenses with less preparation than previously required. The FCC has records of three seven-year-olds who made the novice license on the first try. One was a girl. Of the boys, one found blindness no handicap in achieving his aim.

The enthusiasm that fired these youngsters was shared by Dr. J. Van Becelaere, a retired physician of San Diego, Cal. He got his ticket in July of 1951, when he was a mere 86 years old!

In many households ham radio is a family affair. The contagion starts with a parent or child and works out in either direction.

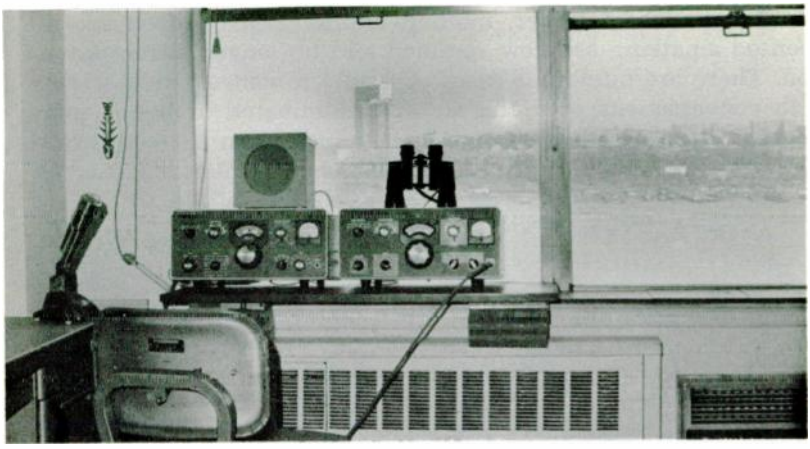
Families in which father, mother, and several children are all licensed amateurs are now common and no longer attract attention. There are numerous cases of "radio romances" that started with conversations over the air and culminated in happy marriages. Since the children of these couples learn to recognize a microphone about the same time they learn to feed themselves, it's no wonder that they become hams at a tender age.

When this photo was taken in 1970, Frank Frimerman, W2FZ, was hale and hearty at 75 years of age and had been an active ham for more than half a century. Equally adept with microphone and electronic keyer, he operates from this Heathkit-equipped station in the Bronx section of New York City. Whether they are 15, 75, or in between, hams share an unbounded enthusiasm for their international hobby.

Standard Types of Licenses

At the end of 1975 there were about a quarter of a million amateur licenses in effect in the United States and its possessions and territories. There are probably four or five times that number of ex-hams who have let their tickets lapse over the years but who retain their interest in the game, usually by continuing to use short-wave receivers. In other countries of the world there are about 50,000 licensed operators. The majority of them speak English, which is now indubitably the international language.

There are five grades of ham licenses: *novice, technician, general, advanced, and amateur extra.* As their names imply, they require different degrees of technical know-how; also, they offer progressively better operating privileges on the air. The licensing procedure is described in detail in Chapter 5, but there is some-



Living in a crowded New York apartment is no deterrent to a determined ham. Here, a board across a windowsill holds a Collins receiver and transmitter without blocking the view of the Hudson River and of the New Jersey cliffs across from Manhattan. An automobile type antenna protruding from under another window permits plenty of DX contacts. Field glasses are for observation of the passing parade of ships of all kinds.

This lady isn't posed in the picture just to give it human interest. She makes good use of this almost bewildering array of receivers and transmitters, acquired by her and her husband over a period of years. She is Vera K. Woods, W7TGG, Brady, Montana, and her "old man" is Ray, W7SFK. They must be the local power company's best customer!

thing you should know immediately: *You do not have to start with the novice license.* If you feel qualified, you can apply directly for the technician, general, advanced, or even the amateur extra ticket.

Modest, but busy, ham station in the corner of a room. On table, left to right: Electro-Voice 664 microphone, Heathkit SB-102 five-band transceiver, Italian-made Geloso general-coverage receiver. Accessories on shelf: three-inch oscilloscope, 24-hour clock on antenna tuning indicator, speaker, and callbooks. Operator is using earphones to avoid bothering TV listeners in the same room.

To appreciate the differences among the various licenses, it is necessary to have a picture of the divisions of the seven most popular ham bands (Table 1-1). The latter are designated roughly in terms of wavelength as *80 meters, 40 meters,* etc., and more accurately in terms of frequency. The abbreviation *MHz* stands for *megahertz.* The prefix *mega,* of course, means *million.* The unit *hertz* was adopted by international technical societies in the 1960's to honor Heinrich Hertz, a German scientist whose experiments in the 1880's led to the practical development of the "wireless." The term *hertz* has exactly the same meaning as *cycles per second,* and takes various common prefixes such as *kilo, mega, giga,* etc.

Technically, radiotelegraphy is permitted in all portions of all bands, while radiotelephony is permitted only in the assigned

phone sections as shown in Table 1-1. However, it is very unusual to hear anything but voice on the phone frequencies.

Table 1-1. Frequency Division in Ham Bands

Band	*Frequency (MHz)*	
	Entire Band	*Phone Section*
80 Meters	3.500-4.000	3.775-4.000
40 Meters	7.000-7.300	7.150-7.300
20 Meters	14.000-14.350	14.200-14.350
15 Meters	21.000-21.450	21.250-21.450
10 Meters	28.000-29.700	28.500-29.700
6 Meters	50.000-54.000	50.100-54.000
2 Meters	144.000-148.000	144.100-148.000

The novice license, as you might expect, is the easiest to obtain. You must be able to send and receive code at the rate of five words per minute and pass a simple examination covering basic radio theory and operating procedures. Considering the ages of the boys and girls who sail through the tests without strain, the novice ticket is, literally, kindergarten stuff. Operating privileges are a bit limited, but at least you can get on the air quickly. You may use only radiotelegraphy, with a maximum of 250 watts of transmitter power, on 3.700 to 3.750 MHz; 7.100 to 7.150 MHz; 21.10 to 21.20 MHz; and 28.10 to 28.20 MHz. *You are not permitted to use radiotelephony at all.* A novice license runs for two years and is not renewable. You can apply for a higher license at any time during this period.

The novice ticket is available not only to rank beginners but also to former hams who have not been licensed for 12 months or more prior to the date of any new application.

The technician license also requires the five-word code test, but the written test calls for more technical knowledge. You may operate telegraph and voice with as much power as 1000 watts on 50.1 to 54 MHz and 145 to 148 MHz. The ticket is good for five years and can be renewed indefinitely every five years thereafter. Nine relatively unexplored bands, starting at 220 MHz, are also open to technicians for virtually unlimited experimentation.

For the general/conditional license, the applicant must do 13 words per minute with the code and pass a written test dealing with general amateur practices and the FCC regulations. All of some bands and major parts of the others are open to holders of this ticket. The exclusions comprise certain segments reserved for advanced and amateur extra operators. Lots of people of all ages qualify for the general/conditional as their first ticket.

The advanced license, the next higher grade, consists of the 13 word-per-minute code and a slightly more extensive written exam. The highest license, the amateur extra, really should be called the *expert* because it calls for code at 20 words per minute and a really tough technical and operating exam. The only way to build up code speed is by practice, so most holders of the extra ticket are hams with a lot of experience on the air.

Look closely at this picture. Would you believe that the occupant of the motor-driven chair, a disabled victim of multiple sclerosis, has been called a life saver by grateful people who have never met him? He is Francis Healey of Oakland Park, Florida, better known to fellow hams on several continents as WA4VWJ. On one occasion he was able to organize a rescue party to an isolated section of Honduras; on another occasion, he helped to save a boatload of passengers on a stricken vessel off Guatemala. He has spent as much as eleven hours a day at his station, which was assembled for him by friends. What a wonderful activity ham radio is for this ex-Marine and for many other men and women in his position!

These restrictions and allotments aren't as bad as they sound. Actually, the bands are very wide in terms of tuning space on the dials of transmitters and receivers, and some sections of the bands are relatively uninhabited.

Like the technician, the three higher licenses are good for five years, are renewable in the same manner, and allow the use of 1000-watt transmitters.

This division of the ham frequencies does not mean that holders of one class of license must communicate only with other holders of the same ticket. Extras, advanceds, and general/conditionals are free to move into the novice and technician bands and to hobnob with the licensees here, giving them code practice, technical assistance, operating hints, etc. However, novices and technicians may not go into the segments reserved for the other classes. This sounds like discrimination, and it surely is, but it only encourages beginners to elevate themselves quickly into the higher grades.

The frequencies assigned for amateur operation are subject to change in accordance with international and domestic regulations. For current information consult the magazines *QST*, *CQ*, and *Ham Radio*, which are sold by most ham radio dealers.

CODE VS. PHONE

Some newcomers to the game are bothered by the necessity of learning the code. "I intend to use only voice operation. Why should I mess with dits and dahs?" is a common complaint. It is only after a beginner masters the code that he begins to appreciate its usefulness, and also to understand why the FCC and the great majority of the hams themselves insist on keeping it as a basic requirement for a license.

Communication by dits and dahs is usually called "CW" operating. (The letters stand for "continuous wave.") The dits and dahs are merely short and long spurts of these waves, made by the action of a hand-operated telegraph key. In radiotelephone operation, usually referred to simply as "phone," the same continuous waves are modulated to conform to the voice of the operator as he impresses it on a microphone, or "mike." A CW signal occupies a very sharp, narrow slice of space on the air, while a phone signal needs a much wider slot. You might liken the former to a motorcycle, which can weave in and out of traffic readily; and the latter to a passenger car, which is much less maneuverable.

CW signals convey intelligence only by their length, not by their musical quality or tone. Any short sound or noise is a dit (sometimes called a dot), a slightly longer one a dah (sometimes called a dash). CW signals can be weak, distorted, hacked up by interference, almost obliterated, yet a skilled operator can usually

Two duplicate operating positions, five separate kilowatt amplifiers for the bands 10 through 80 meters, five separate antennas, and a generally elegant atmosphere are some of the features of station W2AB, assembled over a period of years by Lawrence LeKashman, Long Island, N.Y. A noted winner of operating contests, Larry can work on two bands at the same time by means of split headphones! Head of an electronic firm, he is one of many active hams who work professionally in electronics and enjoy radio as a hobby.

catch enough letters or whole words to form an understandable message. Many experienced hams can even "read" two simultaneous signals if they are of slightly different pitch!

Phone signals, on the other hand, are much more vulnerable to the effects of noise and interference. Since voice intelligence is conveyed by changes and shading in enunciation, inflection, etc., it is not surprising that the usefulness of received signals drops very rapidly if they are broken up by other modulated signals on closely adjacent frequencies. Phone signals can be very loud and still have no more meaning than the sounds in the testing room of a saxophone factory.

Transmitter power, operating frequency, atmospheric conditions, etc., being equal, CW and phone signals will travel equally as far. However, because CW signals can be separated more easily in a receiver and are understandable even if weak and distorted, they provide useful communication in circumstances that render phone signals useless. From the practical standpoint, this means that you can communicate with CW over much greater distances with much less trouble than with phone. Putting it another way,

you need much more power on voice to achieve the same relative degree of reliability as on CW.

Many, many years of experience bear this out. With simple, low-powered CW transmitters one-third the size of a standard short-wave receiver, hams have no trouble at all working around the globe. Some years ago an amateur in the Bronx, in New York City, was the most reliable contact with an expedition in the wilds of South America. Day after day he received dispatches from the explorers and sent back news and other information, all on CW. He tried to keep the details of his transmitter a secret, because he felt that no one would believe him. The rig used one, solitary receiving tube of a type then called "peanut" (today we'd call it "miniature"), energized by three 45-volt "B" batteries and drawing the grand power of exactly one watt!

You may learn the code only because of the FCC requirements, but you will soon become quite proud of your ability to sling the dits and dahs. You will probably discover, as many hams do eventually, that it is much more challenging and sporting to work a New Zealander with one to ten watts of CW than to contact a

What's a TV camera doing in this beautiful ham shack of John A. Smetona, K3SLJ, of Pottsville, Pa.? Transmitting slow-scan pictures of John to other hams, that's what! Note monitor receiver under the clock. This television equipment, designed especially for amateur purposes, is made by Robot Research, Inc., San Diego, Cal.

North African with 100 or 1000 watts of phone. It's like in golf. Which is more satisfying . . . dropping a ball into a tiny cup at 200 yards with one stroke, or sinking an easy putt at two feet?

AMATEUR TRANSMISSIONS

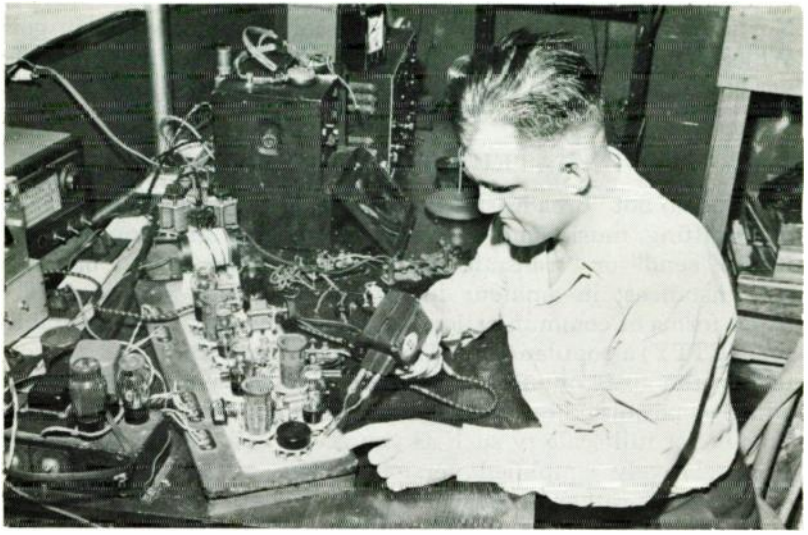
Hams do not "broadcast." They are specifically prohibited from transmitting music and material of general listening interest. Hams "send" or "transmit" only to each other, under ordinary circumstances; in amateur lingo this is called "working." The usual forms of communication are phone and CW, with radioteletype (RTTY) a popular third. The ultimate in person-to-person contact on the air is unquestionably ham television (yes, *television!*) which is permitted on frequencies of 420 megahertz and upward. This is not full-scale tv such as you see in color in the home, but is a relatively simplified version known as "slow scan." The equipment is rather expensive, but this doesn't stop an increasing number of hams from experimenting with it. Several manufacturers are offering cameras, monitors, receivers, etc.

HAM RADIO AND CB

There is absolutely no connection of any kind, legally or technically, between amateur and Citizens-Band operation. Any ham may work any other ham, but CB is primarily intended for communications between units of one owner; for example, a central control station in the office of a delivery service and individual trucks on the road. In this sense CB is intended to serve small business firms. A CB license does not require a technical examination of any kind, whereas all grades of the ham ticket involve a two-part test. A ham ticket is not valid for CB purposes and a CB ticket is not valid for ham purposes. However, there is nothing to prevent you from holding both types of licenses and to use them independently of each other.

THE HAM'S POSITION IN THE RADIO SPECTRUM

The frequencies allotted to amateur radio are only small fillers in an enormous electronic sandwich whose bottom slice is the 10-kilohertz lower limit of the long-range navigation stations and whose top is the 275-gigahertz edge of satellite assignments. In the United States alone, there are more than a million and a half licensed stations of various kinds, and there are thousands more in other countries. Therefore, a prime responsibility of hams everywhere is to stay on their frequencies with properly adjusted



There is nothing unusual about this picture of a ham wiring up a "breadboard" transmitter except for one thing: He happens to be totally blind! Blindness did not stop Robert W. Gunderson, W2JIO, from becoming active as a teacher of radio as well as the designer of a line of electronic gear that is "read" by the fingers of sightless persons.

equipment that does not cause interference to any other service. Happily, hams over the years have earned a remarkable reputation for technical competence and their ability to police their own bands; in no small way, this accounts for the privileges they enjoy.

Actual revocations of licenses for purposeful infractions of FCC regulations are extremely rare, and even temporary suspensions for minor incidents number hardly a dozen a year. This is indeed a good record when you consider the number of amateur stations on the air.

FCC REGULATIONS

The ham's code of behavior is set forth in the *Rules and Regulations of the Federal Communications Commission* Part 97, "Amateur Radio Service." This was formerly a part of Volume VI, which is no longer issued. Part 97 can be purchased by mail from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. The Stock No. is 004-000-00325-0, and the price is $1.50. Send a check or money order. The booklet will prove to be a worthwhile investment.

A few of the rules of immediate interest to newcomers are reprinted here, with comments the author thinks might be helpful.

SUBPART A—GENERAL

§ 97.1 Basic and purpose:

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

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

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

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

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

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

§ 97.3 Definitions.

(a) *Amateur radio service.* A radio communication service of self-training, intercommunication, and technical investigation carried on by amateur radio operators.

(c) *Amateur radio operator.* A person interested in radio technique solely with a personal aim and without pecuniary interest, holding a valid Federal Communications Commission license to operate amateur radio stations.

§ 97.39. Eligibility of corporations or organizations to hold station license.

An amateur station license will not be issued to a school, company, corporation, association, or other organization, except that in the case of a bona fide amateur radio organization or society, a station license may be issued to a licensed amateur operator, other than the holder of a Novice Class license, as trustee for such society.

Comment

The first part of paragraph 97.39 is in line with the idea that amateur radio is strictly amateur. The second part covers civilian radio clubs. In connection with the first part, it should be pointed out that a collection of equipment in the store or showroom of a radio dealer, jobber, or other commercial sales agency does not constitute an amateur radio station, and should not be put on the air for so-called demonstration purposes either by licensed employees of the firm or by visiting hams who might be prospective customers. This is illegal operation from several standpoints.

CALL SIGNS

§ 97.51 Assignment of call signs.

(a) The call signs of amateur stations will be assigned systematically by the Commission with the following exceptions:

(1) A specific unassigned call sign may be reassigned to the most recent holder thereof;

(2) A specific unassigned call sign may be assigned to a previous holder if not under license during the past 5 years;

(3) A specific unassigned call sign may be assigned to an amateur organization in memoriam to a deceased member and former holder thereof;

(4) A specific unassigned call sign may be temporarily assigned to a station connected with an event, or events, of general interest;

(5) One unassigned two-letter call sign (a call sign having two letters following the numeral) may be assigned to a previous holder of a two-letter call sign, the prefix of which consisted of not more than a single letter. Additionally, a two-letter call sign may be assigned to an Amateur Extra Class licensee who submits evidence that he held any amateur radio operator or station license, issued by any agency of the U.S. Government or by any foreign government, 25 years or more prior to the receipt date of an application for such assignment. Applicants for two-letter call signs are not permitted to select a specific assignment except in accordance with subparagraphs (1) and (2) of this paragraph.

§ 97.71 Control operator requirements.

(a) The licensee of an amateur station shall be responsible for its proper operation.

(b) Every amateur radio station, when in operation, shall have a control operator at an authorized control point. The control operator shall be on duty, except where the station is operated under automatic control. The control operator may be the station licensee, if a licensed amateur radio operator, or may be another amateur radio operator with the required class of license and designated by the station licensee. The control operator shall also be responsible, together with the station licensee, for the proper operation of the station.

(c) An amateur station may only be operated in the manner and to the extent permitted by the operator privileges authorized for the class of license held by the control operator, but may exceed those of the station licensee provided proper station identification procedures are performed.

(d) The licensee of an amateur radio station may permit any third party to participate in amateur radio communications from his station, provided that a control operator is present and continuously monitors and supervises the radio communication to insure compliance with the rules.

Comment

The last part of this paragraph contains a wide open loophole in the form of the words ". . . any third party . . ." this means that a visitor doesn't need a license of any kind to talk over a phone station, providing the owner is present and handles the equipment as prescribed. The main purpose of the provision is to permit hams to furnish free person-to-person voice communication for people separated great distances (see Chapter 9). It also gives them the chance to put visitors on the air briefly for what thrills they get out of the experience.

§ 97.3 Definitions.

(b) *Amateur radio communications.* Noncommercial radio communication by or among amateur radio stations solely with a personal aim and without pecuniary or business interest.

(d) *Amateur radio license.* The instrument of authorization issued by the Federal Communications Commission comprised of a station license, and in the case of the primary station, also incorporating an operator license.

(e) *Amateur radio station.* A station licensed in the amateur radio service embracing necessary apparatus at a particular location used for amateur radio communication.

§ 97.29 Manner of conducting examinations.

(d) All written portions of the examinations for amateur operator privileges shall be completed by the applicant in legible handwriting or hand printing. Whenever the applicant's signature is required, his normal signature shall be used. Applicants unable to comply with these requirements, because of physical disability, may dictate their answers to the examination questions and the receiving code test. If the examination or any part thereof is dictated, the examiner shall certify the nature of the applicant's disability and the name and address of the person(s) taking and transcribing the applicant's dictation.

§ 97.37 General eligibility for station license.

An amateur radio station license will be issued only to a licensed amateur radio operator, except that a military recreation station license may also be issued to an individual not licensed as an amateur radio operator (other than a representative of a foreign government), who is in charge of a proposed military recreation station not operated by the U.S. Government but which is to be located in approved public quarters.

Comment

The last portion of 97.37 takes care of Naval Reserve, Military Affiliate Radio System and ham club stations at various military establishments. The licensee in these cases is usually the commanding officer of the unit or activity through which the station is administered.

§ 97.83 Availability of operator license.

The original operator license of each operator shall be kept in the personal possession of the operator while operating an amateur station. When operating an amateur station at a fixed location, however, the license may be posted in a conspicuous place in the room occupied by the operator. The license shall be available for inspection by any authorized Government official whenever the operator is operating an amateur station and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost or destroyed, and request has been made for a duplicated license in accordance with § 97.57. No recognition shall be accorded to any photocopy of an operator license; however, nothing in this section

shall be construed to prohibit the photocopying for other purposes of any amateur radio operator license.

§ 97.85 Availability of station license.

The original license of each amateur station or photocopy thereof shall be posted in a conspicuous place in the room occupied by the licensed operator while the station is being operated at a fixed location or shall be kept in his personal possession. When the statiton is operated at other than a fixed location, the original station license or a photocopy thereof shall be kept in the personal possession of the station licensee (or a licensed representative) who shall be present at the station while it is being operated as a portable or mobile station. The original station license shall be available for inspection by any authorized Government official at all times while the station is being operated and at other times upon request made by an authorized representative of the Commission, except when such license has been filed with application for modification or renewal thereof, or has been mutilated, lost, or destroyed, and application has been made for a duplicate license in accordance with § 97.57.

Comment

From reading paragraph 97.85, and also 97.83, you might get the idea that the *operator license* and the *station license* are two separate pieces of paper. They aren't; actually, they are a single file-size card bearing the heading *Amateur Radio License,* with spaces for the assigned call letters and the designation of the operator privileges. That's what makes these two paragraphs confusing. § 97.83 says, "No recognition shall be according to any photocopy of an operator license," but § 97.85 says, "The original license of each amateur station or a photocopy thereof shall be posted . . ." The best thing to do is take very good care of your license and to have it with you whenever you operate your own home station, your mobile station in your car, or the stations of friends.

§ 97.89 Points of communications.

(a) Amateur stations may communicate with:

(1) Other amateur stations except those prohibited by Appendix 2.

(2) Stations in other services licensed by the Commission and with U.S. Government stations for civil defense purposes in accordance with Subpart F of this part, and on a temporary basis, for test purposes.

(3) Any station which is authorized by the Commission to communicate with amateur stations.

(b) Amateur stations may be used for transmitting signals, or communications, or energy, to receiving apparatus for the measurement of emissions, temporary observation of transmission phenomena, radio control of remote objects, and similar experimental purposes and for purposes set forth in § 97.91.

(d) Control stations and auxiliary link stations may not be used to communicate with any other station than those shown in the system network diagram.

§ 97.91 One-way communications.

In addition to the experimental one-way transmissions permitted by § 97.89, the following kinds of one-way communications, addressed to amateur stations, are authorized and will not be construed as broadcasting: (a) Emergency communications, including bona-fide emergency drill practice transmissions; (b) Information bulletins consisting solely of subject matter having direct interest to the amateur radio service as such; (c) Round-table discussions or net-type operations where more than two amateur stations are in communication, each station taking a turn at transmitting to other station(s) of the group; and (d) Code practice transmission intended for persons learning or improving proficiency in the International Morse Code.

§97.112 No remuneration for use of station.

(a) An amateur station shall not be used to transmit or receive messages for hire, nor for communication for material compensation, direct or indirect, paid or promised.

§ 97.113 Broadcasting prohibited.

Subject to the provisions of § 97.91, an amateur station shall not be used to engage in any form of broadcasting, that is, the dissemination of radio communications intended to be received by the public directly or by the intermediary of relay stations, nor for the retransmission by automatic means of programs or signals emanating from any class of station other than amateur. The foregoing provision shall not be construed to prohibit amateur operators from giving their consent to the rebroadcast by broadcast stations of the transmissions of their amateur stations, provided, that the transmissions of the amateur stations shall not contain any direct or indirect reference to the rebroadcast.

§ 97.115 Music prohibited.

The transmission of music by an amateur station is forbidden.

§ 97.117 Codes and ciphers prohibited.

The transmission by radio of messages in codes or ciphers in domestic and international communications to or between amateur stations is prohibited. All communications regardless of type of emission employed shall be in plain language except that generally recognized abbreviations established by regulation or custom and usage are permissible as are any other abbreviations or signals where the intent is not to obscure the meaning but only to facilitate communications.

2

Conquering the Code

The radio code is known officially as the "International Morse Code." The letters of the alphabet, the ten numbers, the punctuation marks and certain special characters are represented by combinations of short and long sounds. These are often referred to as "dots" and "dashes" because that's a convenient way of showing them in printed charts. A more accurate approach is to call the sounds "dits" (usually referred to as *di* except when it is the last element within a character) and "dahs." Ideally, the dah sound is supposed to be three times longer in duration than the very short dit sound. The spacing or silent period between dits and dahs of the same character is equivalent to the duration of one dit; between letters three dit spaces; and between words five dit spaces. Actually, it makes little difference how short or long the sounds are, providing only that the dahs are noticeably longer than the dits. However, the spacing is important, and you'll understand why when you look over Chart 2-1.

Note that a single dit represents the letter *E*, a single dah is *T*, and a dit followed by a dah is *A*. The word *eat* would thus be sent:

dit di-dah dah

If the sending is sloppy and the first three signals are run together, the transmission becomes:

di-di-dah dah

The first character is the letter *U*, so the word comes out *ut* if you can call that a word.

If the last three signals are run together, the transmission sounds like:

dit di-dah-dah

The second letter is now *W* and the word is *ew*, again, not even remotely connected with *eat*.

Chart 2-1. The International Morse Code

ALPHABETICALLY

A—di-dah
B—dah-di-di-dit
C—dah-di-dah-dit
D—dah-di-dit
E—dit
F—di-di-dah-dit
G—dah-dah-dit
H—di-di-di-dit
I—di-dit
J—di-dah-dah-dah
K—dah-di-dah
L—di-dah-di-dit
M—dah-dah
N—dah-dit
O—dah-dah-dah
P—di-dah-dah-dit
Q—dah-dah-di-dah
R—di-dah-dit
S—di-di-dit
T—dah
U—di-di-dah
V—di-di-di-dah
W—di-dah-dah
X—dah-di-di-dah
Y—dah-di-dah-dah
Z—dah-dah-di-dit

BY GROUPS

Group 1

E—dit
I—di-dit
S—di-di-dit
H—di-di-di-dit
5—di-di-di-di-dit
T—dah
M—dah-dah
O—dah-dah-dah

Group 2

A—di-dah
W—di-dah-dah
J—di-dah-dah-dah
N—dah-dit
D—dah-di-dit
B—dah-di-di-dit

Group 3

R—di-dah-dit
F—di-di-dah-dit
L—di-dah-di-dit
U—di-di-dah
V—di-di-di-dah

Group 4

K—dah-di-dah
X—dah-di-di-dah
C—dah-di-dah-dit
Y—dah-di-dah-dah
Q—dah-dah-di-dah
G—dah-dah-dit
Z—dah-dah-di-dit
P—di-dah-dah-dit

NUMERALS

1—di-dah-dah-dah-dah
2—di-di-dah-dah-dah
3—di-di-di-dah-dah
4—di-di-di-di-dah
5—di-di-di-di-dit
6—dah-di-di-di-dit
7—dah-dah-di-di-dit
8—dah-dah-dah-di-dit
9—dah-dah-dah-dah-dit
0—dah-dah-dah-dah-dah

PUNCTUATION

Period—di-dah-di-dah-di-dah
Comma—dah-dah-di-di-dah-dah
Semicolon—dah-di-dah-di-dah-dit
Colon—dah-dah-dah-di-di-dit
Question Mark—di-di-dah-dah-di-dit
Double Dash—dah-di-di-di-dah
Fraction Bar—dah-di-di-dah-dit
Quotation Marks—di-dah-di-di-dah-dit
Hyphen—dah-di-di-di-di-dah
Parenthesis—dah-di-dah-dah-di-dah

SPECIAL CHARACTERS

Wait—di-dah-di-di-dit
Invitation to Transmit—dah-di-dah
End of Message—di-dah-di-dah-dit
End of Work—di-di-di-dah-di-dah
Error—di-di-di-di-di-di-di-di

THE WIRE TELEGRAPH CODE

International Morse is often called "Continental Morse" or simply "Continental," because it was used on European wire telegraph systems for years before the invention of "wireless." Don't confuse it with "American Morse," which was named for Samuel F. B. Morse, the inventor who made wire line telegraphy practicable. In both codes the characters consist of dits alone, dahs alone, and combinations of dits and dahs. Fifteen characters of the alphabet and one number use the same combinations in both. In International Morse, the spacing within individual characters is uniform. In American Morse, however, variations in the spacing within some characters determine the identity of the letter. The best example is the combination of three dits. Sent straight, with the spacing between dits equal in duration to a single dit, it is the letter *S* in both codes:

dit (one space) dit (one space) dit

In American Morse a combination of three dits has two additional meanings, depending on where a double-dit spacing is used. Thus:

dit (one space) dit (two spaces) dit — the letter *C*,
dit (two spaces) dit (one space) dit — the letter *R*,

In both codes the letter *I* is di-dit, but in American Morse, when the two dits are separated by a double space, they become the letter *O*!

The opportunities for confusion are obviously great. You need a very sharp ear to distinguish between dit dit dit for *S* and di-dit dit for *C*; in fact, you're quite likely to write down *ie* for the latter.

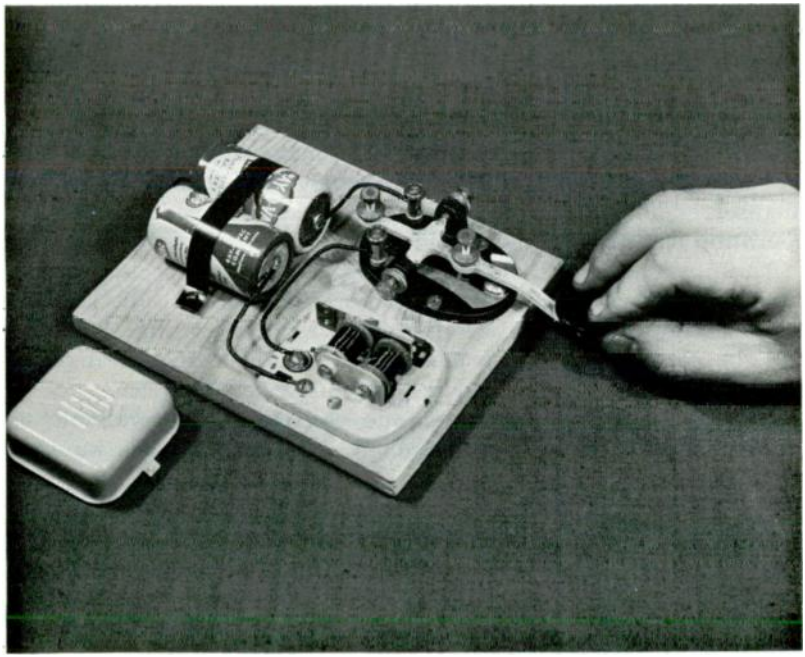
In wire line telegraphy, all the sounds emitted by the receiving instrument are actually individual clicks produced by a spring-loaded brass lever striking against a U-shaped brass anvil. Appropriately enough, this instrument is called a "sounder." When a transmitting operator taps his key once to make the letter *E*, the sounder makes one click going down and another when it springs back. When he holds his key down to make the single dah of the letter *T*, the sounder again makes one click going down and another going up, and the dah is indicated by the length of the silence between the two clicks. Tricky? It sure is. In radio work, the dits and dahs are all positive buzzes or whistling sounds; therefore they are easier to recognize and memorize.

During the period between the Civil War and World War I, clicking sounders in railroad stations and telegraph offices repre-

sented the major means of electrical communication. This service soon gave way to the telephone and the teletypewriter, and today American Morse is virtually a dead language. However, telegraph practice sets consisting of a key and a sounder on a common base are still being sold, mainly because they look interesting. Some Morse is transmitted on CW, mostly by old-time operators trying to relive their adolescence.

CODE PRACTICE SETS

"What's the best way to start on the code?" you're probably asking by now. The very first thing you should do is to buy or make some sort of a code-practice set. It can be a line-powered audio oscillator with a built-in speaker, or it can be a very simple, inexpensive and easily constructed unit. The set illustrated in the accompanying photograph consists of a standard radio "key," a common house buzzer, and two flashlight cells. For a baseboard use any clean piece of wood about 5 by 6 inches. Mount the key and the buzzer with short wood screws. Place the batteries so that



Home-constructed buzzer set. The use of this unit should be followed by intensive listening to "live" stations on a short-wave receiver.

the center contact of one is adjacent to the plain bottom of the other, and fasten them down with tape or a strap cut from a tin can.

Wire the components as follows: right-hand binding post of key to center post of the right-hand battery; bottom of right-hand battery to center post of left-hand battery; bottom of left-hand battery to left-hand post of buzzer; right-hand post of buzzer to left-hand post of key. Use solid or flexible wire. Clean all ends well, and solder the connections to the batteries.

A radio key is merely a single-pole switch. It is called a "key" because it opens and closes the circuit in which it is connected. To operate it, merely place your first two fingers on the knob, with the thumb alongside, and press down to close the contacts. Relax your fingers slightly, and the lever will move up to open the contacts. The spacing between the contacts and the tension of the spring that keeps them open are both adjustable by means of knurled screws. Experiment with the side-bearing screws and be sure the lever moves up and down without binding.

Spring tension and contact spacing are both matters of personal preference. Some people like very light tension and close contacts, but for a beginner it is somewhat better to use a fairly stiff lever and spacing of about 1/16 inch or slightly less. With these adjustments, cleaner dits and dahs can be made, and the tendency to slur them together will be lessened. As you develop dexterity with the key you will gradually ease the adjustments.

In the early days of radio, keys were made of heavy brass, and an operator had to pound them vigorously. To this day, hams call themselves "brass pounders," and they refer to radiotelegraphy operating as "pounding brass."

An untreated household buzzer makes a raucous racket. To increase its pitch and make it sound more like actual radio signals, insert a tiny matchstick wedge between the vibrating armature and the contact spring attached to it. A drop of model airplane cement or similar adhesive will keep this wedge in place.

Battery-operated, solid-state code oscillators are available at low prices in both factory-assembled and kit form. The kit jobs can be put together in an hour or less. Units of this type are compact, light in weight, readily portable, and have a pleasing tone that closely resembles that of real radio signals. A typical one is shown on page 40.

PRACTICING WITH A PARTNER

The exact system or method of code practice you will follow depends on whether you will work alone or with a partner. It's a

much easier undertaking if two people start together. They can check each other's mistakes and in general accelerate each other's progress. Father-and-son teams are very effective. Many a dad starts with his son just to help him out and show that he's a good fellow, and he ends up becoming an avid ham himself. What usually happens, if you announce to your friends and family that you're learning the code and intend to go on the air with your own radio transmitter, is that too many assistants volunteer their services!

Let's assume that you have one partner. In addition to the code practice set you will need a supply of ruled paper and a soft pencil or a free-flowing pen. Have your partner sit directly next to you so that you can share the code chart and so that you can each watch what the other writes down when the practice sessions get under way.

Notice something odd about this picture of a group of high-school students practicing the code? The girls outnumber the boys four to two! There are many female amateur radio operators of all ages.

Perhaps you have noted that so far nothing has been said about memorizing the code characters themselves. The time to start is now, with the practice set in front of you. Move it in from the edge of the table so that your arm up to the elbow rests comfortably on the table. If the set tends to move around, weight it down with a book. You cannot make clean, sharp Morse characters if the key is not well secured.

Instead of starting with the letter *A* and working on through, learn the characters according to the four groups. *Do not* say to

yourself, "*E*, one dot." Merely look at Chart 2-1, note that in Group 1 the letter *E* is represented by one dit, and tap the key smartly once. The buzzer will emit a short buzz. This is the sound you must learn to associate with the letter. From now on don't even utter the words dits, dahs, dots, or dashes. Keep all conversation to a minimum and avoid distractions.

When you make the first dit, your partner should glance at the code chart, note silently that a single dit is the letter *E*, and write *E* on his paper. Since this is the simplest and shortest of all the code characters, he has to be pretty dense to miss it. If he doesn't have it down on paper within about three seconds, repeat it. The act of transcribing code signals is called *copying*, and the written material or message is called *copy*. The understanding in all practice sessions is that the receiving operator will copy everything he hears.

Proceed down Group 1 as far as the number 5, sending each character two or three times. Keep looking at your partner's paper and check his copy. After sending *E*, *I*, *S*, *H*, and 5 in straight succession twice, mix 'em up a little. Allow yourself about five minutes of this random sending. Now move the practice set over to your partner and let him repeat the performance for your benefit. In all probability you'll copy with less hesitation than he did because you've already heard the signals from your own sending.

Take the practice set back and send *T*, *M*, and *O* in succession a few times. Again switch with your partner. If you're both of normal intelligence (or better!) fifteen minutes should be enough to impress the eight simple characters on your brain.

Don't try to measure the relative lengths of the dits and dahs. Just make the dahs appreciably longer than the dits so that your partner can't possibly confuse the two sounds. At the beginning you'll probably make the dahs overly long, but with practice you'll find yourself speeding them up.

Practice Words and Sentences

A learner is greatly encouraged when he is able to make words out of the dits and dahs. Therefore, immediately after both of you have mastered the Group 1 signals, start sending the following practice sentences:

Group 1 Practice Sentences

He is Tom
She is his sis
Tessie is his mom
He shoots moths
Its Moses

Hi Tootsie
Meet me sometime
The time is 5
He is a hot shot
She is the most

These sentences are short and necessarily limited in construction because the words consist only of the eight basic dit and dah characters. Allot yourself the first five to send. Tap out the four dits of *H* of the first word of the first sentence, and watch your partner's paper. The instant he gets the *H* written down, follow with *E*. When he has that, wait a fairly long time, say five seconds, to give him the idea that a new word is coming along, and proceed with *is* and *Tom*.

"Gee, I got it!" will undoubtedly be his pleased reaction.

No punctuation marks are included with these practice sentences. In informal ham operating punctuation is rarely used, as it usually is not necessary to the sense of the messages. In formal messages, where punctuation is required, the marks are usually spelled out as complete words. The use of the punctuation marks and special characters is discussed later in this book.

Numerous amateurs have learned the code by listening to the practice transmissions, at a variety of speeds, from W1AW, the headquarters station of the American Radio Relay League, in Newington, Conn. The operating schedules are published monthly in the league's magazine, QST, *which every ham should read regularly.*

Correcting Errors

If your partner copies a character incorrectly, merely touch his arm, shake your head, and repeat it until he does get it right.

What do you do if you send a letter incorrectly? For example, you inadvertently add an extra dit to the letter *S* of the word *is*. This makes the letter *H*, and if your partner copies it as *H* he is perfectly right. Look in the list of punctuation and find the *Errors* signal. This is a string of eight dits. Send it. The technique now is for the receiving operator to cross out the word *ih*, which is what he copied, and to wait for you to repeat the entire word correctly. During all of this, there should be no conversation. The less talking, the faster the progress.

After your co-worker has made perfect copy of the first five sentences, switch places and let him send the second group of five to you. Allow yourself a total of about an hour for Group 1, and don't attempt the other groups the first night. It's a mistake to cram too much into one session. If you stick to a daily schedule you should have the entire code down pat in a week, and from then on speed is entirely a matter of practice. Remember, copy only what you hear, and don't try to fill out words in advance. You can be fooled very easily!

The second evening, begin by reviewing all of Group 1. With this as a refresher, tackle Group 2, which consists of three characters starting with single dits and three starting with single dahs. Follow the same routine as before, each person sending the letters, first in succession, then scrambled. Now tackle the Group 2 sentences, which contain the characters of Groups 1 and 2.

Group 2 Practice Sentences

The band is not hot
Joe is in Boston
I want to swim
Jane is a new deb
His dish is meat

With the foregoing words you have to pay particular attention to spacing of the signals. If you think you have slurred dits and dahs together when they should be separated, fall back on the error signal and try again. If your partner copies a letter wrong, keep repeating it patiently until he gets it right. If he continues to have trouble with certain letters, break the block by exchanging places and letting him pound brass. It's not unusual for some people to learn the code more quickly from their own sending than from another person's.

When you take your actual license test, your copy must be legible to the examiner. Therefore, check your handwriting as well as your text during all practice sessions. Here's a good tip: Write small letters. They take less time than big ones, and time is a very important part of the code test.

The third evening, review Groups 1 and 2, and, then progress to Group 3. The practice sentences are now longer and include characters from all three groups:

Group 3 Practice Sentences

Love that roast ham
Lets have some fun
This fish is too hot to eat so soon
His vest is red and blue
The wash is out 5 minutes

It's still too soon to concern yourself about copying speed. There's time for that after you master Group 4 and the rest of the numbers, punctuation marks, and special characters. Then you can use any text from a newspaper or book, and check your speed against a clock. To make a five word per minute check, count off 75 letters in a sentence or series of sentences and send them in three minutes. You'll undoubtedly have to try several different rates of sending before you hit the approximate five word rate. You'll be pleasantly surprised, after a week or so of diligent practice, to learn that 5 wpm is very, very slow.

As you practice, you'll discover that you can understand or "read" whole words and even short sentences without writing down the individual letters as they are transmitted. This is known as "copying in the head." Experienced operators carry on long exchanges of conversation in this manner without putting a word on paper. Practice is what does it.

LEARNING ALONE

If you have more than one eager-beaver partner, follow the foregoing routine exactly as described, but allow a little more time for each session. But suppose you have no partners at all . . . in other words, you are forced to work alone. What to do? Take heart from the fact that thousands of hams have learned the code, read up on the technical questions, and passed the license test entirely on their own and without assistance of any kind. You can do as well if you merely make up your mind to it.

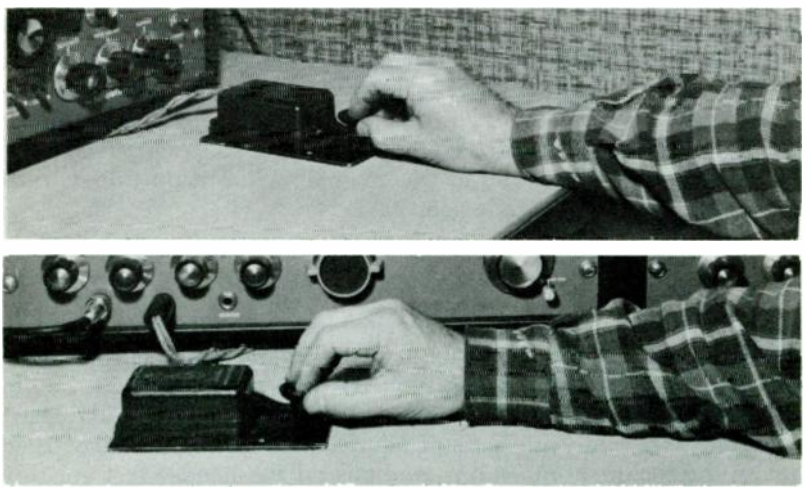
Start with the same buzzer practice set, memorize the code by groups, and maintain a steady pace of daily sending exercises of

printed text matter. The more you send the more thoroughly your brain will associate the combinations of sounds with letters and numbers. You'll finally reach a point, of course, where you simply must have a real receiving practice. That is the time to buy a good short-wave receiver—you'll need one anyway for your "shack." (See Chapter 4.)

You can't possibly imagine how many CW stations are on the air, morning, noon, and night, until you start tuning across the various short-wave bands. Not just ham stations, but hundreds of commercial ship and shore stations, naval and military stations, etc. The transmitting at most large stations is not done with hand keys, but with motor-driven tape machcines. These grind out perfectly formed and spaced characters that are a pleasure to copy. Tune around, pick out some loud station that sounds like fair game, and try your luck.

For "live" receiving practice on a more organized basis, look up the current operating schedules of ham stations that send accurately timed practice text, at announced speeds, for the specific benefit of beginners. You'll find these schedules in publications devoted exclusively to amateur radio, such as *QST*, *CQ*, and *Ham Radio*, as well as in some general-hobby magazines like *Popular Electronics*.

Copy what you can, and don't try to figure out lost characters. You'll hear all sorts of things: clear text press dispatches, personal



The wrong and the right way to use a radio key: In the top photo the arm is too far off the table and will tire easily. In the bottom photo the arm is supported from the elbow to the wrist. This position leaves the fingers and the arm muscles relaxed, is conducive to good sending.

messages, ship and weather reports, etc., in a variety of languages that use the basic "English" alphabet. There's nothing to prevent you from copying these transmissions, but don't let them go any further than your shack. It's unlawful to divulge the contents of specific messages to people other than the addressees. The matter is covered in Section 605 of the Communications Act of 1934, "Unauthorized Publication of Communications." Actually, you'll throw away your practice copy as fast as you accumulate it, but you should know what the law is. The restriction does not apply, by the way, to messages transmitted by hams.

You'll also hear a great deal of "hash" that consists of unpronounceable five-letter groups. This stuff is often referred to as real radio "code"; that is, messages with secret meanings. For hours on end you can copy qwert yuiop lkjhg asdfg zxcvb mnbvc, until you don't know whether you're coming or going. The term "code" in this application is not technically correct. Because there is so much of this type of transmission on the air, the subject can stand a bit of clarification.

CODES AND CIPHERS

Messages having secret or hidden meaning are called *cryptograms.* There are two distinct varieties. In the *code* type (the word "code" having nothing whatsoever to do with the dits and dahs of International Morse), altogether different meanings are assigned to intelligible complete words, phrases, and sentences. This must be done by prearrangement between the sender of the message and the recipient. A message might read, "Oceans of love and best wishes for a pleasant crossing," and by itself it makes sense and appears to be innocent. However, the person receiving it might understand it to mean, "Dump the diamonds overboard. Someone has squealed to Customs." For less sinister commercial purposes there exist fat books of code lists whose purpose is economy rather than deception. For instance, the single word "boy" might mean "Arriving in Baltimore," or "girl" might mean "Your order received." When you pay 25 or 50 cents a word for overseas transmission, you want to use as few as possible!

Contrary to the fond belief of many writers of romantic spy stories, there is no way of "breaking a code." You either know the arbitrary meanings of the words or phrases or you don't. What these writers have in mind when they say "code" is properly known as *cipher.* In a ciphered message the individual letters of the original clear text are either rearranged or are replaced by other letters, the result in either case being unintelligible. The method of scrambling must of course be known to both parties,

and is called the *key*. A very simple but obvious cipher has the whole message sent backwards. In another, a reversed alphabet is used to replace the letters of the original; that is, *A* becomes *Z*, *B* becomes *Y*, etc. Through intensive study of the recurrence rates of the various letters, it is possible to "break" even very complicated ciphers.

Cipher mesages are usually sent in the form of five-letter groups just to make things harder for cryptographers who want to break them down for one reason or another. If the words are kept in their original lengths it is fairly easy to identify many of them. For instance, in English a single letter word would have to be *A* or *I*; two letters could be *is*, *am*, *be*, *in*, etc. When a cipher message in five-letter form is deciphered, the recipient only has to read it slowly to reform the letters into understandable words.

Cipher traffic is rather dull to copy for code practice, but its virtues are its plentitude and its accuracy. A large percentage of it is of military origin and is machine-transmitted.

CODE RECORDS AND TAPES

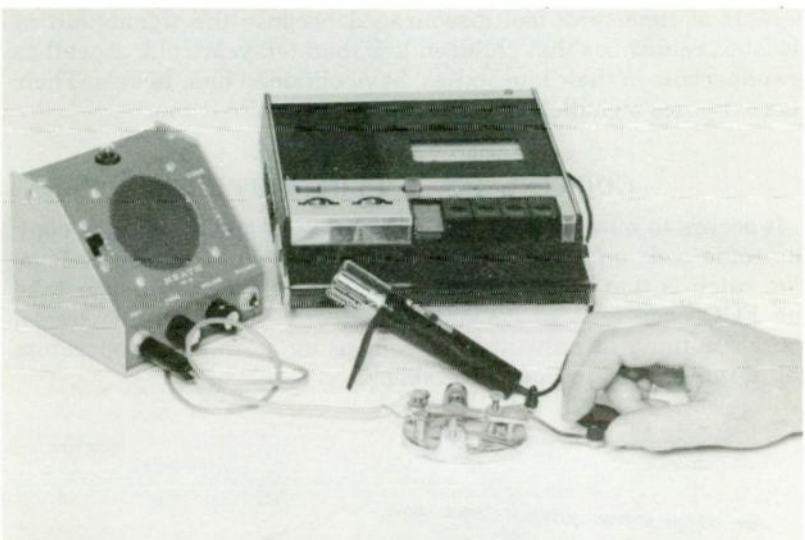
Phonograph records and magnetic tapes of practice transmissions at various speeds are available at reasonable prices. They are excellent for both individual and group instruction because they can be run repeatedly until the students know them thor-

Code practice with special records is good for student working alone.

oughly; then they can usually be sold—or donated, if you feel magnanimous—to other newcomers.

A tape recorder of any size or type is a very valuable aid to a would-be ham. To record live signals from a CW station, merely place the microphone near the loud speaker of the receiver. You can then run the tape as often as you wish either for yourself or for friends. You can also use the machine to check your own "fist." Proceed as follows:

Select a column of stock quotations, hog prices, money exchange rates, or similar material containing mixed words and



Record your own sending on tape, and then check it later by attempting to copy it back. This is quick and effective means of showing faulty keying.

figures that can't be guessed at, from a newspaper. Place your buzzer set or code oscillator close to the recorder microphone and tap off about ten minutes of this text. Rewind the tape and shut off the machine. The next day, play the tape back and compare your copy with the original. You may be in for a rather large surprise. Your first reaction will probably be something like, "Do I really sound like that?"

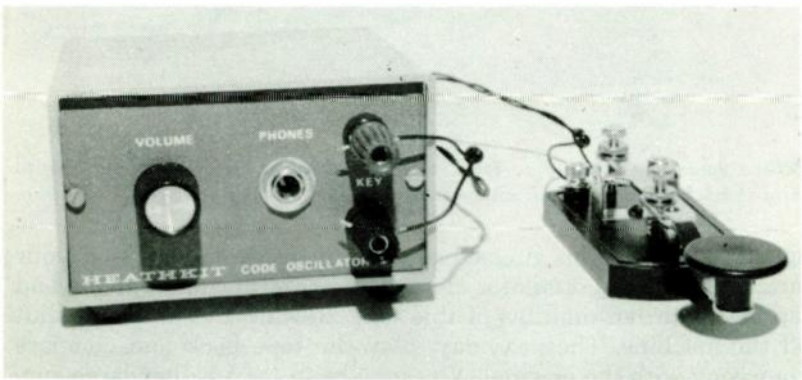
Another stunt is to exchange tapes with a friend who also has a recorder. To start, ask a lot of questions, and include a few of arithmetical nature. His answers will indicate whether he read you correctly.

Code Instruction System

Over a period of more than thirty-five years the writer has taught the code to many individuals, small groups gathered around a dining room table, troops of Boy Scouts, radio clubs, and (during World War II) several thousand more or less reluctant GI's. He is convinced that there is no effective "system" of learning other than steady, applied practice. Once you start, maintain your momentum with daily sessions at the buzzer set or your short-wave receiver. If a partner fails to show up one evening, run over some practice sentences yourself. The more you practice, the more quickly you will get into the rhythm of the dits and dahs, and the more firmly the code will become fixed in your consciousness. If at times you feel discouraged because the signals fail to register, remember that children less than ten years old, as well as grandparents in their late sixties, have obtained ham tickets. Their success poses a challenge; surely, you can make it too.

COPYING ON A TYPEWRITER

It occurs to many would-be hams that it is much easier to copy the radio code on a typewriter than with pencil and paper. It is. The catch is that you must use pencil and paper when you take the FCC code test, so it's better to learn that way. Of course, there's nothing to prevent you from using a "mill," as operators call a typewriter, in your own shack.



Compact, battery-operated transistor code oscillator made from a Heathkit. Loud speaker is inside case, phone jack on front panel.

3

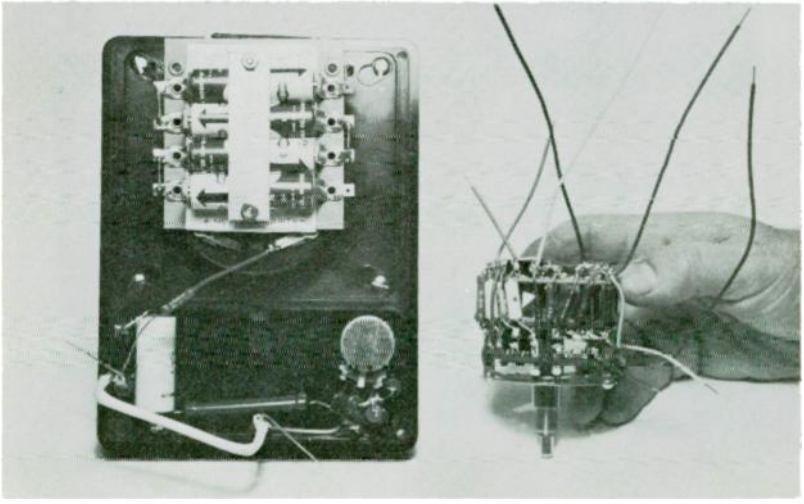
A Kit Provides Valuable Experience

As a beginner anxious to get on the air, you are likely to rush out and buy a lot of fancy gear the minute your license arrives in the mail. There's nothing wrong with this if you can afford it and if you know enough about electronics to be able to use the equipment safely and effectively. However, there's much more to ham operation than mere dial twiddling. You must first have some experience with basic set assembly and wiring, so that later you can handle the chassis of an expensive receiver or transmitter with assurance and confidence.

A typical VOM kit with its components spread out. Resistors are numbered individually for easy identification. The meter proper is part of the front panel. There are several similar kits on the market.

The heart of the VOM is a multiposition rotary switch, to which a cluster of small resistors is soldered. Here, the shaft of the switch is placed in a hole in the scrap piece of wood for support. Note the use of a pencil-tip iron for soldering the leads of the resistors to the lugs of the switch.

Dealers all have their favorite stories about woefully unprepared hams who come back for advice on such ridiculously simple matters as replacing a dead fuse, resetting a loose knob on a shaft, connecting two wires to a plug, etc. These problems would

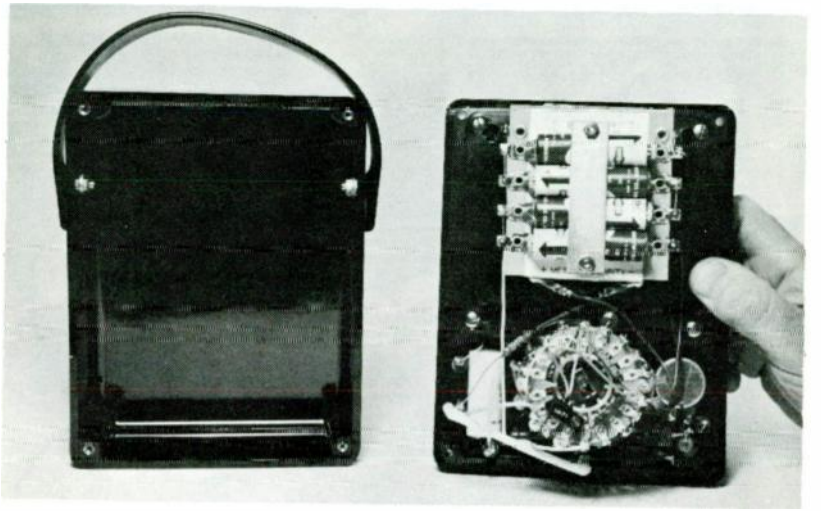


The completed switch assembly of the VOM is at the right. It is ready for mounting in the lower center hole of the panel at the left. The long wires from the switch will be connected to components on the panel.

not arise at all if the customers learned to wield a soldering iron before they reached for their checkbooks.

BUILD OR BUY EQUIPMENT

One of the first questions any ham must answer is, "Will I build my equipment or buy it already assembled?" If it is decided to build the equipment, the next question is, "Should I purchase a kit, or buy the individual parts and use my own circuit?" Unless you have considerable experience, the latter should not be attempted except for very simple devices such as a code practice oscillator.



The VOM panel at the right is completely assembled. The four pen light batteries at the top are held under a clamp. They last a long time, and are easily replaced. The panel fits snugly in the molded case.

Unquestionably, the fastest and most profitable way to acquire practical know-how is to build something from a kit. If you are really a rank beginner (remember, everyone was at one time!), the best initial project is an instrument called the volt-ohmmeter, or VOM for short. This measures voltage and resistance and is absolutely invaluable for a wide variety of electronic trouble-shooting jobs. The type designated in catalogs as "20,000 ohms per volt" is both sensitive and versatile. If you own a few common hand tools, including a soldering iron, you can put a VOM kit together in an evening or two. Several stages in the assembly of a typical meter are shown in the accompanying illustrations.

Test instruments of other types are described in Chapter 10. An old favorite with hams is the vacuum-tube voltmeter, or VTVM, which works off the AC power line. This is giving way rapidly to solid-state meters using field-effect transistors (FET's), which work on small batteries and do almost everything the VTVM does.

Now, when you decide to buy a receiver or transmitter, you will examine it with a critical eye and will be better able to judge the construction and workmanship. Alternatively, you may feel encouraged enough from your duel with a soldering iron to go

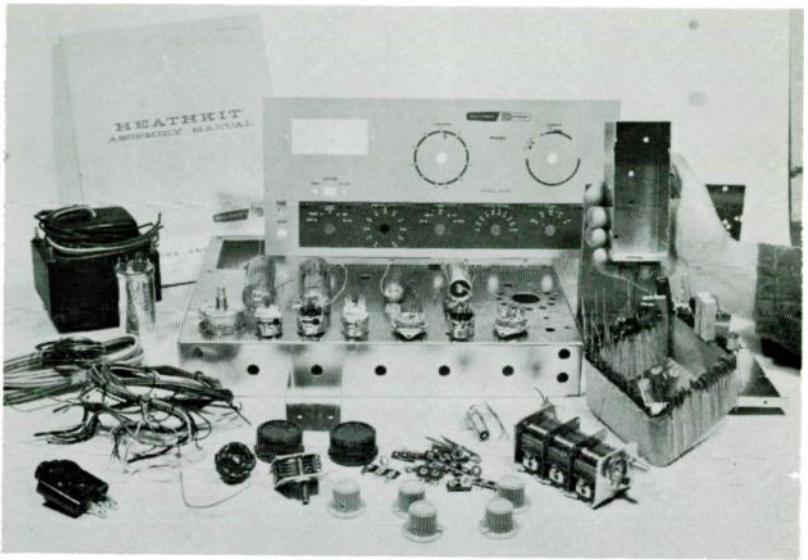
"Continuity checking" is an important use of the VOM. Here, the meter probes are connected to a mike plug to test the push-to-talk switch on the stand. Open, the meter should read infinity ohms; closed, zero ohms.

on to a more challenging item; let us say an entire receiver or transmitter in kit form. Here an odd fact presents itself: most ham transmitters made from kits are much simpler to assemble and place into operation than most ham receivers. The alignment of certain receiver circuits is quite critical, and may require auxiliary equipment that costs more than the set itself. Furthermore, this equipment may not be of any further use to you after the job is finished. On the other hand, even some pretty big

transmitters can be adjusted in ten minutes with the aid of the meters and other facilities built into them.

You should have a short-wave receiver at an early stage for live code practice, as mentioned in Chapter 2; therefore, it is probably best to buy a manufactured one. Later, a transmitter kit can be purchased for nut-and-bolt practice.

If by chance you were previously interested in the technical aspects of hi-fi and built a tuner or amplifier or two, you may not need much further preparation for your new hobby. If this is so, go out, spend your money on new gear, and have a good



Everything you need to build an excellent low-power ham transmitter is in this Heathkit Model DX-60. The prepunched chassis and panel save a great deal of time and effort and enable the builder to concentrate on the more important jobs of assembly and wiring. Kit costs about $90.

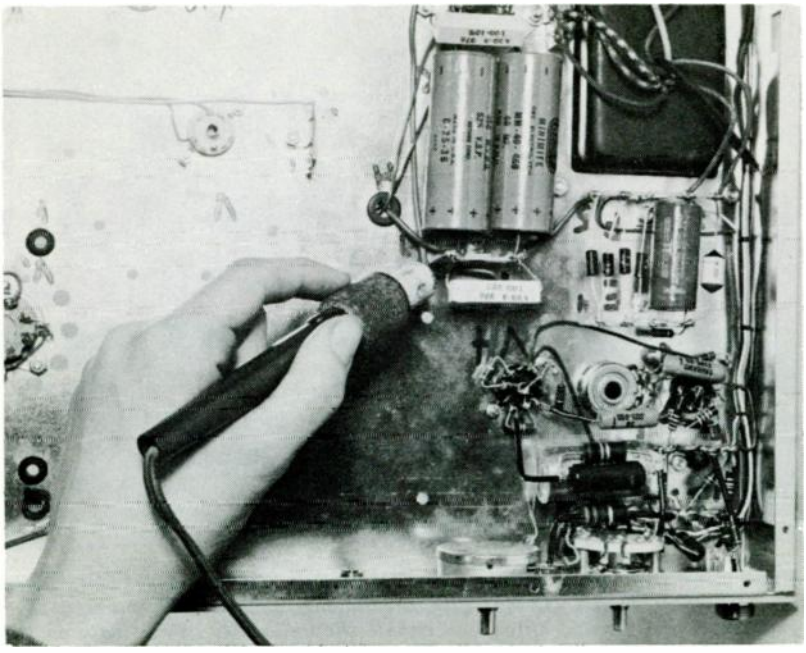
time! Later, you may still find it enjoyable to fall back on kits for a wide range of station accessories, such as monitor oscilloscopes, antenna couplers, field strength meters, frequency standards, etc.

The cost saving between a kit and a comparable factory-made instrument is not really very great. What is important about kit work, aside from its educational aspect, is the relaxation and satisfaction it gives. You forget all about your everyday problems when you concentrate on soldering three resistors and two capacitors into one hole of a terminal lug or guiding a transmitter signal

from a crystal oscillator through to the antenna. Also, when the job is finished and working, you will unconsciously puff up with pride and proclaim to all within earshot, "I made it myself!"

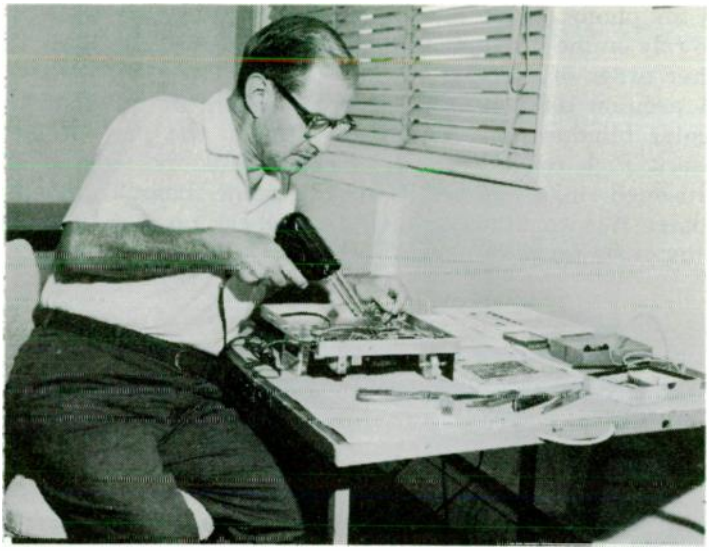
KIT TROUBLES

Producers of kits say that there are no *kit* troubles, only *builder* troubles. The writer has visited the service departments of several large kit suppliers, and has examined many finished but inoperative items sent in for adjustment; he agrees with the general



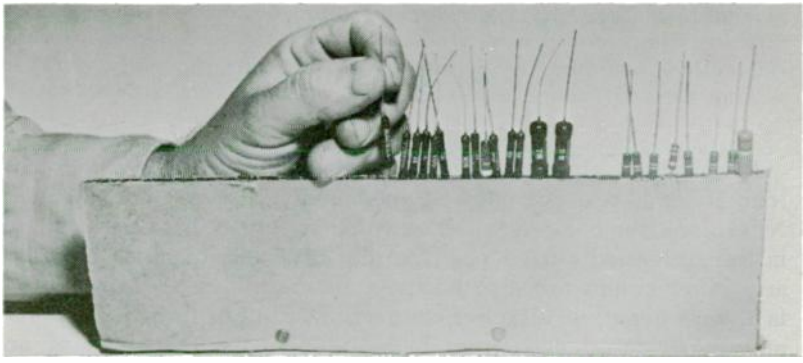
This underchassis view of the Heathkit DX-60 in the process of assembly shows how resistors and capacitors are mounted by their own leads to lugs and terminals. The major part of the entire project is soldering.

diagnosis of the repair technicians that poor soldering is the major headache. Builders simply do not keep the irons on joints long enough to cook out the gummy rosin flux. When the flux cools, it usually forms an excellent film of insulation between the surfaces the solder is supposed to unite. Time and again, the mere application of a clean, hot iron to some or all of the connections in a set is enough to bring it to life.



An ordinary card table makes an excellent temporary work bench for kit work. Keep small parts and hardware in shallow boxes to prevent them from rolling off. Hand tool shown here is soldering gun.

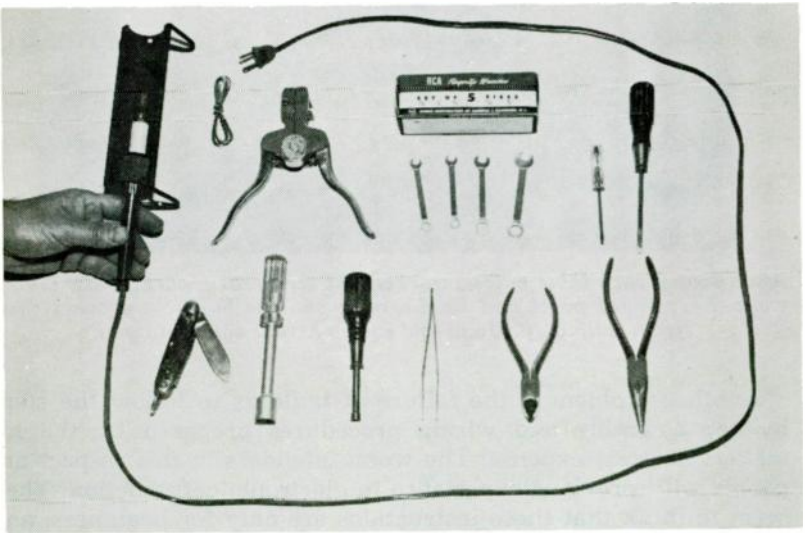
Another problem is the failure of builders to follow the step-by-step assembly and wiring procedures prepared by the kit makers at great expense. The worst offenders in this respect are people with previous experience in electronic construction. They seem to think that these instructions are only for beginners, and that they can bypass them and follow only the schematic diagram



Corrugated board is handy support for small resistors and capacitors. First identify their values from their color coding, arrange them in ascending order from the left, and stick their pigtails into the board.

and the photos. Some can, but evidently most cannot. Beginners who rely on the instructions and obey them explicity have a much higher order of success.

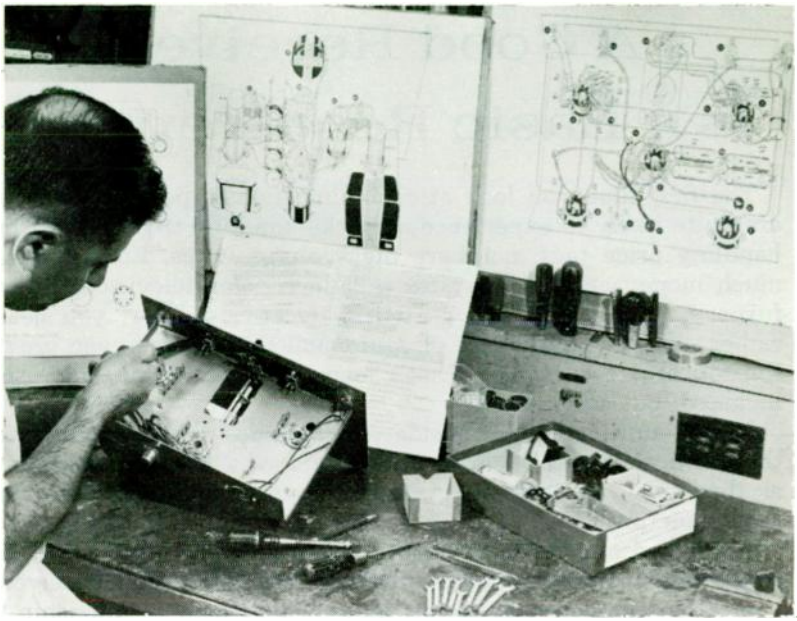
A peculiar difficulty that defied isolation for quite some time is color blindness in varying degrees on the part of kit purchasers. Pick up any bunch of small resistors, look at all the multi-hued rings, and see if you can name them. To avoid trouble later, it is worth taking the time to check resistors individually on the *ohms* range of a VOM.



With these basic hand tools you can assemble and wire any kit. From left to right they are: (top row) soldering iron, solder, wire stripper, ignition-type wrenches, screwdrivers; (bottom row) knife, nut drivers, tweezers, side cutters, and long nose pliers. The tweezers are especially useful for picking up and holding soldering lugs, washers, nuts, transistors, etc.

Polarity markings on electrolytic capacitors are a related problem. If leads are not marked specifically + and − or POS and NEG, look for colored wires or color stripings of some sort. Red is the universally-used positive marking and black is negative; any other colors are also positive. In metal-cased units, the can is always negative, all other connections are positive. Some metal- and paper-cased capacitors have no polarity markings of any type; these units are paper-dielectric units and can be connected into a circuit either way. Likewise, mica capacitors have no polarity markings.

Foolish little things constantly turn up. Failure to put a line fuse in the holder on the back of a chassis is common. Tubes are placed in the wrong sockets. Meters are connected backward. Wires with insulation still on them are twisted together and caked with undigested solder.



Clip or staple diagrams to cardboard and stand them upright on workbench for easy viewing. Strong but diffused illumination over work area is important. Double 40-watt fluorescent fixture is highly recommended.

The most puzzling cases of all concern equipment that is sent in for "repair" yet works perfectly when hooked up in the shop. Possibly the shaking a chassis receives during the trip breaks off the caking in one or more cold-soldered joints. In at least one instance it was learned—only after a considerable exchange of correspondence with the customer—that the wall outlet into which he had plugged his receiver was dead. Beat that!

4

A Good Receiver Is a Basic Requirement

The first time you look at communications-type receivers you are quite likely to experience a shock—the kind that comes from handling price tags, not bare high-voltage wires. For about as much money as you'd pay for a 25-inch color television, a new furnace for your house, or a fairly decent used car, you get a rather severe looking piece of equipment that doesn't even crowd the top of a card table. What's more, the speaker usually isn't included, but costs extra!

It isn't until you look inside and consider the capabilities of these sets that you begin to understand why they cost as much as they do, why they are excellent investments, and also why they sometimes outlive their owners. Communications receivers are designed to meet performance requirements entirely different from those of conventional broadcast and television receivers. From the technical standpoint, they bear as little relationship to the latter as a Jaguar does to a Model A Ford.

The frequency allocations for TV and sound broadcasting stations are set up so that in any one center of population there is virtually no mutual interference. The transmitters themselves are

The Drake DSR-2 is a sophisticated general-coverage short-wave receiver, covering 10 kHz through 30 MHz. It has a digital readout of frequency accurate to 100 hertz, displayed along top edge of front panel.

powerful (50 kilowatt sound stations, for example, are common), so perfectly satisfactory reception is possible with small, inexpensive sets of low sensitivity and selectivity. On the other hand, the ham bands are wide open for unlimited use by thousands of licensees, the great majority of whom use only a small fraction of the one-kilowatt maximum power permitted by the FCC. To

The Heathkit SB-303 is a solid-state ham-band receiver offering every desirable operating feature. Sold only in kit form, it is an appealing assembly project for those with some previous experience in electronic construction. The job is not difficult; it merely requires time, patience, and a clean soldering iron.

separate the weak signals of a dozen different ham transmitters—all seemingly coming in on the same spot on the dial—a receiver needs lots of circuits, lots of tubes or solid-state devices, and lots of refinements. Sure, these cost money, but once you've paid for them you have something to enjoy for a long time. It is virtually impossible to "wear out" a good receiver.

RECEIVER CHARACTERISTICS

A number of things make a "good" receiver. It isn't easy to express these qualities in quantitative or even relative terms, because methods of measurements and the interpretation of the measurements themselves do not conform to really rigid standards.

In the consideration of receiver ratings or performance promises, an important factor often overlooked is the skill of the operator. It takes weeks to master the maze of controls on some of the more advanced sets. Even some of the simple jobs have as many as a dozen knobs and dials, all of which do something to the reception.

So that you might be able to understand something about receivers and evaluate them in your own mind, let's take a broad general look into the various elements of receiver design and construction.

Sensitivity

Sensitivity is the measure of a set's ability to pick up weak signals. Sensitivity, amplification, and gain all mean the same and are used interchangeably. It is relatively easy to build up sensitivity by using enough tubes, one after the other, as amplifiers.

The Drake SSR-1 is a modest all-band communications receiver with built-in speaker, direct-reading tuning dail, signal-strength meter, SSB and AM capability, coverage to 30 MHz.

The first tube gives the signal a little boost, the second strengthens it some more, and so on along the line. Present day circuits and tubes are the highly-refined results of more than fifty years of intensive research and development. There is some feeling in engineering circles that the ultimate in usable sensitivity has been obtained from vacuum tubes and vacuum-tube circuits. In fact, sensitivity claims by themselves do not mean much anymore unless they are qualified in terms of signal-to-noise ratio. Some amplifier arrangements are so extraordinarily sensitive that they reproduce, as audible sounds, the slightest irregularity of electron emission from the cathodes or filaments of the tubes. This sound is usually heard as a high-pitched hiss. If a weak radio signal

entering these tubes has electron movement of the same very low order, the signal and the noise are both amplified and reproduced equally, and the signal usually loses its identity as such in the output.

Often a ham condemns a set as "noisy" when the interference is actually external and not internal. In some industrial areas, particularly those fed by overhead high-voltage power lines, the air is literally saturated with strong electrical impulses. In dry weather, at night, a blue discharge around the line insulators is clearly visible (the effect, eerie indeed, is called "corona"), and the disturbance in the receiver takes the form of loud crackling. In wet weather the noise is more of a frying sound.

The Hallicrafters SX-133 is an AM broadcast and general-coverage shortwave receiver for monitoring applications on the international broadcast bands, the amateur bands, and the marine ship-to-shore frequencies. A large bandspread dial simplifies tuning.

Solid-state devices such as transistors and related items have been slow to appear in amateur receivers because many early types were inherently noisy, offered only low gain, and were difficult to manufacture with uniformity. However, great improvements have been made in them, and new types are performing very well in new receivers of interesting concept and construction.

Selectivity

There are over two hundred and fifty thousand hams in the United States alone, and there are times when you'll swear that

half of them are transmitting on the same frequency at the same time. The most important feature of a modern amateur communications receiver thus is its selectivity. This is defined simply as the ability to separate signals of closely adjacent frequencies. A set with a high order of selectivity is said to be "sharp" or to

Using a combination of tubes and solid-state devices, the Allied A-2516 ham-band receiver is moderately priced and attractive in appearance. In addition to the regular 10-80 meter bands, it also tunes the 10-MHz signals of WWV, the station of the National Bureau of Standards.

"tune sharply." One with poorer selectivity is "broad," or "tunes broadly." In the better ham receivers the selectivity is adjustable from relative broadness to needle-point sharpness, to suit the skill of the operator and the interference conditions of the moment. The greatest improvements that have been made in ham receivers in recent years have been in this department.

A remarkable degree of sharpness is achieved in some communications receivers through the use of adjustable or fixed filters of the electrical, mechanical, and piezoelectric (quartz crystal) types. For many years the crystal filter was considered the most effective. However, the trend is now away from crystals to the more flexible electrical filters.

Bandspreading

A means of spreading out the ham bands so that they occupy a goodly portion of a tuning scale instead of only a few degrees on it is a basic feature of all amateur receivers. Bandspread plus good selectivity enable you to crawl slowly across a band and to unscramble what at first sounds like a mess of stations.

In most sets bandspreading is accomplished by the use of a small multiple-section variable capacitor connected in parallel with the main tuning capacitor and equipped with its own calibrated dial. Other electrical means, sometimes combined with dials having high reduction drive ratios, are also employed. To facilitate tuning, which can be very critical, the controls must be smooth, easy, and absolutely free of backlash.

The Heathkit HR-10B is an excellent ham-bands-only receiver for the novice or beginning general-class operator. Assembly is simple, and critical circuit elements are in prealigned form.

Stability

If you have to retune a receiver slightly every now and then to hold the signals of a station, either the receiver or the transmitter can be suffering from lack of stability. This drifting action in receivers is usually due to changes in the values of capacitors and other parts as they absorb heat from nearby tubes, transformers, and resistors. The problem has been pretty well licked by the

"Wife approved" is how Ray Grenier, K9KHW, describes this handsome operating console in the living room of their home. Desk is the Design Industries "Diplomat," obtained from Amateur Electronic Supply, Milwaukee, Wis. Back edge is angled to put panels of Collins "S" equipment directly in line with operator's vision. Storage bins are at right end.

use of various circuit refinements and special temperature-compensated capacitors in certain critical circuit positions.

It is normal for a receiver to drift a little after it has been turned on, but it should settle down to complete stability in ten to fifteen minutes. One set, the Hallicrafters SX-101, has a built-in heater that is on all the time, even when the main power switch is off. By keeping the chassis warm during idle periods, this heater minimizes drift when the receiver is turned on full. Some hams who do a lot of operating go a step further; they keep their sets running all the time, and merely turn down the volume controls to silence them when they're not being used.

If some stations stay put on your dial and others seem to wander, you are safe in assuming that your receiver is stable and that the transmitters are at fault. Don't be confused by fading. This is a change in the strength of a signal, but not in its dial setting. All you can do to catch a fading signal is to crank up the volume control to maximum and hope that the fade will reverse its direction.

In actual operating practice, drift is much less serious than it sounds. If a signal does wander a little you can usually restore it with a barely perceptible touch on the tuning knob of the receiver.

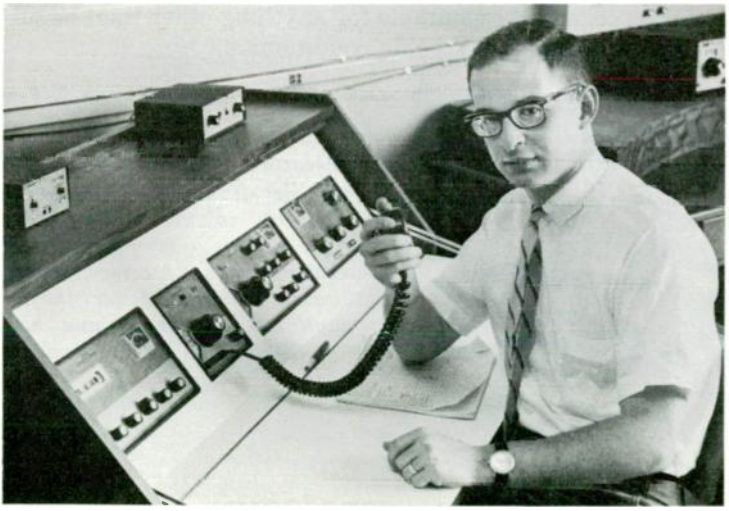
FREQUENCY COVERAGE

There are two distinct types of communications receivers, the "general coverage" or "all-wave," and the "ham bands only." The tuning range of the first is extremely wide. It usually starts at 540 kHz (the bottom of the broadcast band) and runs upward without gaps to 30 MHz, which is beyond the top of the 10-meter amateur band. Thus, it includes the ham bands from 160 through 10 meters in addition to an enormous variety of other short-wave services. In some sets, separate band-spread scales are provided for the ham bands; in others, any portion of any band can be spread out for easier tuning. The big advantage of a general-coverage receiver is its versatility. When it is not being used for hamming, it can furnish all members of the family unlimited listening possibilities on the police, fire, citizens, aeronautical, maritime, and domestic and international broadcasting channels.

The ham-band receiver defines itself. It is a highly specialized set offering maximum selectivity and bandspread on the amateur channels, and on only some of them at that. Most models take in only the 80-, 40-, 20-, 15-, and 10-meter bands, which are by far the most popular in general use, others might have the 6- and 160-meter bands in addition.

The Hallicrafters S-120A is a transistorized, updated version of the S-120, which in its original tube version was probably the most widely used of all general-coverage receivers. It covers four bands and has built-in speaker and antenna.

Choosing between the two types of receivers is a personal matter. Many hams start with a modestly-priced, general-coverage set and add a ham-band job later as they acquire experience and cash. Others jump in immediately with the specialized receivers because they're anxious to work the maximum DX in the minimum time.



Still another radio executive whose work is also his hobby is Larry Meyerson, WØWOX, president of World Radio Laboratories. He operates from this business-like console, which contains (left to right) the Galaxy DeLuxe Accessory Console, Galaxy Remote VFO, Galaxy V Mark 2 transceiver, and Galaxy Model 2000 Linear Amplifier. A very neat rig!

Operating requirements on 2 and 6 meters are somewhat different from those on the other bands. Hence, different equipment and techniques are usually called for. Many hams favor entirely independent receivers for these bands or for the two in combination. Others find it effective to add "outboard" converters ahead of their regular receivers. These units change the high-frequency signals to lower-frequency ones that fall within one of tuning ranges of the sets. The combination is fairly successful when the converter is paired with a general-coverage receiver, but it may not be practical with many ham-band–only jobs. The major trouble with the conversion method is that the receiver tends to pick up signals on the conversion frequency; these signals constitute interference for the injected 2- or 6-meter signals.

Band Changing

In modern communications receivers, band changing is accomplished by a front-panel switch that connects various tuning coils, capacitors, or crystal oscillators into the circuits. Plug-in coils which must be shifted in and out of a single socket are used in some very simple sets sold in kit form. These receivers are intended primarily to give newcomers a little practical experience in assembly and wiring. While they are quite sensitive and pull in many stations, their selectivity leaves much to be desired, and they cannot be regarded as suitable for anything other than beginner CW operation under favorable conditions.

Temperature compensation of oscillator circuits provides high order of stability in the Hallicrafters SX-122. This is a very high-grade general-coverage receiver, with calibrated bandspread for the 10 through 80 ham bands and also the CB band. Uses separate speaker and is AC operated.

RECEIVER ACCESSORIES

Oddly enough, the lower priced ham receivers have built-in speakers, but the higher priced ones do not! In the latter, the chassis space is taken up with too many more important components.

In communications work, high-fidelity sound reproduction is not only unnecessary but is actually undesirable. We are interested only in the voice range of frequencies, and anything lower or higher is just so much interference. For this reason, the audio amplifier section of ham receivers is usually very modest, and any small speaker (between four and eight inches in diameter) is entirely satisfactory. Most receiver manufacturers sell speakers in small cabinets to match the sets.

If the ham shack is in the living quarters of a house or an apartment, the other members of the family may be annoyed by the rather noisy mixture of CW and phone signals, static, and ignition interference coming from the speaker. To keep peace, it is advisable to use a pair of earphones, or "cans." In all receivers, the speaker is cut off automatically when the earphone plug is inserted in the earphone jack.

A large variety of phones is available. The conventional type consists of two units on a double-wire frame, fitting over the head. Light phones of the hearing-aid type are becoming popular too.

Earphones have advantages other than household quietness. Even many experienced technicians do not realize that they are probably the most sensitive of all electronic reproducing devices—they respond to infinitesimal changes of current. Earphones make signals ordinarily lost in a speaker intelligible. Because they require so little energy, you will find you can turn the receiver gain controls way down from the usual speaker adjustments. This usually reduces the noise level considerably and makes for more comfortable reception.

Phones put the sound directly into your ears. Fitting snugly against the latter, they shut off room noise and enable you to concentrate better. The more you use phones, the more you will like them and will marvel at their ability to produce weak stations out of nowhere.

Oversize earphones like these have foam-rubber cushions that shut out room noises and permit a radio operator to concentrate on weak signals. Hams commonly refer to these as "cans."

Short-wave radio signals have amazing penetrating ability, and can be heard quite well with small antennas inside seemingly tight buildings. In fact, sometimes they can be heard with no antenna at all! Evidently they seep in through openings in the metal chassis or cabinet of a receiver, or enter by way of the AC power line. (In the early days of broadcasting a popular stunt was to connect the antenna lead of a set to one side of the line, with a small mica capacitor in series to eliminate shock hazard.)

The Heathkit GR-78 is a six-band, solid-state, portable general-coverage receiver. It operates from a built-in nickel-cadmium battery, kept in condition by a self-contained AC charger. In addition to a full-tuning range from 550 kHz through 30 MHz, it also takes in the low-frequency band of 190-410 kHz. Never a dull moment with this set!

However, it is helpful to use an outside antenna. Before a transmitter is added to the "shack," a random length of any strong wire, hung as high and as clear as possible and insulated at the ends with small glass or ceramic insulators, will serve as the antenna. The overall length, from the receiver to the farthest point can be 25 to 100 feet. Longer stretches don't seem to work any better, and often create other problems because of sagging.

The situation will be different when you get on the air, because most transmitting antennas have marked directional effects that are equally advantageous for receiving. The antenna connections are changed from the transmitter to the receiver by a manual switch, or, more likely, by an automatic relay actuated by the microphone circuit or the CW key.

A Drake 2-B ham-band receiver is featured in this compact L-shaped radio shack of Mrs. Eileen Cline, KØILM, Fort Madison, Iowa. An expert CW operator, Eileen often flabbergasts other hams by sending at 60 words per minute, a speed she can follow herself when she is receiving.

QUALITY AND PRICE

It is fortunate for prospective purchasers of communications receivers that the market is remarkably free of "lemons." The excellent reputations enjoyed by ham manufacturers, some of

The Galaxy R-530 is a rugged solid-state receiver of modular construction. Tuning coverage is continuous from .5 through 30 MHz. It features very accurate frequency readout on the main tuning dial. Really a professional set, which is why hams will like it.

Unusually wide frequency coverage is the feature of the Drake SPR-4, one of the new breed of solid-state communication receivers. It can actually be programmed for a total of 24 bands, from 150 kHz to 30 MHz. It can be operated from AC or battery; speaker is separate.

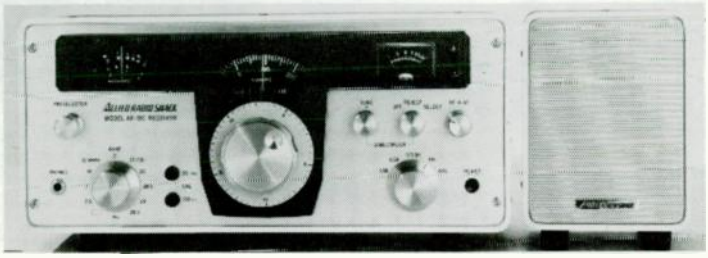
whom have been in the game for half a century, are based on one thing—performance. A manufacturer who wants to stay in business cannot afford to put out a poor instrument. If he is foolish enough to try, the first unhappy buyer will scream bloody murder over the air, and in a couple of days the whole ham fraternity will know about it. After all, isn't radio the fastest way to disseminate information internationally?

Receivers range in price from $50 to $2200. Why such a great difference? The answer is simple. Some people have very little money to spend on their hobbies, others have a moderate amount, and still others hardly look at the price tags. Manufacturers merely try to satisfy them all. Even the lowest priced set enables

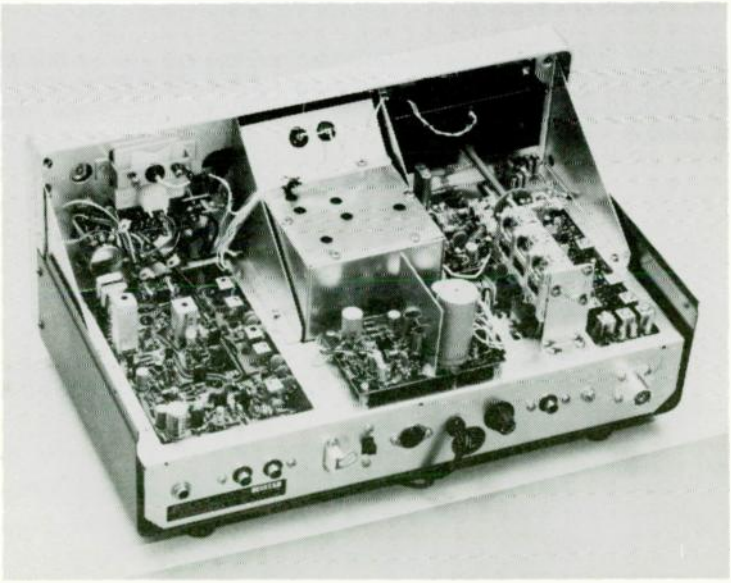
"Neatness" is the word for this all-Collins station of Sol Weingast, WA2WXT, Atlantic Beach, N.Y. Left to right: 75S-3 receiver, 312B-4 control panel, and 32S-1 transmitter. Only wire in sight is mike cord!

a ham to enjoy the thrills of local and foreign contacts. The higher priced ones merely offer more in the way of selectivity, gain, bandspread, accuracy of calibration, ease of tuning, etc.

Communication receivers are primarily built for performance and have little useless ornamentation or other "eyewash." It is therefore possible to grade them directly by cost and to say that two sets of about the same price can be expected to produce about the same results. In general, hams find it wise to invest in the higher priced jobs. Not only are they superior in obvious respects to the cheaper sets, but they have much higher trade-in value. This is an important consideration, because hams by nature are gadgeteers and sooner or later they change their equipment just to have something different—not necessarily new, but just different—to play with.



Allied Radio Shack, AX-190 is high-grade ham-band receiver, all solid state. Chassis is so crowded with circuit components that speaker is furnished as separate accessory, above.



POWER CONSUMPTION

Most communications receivers require so little power from the AC line that the manufacturers do not usually bother to include the figure in their specifications. The smaller sets take only about 50 watts, and the largest about 120 or 150 watts. This means that they can be safely plugged into any wall outlet.

The popular slide-rule type of tuning scale enables the user of this Radio Shack DX-160 general-coverage, solid-state receiver to keep track of ham and CB stations, short-wave programs from all over the world, marine and aviation weather, time signals, etc. The frequency range is 150 kHz through 30 MHz. The speaker is a separate accessory; earphone jack provides for quiet listening.

5

Getting Your Ticket

Of the five types of amateur licenses, novice, technician, general, advanced and amateur extra, you can hold only one at a time. The maximum operating privileges are afforded by the amateur extra, with the advanced and general running close behind.

While you are studying the code and radio theory, in preparation for a license examination, by all means write to the Federal Communications Commission, Washington, D.C., 20554, and ask for a copy of the bulletin entitled "Amateur Radio Service." This is valuable because it contains current information on license fees, changes in license requirements and operating privileges, location of FCC facilities, and similar matters of direct interest to would-be hams. The bulletin is free. To make sure that it will reach you, clearly print or type your name, full address, and Zip Code.

THE TOP LICENSES

To obtain an amateur extra, advanced or general ticket, you must appear in person at any district office or examination point of the FCC and take the two-part test in person. You can go to any one of them, not necessarily the one nearest your home.

A district office is a permanent establishment and is usually open during normal business hours Monday through Friday or Saturday. An examination point is a more or less temporary office, set up several times a year to take care of applicants in less populated areas.

The Commission may permit the examinations for an amateur extra, advanced, general, or technician class license to be administered at a location other than a Commission examination point by an examiner chosen by the Commission when it is shown by physician's certification that the applicant is unable to appear at a regular Commission examination point because of a protracted disability preventing travel.

THE CONDITIONAL-CLASS LICENSE

This particular license was discontinued in June, 1976. However, anyone renewing a conditional-class license will receive in its place a general license. The examinations for a conditional-class license were given by a voluntary examiner at a point other than a Commission examination point for persons who lived more than 175 miles from an FCC district office or examination point, or could not travel because of physical impairments. However, as stated previously, a general license can be obtained by testing at a local location if certain protracted disabilities prevent travel.

Regardless of where you live, you can travel to any FCC examining office where amateur tests are held and take the general, advanced, or the amateur-extra examination. The FCC office sends the papers to Gettysburg and there you are assigned a call

At many FCC offices, applicants for the ham license examination are greeted by affable receptionists who put them at ease with friendly words and smiles. They hand out FCC Form 610, "Application for Individual Amateur Radio Station and/or Operator License," explain the test procedure, and take the applicants' filing fees. It will save time if you have a check for the proper amount already made out.

This is one type of tape keyer used in some FCC offices. The output is fed to earphones at the desks or tables at which applicants take the examination.

sign appropriate to your home location. There is a large "transient" business in the FCC offices in the big cities like Boston, New York, Philadelphia, Chicago, San Francisco, etc., where examinations are given on a continuous rotation basis every business day of the week. You don't need an appointment; just drop in, get an application form, take the code test, do the written parts, and scram! If you are sufficiently prepared, you can go through the process in about as much time as you need for a good lunch. During holiday periods, the FCC offices are usually jammed with students.

THE NOVICE AND TECHNICIAN LICENSES

Examination for the novice class license will be taken at home. The test will be conducted and supervised by a volunteer examiner selected by the applicant.

An important point to remember in connection with the novice ticket is that it is good only for two years and cannot be renewed. To obtain a new novice license, you must take a new test. Credit

This compact solid-state keyer is rapidly replacing the heavy machine shown on the preceding page. The perforated tape is the same as before, as is the accuracy of transmission. Its built-in speaker eliminates the need for individual earphones, and enables FCC examiners to set up test facilities in any convenient office.

for a novice license can be applied to any of the higher licenses. Remember also that you do not have to wait out two years as a novice; you can apply for any of the higher licenses at any time.

The examination requirements for a technician license were the same as for a novice license, until June, 1976. Now, however, the examination procedure for the technician license is the same as for the top grade licenses. You must appear in person at any district office or examination point at times specified by the Commission.

In the following list of examination points, the numbers to the right of the cities indicate the FCC district offices to which you should write for information schedules:

When you sit down with pencil and paper and wait nervously for the tape to start, it is important to remember that you don't have to copy the entire five-minute transmission without error. All that is required is to copy satisfactorily at no less than the prescribed speed for five minutes. So don't worry if you stumble over the first few words. Relax, listen without looking at the machine, and you'll quickly make sense out of the dits and dahs. Actually, five minutes of code is a lot of code. You can listen to the first couple of minutes without writing a word, and then you will start copying as you get into the rhythm of the perfectly made and spaced characters.

Quarterly Points

Albany, N.Y.	2	Des Moines, Iowa	17
Birmingham, Ala.	6	Fort Wayne, Ind.	18
Charleston, W. Va.	19	Fresno, Calif.	12
Cincinnati, Ohio	19	Grand Rapids, Mich.	19
Cleveland, Ohio	19	Indianapolis, Ind.	18
Columbus, Ohio	19	Knoxville, Tenn.	6
Corpus Christi, Tex.	9	Little Rock, Ark.	8
Davenport, Iowa	18	Louisville, Ky.	18

After you pass the receiving part of the code test, the FCC examiner will plug a key into the tape machine and ask you to send some copy from text material. Speed here is not important, so take it easy and concentrate on making clean characters. He will probably stop you after only a few seconds and say: "OK, you can now take the written."

Memphis, Tenn.	6	Salt Lake City, Utah	15
Milwaukee, Wisc.	18	San Antonio, Tex.	9
Nashville, Tenn.	6	Sioux Falls, S. Dak.	16
Oklahoma City, Okla.	10	Syracuse, N.Y.	20
Omaha, Nebr.	17	Tulsa, Okla.	10
Phoenix, Ariz.	11	Williamsport, Pa.	20
Pittsburgh, Pa.	20	Winston-Salem, N.C.	5
St. Louis, Mo.	17		

SEMIANNUAL

Albuquerque, N.M.	15	Fairbanks, Alaska	23
Boise, Idaho	13	Hartford, Conn.	1
El Paso, Texas	10	Jackson, Miss.	8

Jacksonville, Fla.	7	Salem, Va.	5
Juneau, Alaska	23	Spokane, Wash.	14
Ketchikan, Alaska	23	Tucson, Ariz.	11
Las Vegas, Nev.	11	Wichita, Kans.	17
Lubbock, Texas	10	Wilmington, N.C.	5
Portland, Maine	1		

ANNUAL

Bakersfield, Calif	11	Klamath Falls, Oreg.	13
Bangor, Maine	1	Lihue, Kauai, Hawaii	21
Billings, Mont.	14	Marquette, Mich.	16
Great Falls, Mont.	14	Missoula, Montana	14
Hilo, Hawaii	21	Rapid City, S. Dak.	15
Jamestown, N. Dak.	16	Wailuku, Maui, Hawaii	21

If a district office is nearby, call up and ask about test schedules. In the phone book, look first under "U.S. Government" and then under "Federal Communications Commission." In the larger cities you can usually walk in without an appointment and go through the routine in short order, but in others the tests are given only on prescribed days. A phone call is cheap and might save you a fruitless trip.

Practice and study are the basis of success, of course. But if you become afflicted with buck fever when you walk through the doors marked "Radio-Operator Examinations," you're only human. You know what buck fever is. All summer long a sportsman will practice rifle shooting. He'll get the trigger squeeze just right, he'll learn how to hold high or low to make the bullet hit where he wants, etc. And what happens when he goes into the woods and sees a big deer in the flesh for the first time? He jerks the trigger, he holds a foot over the target, he misses completely, and then collapses to the ground into a state of nervous exhaustion. That's buck fever!

The same thing happens every day at FCC examining offices. Usually it's nervousness, but sometimes it's lack of preparation. That's the opinion of the radio license examiners in the New York City office of the FCC, probably the busiest in the country. These men process as many as 500 applicants a month, ranging in age from 12 to 72. Most of the examiners have taken the test themselves and are active hams. They are therefore qualified to give some good advice. Here is what one of the examiners told the author:

"Too many people rush down the first time someone checks them off at what they think is 13 words-per-minute. They don't make enough allowance for timing errors, or the fact that they

Instant recognition at club meetings, conventions, picnics, etc., comes from wearing call-letter plates like these. On the bottom one, B.A.R.C. stands for the Broward Amateur Radio Club. Broward is a county in Florida, a relief map of which is to the left.

will take the test in strange surroundings. They should protect themselves by becoming really proficient at full 15 per-minute before they try our 13. We don't depend on uncertain hand sending. We use an automatic tape machine that is periodically checked for timing accuracy. When it's adjusted for 13, it sends at 13, no more, no less. When a failing applicant grumbles a little and infers that the sending sounded sort of fast, we just smile and wish him better luck next time."

Besides a pencil or a pen, the important thing to have with you when you reach the FCC office is a confident manner. The license examiner will hand you Application Form 610, which you can fill out in a few minutes.

If you intend to take the test at an examination point rather than a district office, first write to the nearest district office and request a Form 610. Fill this out and send it back to the same

Above: A corner only three-feet wide makes a cozy ham station for a New York apartment dweller. Shelf above transceiver holds accessories. Below: In his retirement home in Florida, Moe Segal, K4IVA, enjoys the comfort of a desktop full of SSB and 2-meter FM equipment.

Notice how the back edge of this "command console" at WA8TKC is angled downward to put the panels of the Drake 4-Line station in the line of sight of operator Ronald Wysong: a very good arrangement. Also note the huge map of the world covering the entire wall. Equipment, right to left: MS-4 speaker and AC power supply for transmitter; R-4B receiver; T-4XB transmitter; MN-2000 antenna tuner; L-4B kilowatt amplifier.

office. In due time you will be told the location and the schedule of the examination point.

Only citizens and nationals of the United States are eligible. However, a curious aspect of the licensing procedure is that applicants are not required to prove that they *are* citizens. When they sign the application blanks they do in effect swear to this status; this action apparently is enough from the legal standpoint to satisfy the FCC.

The code test is the first part of the examination in the FCC office. The code is sent at the rate of 13 (or 20) words per minute for a period of five minutes. You pass if you copy satisfactorily at no less than the prescribed speed. This latter point is very important, because it enables you to sit and relax for the first few moments of the transmission and to adjust yourself to the swing of the dits and dahs. Too many applicants start scribbling nervously when they hear the first peeps in the earphones; by the time they recover their composure the test is finished.

The examiner grades your "copy" immediately. If you pass, he hands you the written part of the examination, which consists of

When he was first licensed in 1922 as 6BPI, at the age of thirteen, this ham had much, much less equipment than he now enjoys as K7UGA. He dropped out of the game during the depression of the 1930's but never lost his interest. His amateur experience proved valuable during World War II, when, among other jobs, he taught radio code and theory to Chinese aviation cadets. Again bitten by the bug in 1962, he quickly got into the swing of things and acquired the call K7UGA for his permanent home in the Southwest and K3UIG for his Washington base. He also operates mobile rigs in his car and boat, and when he had an airplane he was on the air from there too—literally!

Does the face look familiar? It should, because it belongs to Barry Goldwater, twice senator from Arizona, major general in the Air Force Reserve, and erstwhile candidate for the presidency of the United States.

Never too young or too old! Boys not even in their teens and men old enough to be their grandfathers share the ham hobby with equal enthusiasm. Top: William G. Welsh, W1SAD/6 ,thrills a young friend by letting him participate in an overseas conversation. Bottom: Eugene M. Link, a retired Army colonel, who is WØIA, has won public-service citations for organizing an amateur network devoted to weather reporting.

several dozen questions of the multiple-choice type. This test is also graded immediately, and you are told the result. If you pass, you simply leave with a smile on your face. Your ticket is not given to you there and then. It will be mailed to you from the FCC's central processing depot in Gettysburg, Pennsylvania.

If you flunk the code you are not even permitted to take the written test. If you pass the code test and flunk the written test, you flunk out altogether. A waiting period of thirty days is required before you can try again. You can repeat this routine as often as your patience holds out! Actually, the tests are rather easy, and most applicants sail through them in an hour or less.

If you flunk the code you are not even permitted to take the written test. If you pass the code test and flunk the written test, you flunk out altogether. In either case, the $9.00 filing fee is retained by the FCC. A waiting period of thirty days is required before you can try again. At this time the cost is another $9.00. You can repeat this routine as often as your money and your patience hold out! Actually, the tests are rather easy, and most applicants sail through them in an hour or less.

LOCATION OF FCC OFFICES

District offices of the FCC are located as follows:

District No.	*Office Location*	*District No.*	*Office Location*
1	1600 Customhouse Boston, Mass. 02109	7	Room 919 51 S.W. First Avenue Miami, Fla. 33130
2	748 Federal Building 641 Washington Street New York, N.Y. 10014	7T	738 Federal Office Bldg. 500 Zack Street Tampa, Fla. 33602
3	1005 U.S. Customhouse Philadelphia, Pa. 19106	8	829 Federal Office Bldg. 600 South Street New Orleans, La. 70130
4	819 Federal Bldg. 31 Hopkins Plaza Baltimore, Md. 21201	8M	439 U.S. Courthouse and Customhouse Mobile, Ala. 36602
5	Military Circle 870 N. Military Highway Norfolk, Va. 23502	9	New Federal Office Bldg. 515 Rusk Ave., Rm. 5636 Houston, Tex. 77002
6	1602 Gaslight Tower 235 Peachtree St., N.E. Atlanta, Ga. 30303	9B	239 Federal Building 300 Willow Street Beaumont, Tex. 77701
6S	238 Post Office Building P.O. Box 8004 Savannah, Ga. 31402	10	Room 13E7, Federal Bldg. 1100 Commerce St. Dallas, Tex. 75202

LOCATION OF FCC OFFICES (cont'd)

District No.	*Office Location*	*District No.*	*Office Location*
11	Rm. 1758, U.S. Courthouse 312 North Spring St. Los Angeles, Calif. 90012	18	1872 New U.S. Crthse. & Fed. Ofc. Bldg. 219 S. Dearborn St., Chicago, Ill. 60604
11SD	Fox Theatre Bldg. 1245-7th Avenue San Diego, Calif. 92101	19	1054 New Federal Building Wash. Blvd. & Lafayette St. Detroit, Mich. 48226
12	323-A Customhouse 555 Battery Street San Francisco, Calif. 94111	20	328 Federal Building 111 W. Huron St. Buffalo, N.Y. 14203
13	314 Multnomah Bldg. 319 S.W. Pine Street Portland, Ore. 97204	21	502 Federal Building P.O. Box 1021 Honolulu, Hawaii 96808
14	8012 Federal Office Bldg. 1st Avenue & Marion St. Seattle, Wash. 98104	22	322-323 Fed. Bldg., P.O. Box 2987, San Juan, Puerto Rico 00903
15	504 New Customhouse 19th between Calif. & Stout Sts., Denver, Colo. 80202	23	Rm. 53 U.S. P.O. Bldg. & Courthouse P.O. Box 644 Anchorage, Alaska 99501
16	691 Fed. Bldg. & U.S. Crthse. 4th & Robert St. St. Paul, Minn. 55101	24	Room 216 1919 M St., N.W. Washington, D.C. 20554
17	1703 Federal Building 601 E. 12th Street Kansas City, Mo. 64106		

ASSIGNMENT OF CALL SIGNS

For the purposes of call-sign assignment, the United States is divided into ten districts, as follows:

First: All the New England states of Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine.

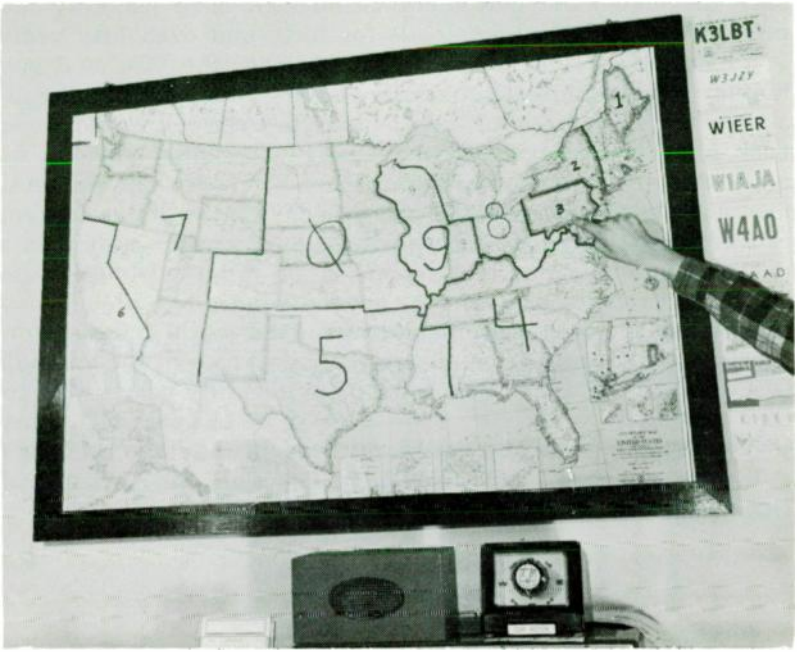
Second: New York and New Jersey.

Third: Delaware, Maryland, Pennsylvania, and the District of Columbia.

Fourth: Alabama, Florida, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and the territories of Puerto Rico and the Virgin Islands.

Fifth: Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas.

Sixth: The states of California and Hawaii, and the Pacific islands not assigned to the Seventh District.



A nice wall decoration for the radio shack: a map of the United States with the boundaries of the ten call-letter districts outlined with a marking pen. Use colored pins to indicate locations of stations worked.

Seventh: Arizona, Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming, Alaska and adjacent islands.

Eighth: Michigan, Ohio, and West Virginia.

Ninth: Illinois, Indiana, and Wisconsin.

Tenth: Colorado, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota.

By international agreement, various initial letters are assigned to various countries to identify radio stations of all kinds. The United States has W and K for commercial and amateur stations, and N exclusively for naval stations. Amateur call signs (also referred to as *call letters* or simply as *calls*) consist of one or two initial letters. The tenth district does not use the combination "10," but "Ø," which is read as "zero." The diagonal line is always struck through the cipher to prevent it from being confused with the letter O. Without it, some interesting mixups on the air might take place if, for instance, WØOF contacted WØLF. "Hello WOOF, this is WOLF calling." Can you imagine the possibilities?

Except in very special cases, call signs are issued strictly in rotation from the available combinations. Two-letter calls obvi-

ously belong to the old-timers. Some men have jealously and proudly retained the same calls for forty and even fifty years. If a ham moves from one district to another the FCC will give him the same combination of ending letters if they are not already assigned. If you let your license expire your call gets thrown back into the grab-bag, although the FCC seems to hold it for a while to give you a chance to recover it. There is also a sentimental little provision that if you ever held a two-letter call you can get one again (not necessarily the same one) either on a new-station application or by modification of an existing license. The FCC probably figures that anyone who is old enough now to have had a two-letter call isn't long for this world and therefore deserves a little humoring! There are many men in their middle 60's who have held ham tickets for more than fifty years; they got them originally when they were only 12 to 15 years old, a feat that is no more unusual today than it was just after World War I.

Typical calls are W2PF, K2DUX, and W6PXH. Novices' call signs begin with the following prefixes:

WBØ	KH6
WB1	KL7
WD2	KP4
WB3	KP6
WD4	KG6
WB5	KS4
WD6	KS6
WB7	KV4
WD8	KW6
WB9	KJ6

A slightly different method of assignment is used for stations in the states of Alaska and Hawaii and in United States possessions. The initial letters are allotted as follows:

KA—Japan (U. S. Personnel)
KB6—Baker, Canton, Howland, and American Phoenix Islands
KC4—Navassa Island
KC4AA-KC4US—Antarctica
KC6—Caroline Islands
KG1—Greenland (U. S. Personnel)
KG4—Guantanamo Bay, Cuba
KG6—Marcus Island and Mariana Islands
KG6I—Bonin and Volcano Islands
KH6—State of Hawaii and Kure Island
KJ6—Johnston Island

If you can't tell from his wild shirt, you can surely tell from his license plate that Ralph E. Thomas and his XYL (ham for wife) live in Hawaii.

KL7—State of Alaska
KM6—Midway Islands
KP4—Puerto Rico
KP6—Palmyra Group, Jarvis Island
KR6-KR8—Ryukyu Islands (Okinawa)
KS4—Swan Island
KS4B—Serrana Bank and Roncador Cay
KS6—American Samoa
KV4—Virgin Islands
KW6—Wake Islands
KX6—Marshall Islands
KZ5—Canal Zone

CALL PLATES FOR YOUR CAR

In recognition of the extraordinary public services rendered by hams during periods of disaster and emergency, many states per-

mit them to obtain license plates for their cars that duplicate their call signs. Of course, this is a highly prized privilege—other "low number" and initial plates are not nearly so distinctive. Check with the motor vehicle licensing authorities of your own state. Where the plates are available, you only have to show your ham ticket to obtain them. In most cases there is a small extra charge, inasmuch as the plates are made to order.

If you are lucky enough to get call-sign plates, you can expect to be asked a lot of questions by curious passers-by, and also you will probably make the acquaintance of a lot of other hams. On the road, you'll hear many greetings blasted out on car horns in International Morse, so you'd better keep your code up. Many hams have installed telegraph keys on the steering columns of their cars, wired across the horn switch contacts, so that they can send properly. It's all a lot of fun.

If you don't want to bother with changing the registration of your car, you can still identify yourself as a ham by mounting a cast aluminum call plaque under the state license tag. Available in a variety of sizes and styles, these plates can be ordered from most amateur supply firms.

6

Going on the Air With a Transmitter

After you've taken your license test, either by mail or at an FCC office, and while you're waiting for your ticket to come through, you will start to think seriously for the first time about a transmitter. "Seriously" is the right word, because the price range of sending equipment is quite wide. You can go on the air with a modest rig costing only about fifty dollars and taking up no more space than a hat box, or you can make a real splash with a spectacular outfit costing approximately two thousand dollars and requiring a specially reinforced floor to support its size and weight.

Unlike receivers, transmitters can be built up progressively. You can start with a small variable-frequency oscillator exciter unit and work quite a few stations with it on CW. Then, as you

The Atlas 210 solid-state, five-band transceiver by itself is the size of a cigar box. Combined with an AC power supply and speaker, it forms a neat console that can fit on a shelf.

Here's a complete 6-meter station that occupies very little table space. Main unit is the Knight TR-106 transceiver, with V-107 VFO (variable frequency oscillator) and P-2 power meter. QSL cards on wall, which belong to Don Saxon, WA9FCD, Berwyn, Ill., represent 24 countries. Map shows local times in various countries having hams.

get ambitious, you can add a modulator for voice operation, or a high-power amplifier. You can make your first contacts on the air with a piece of TV lead-in wire as the antenna, and then install an elaborate beam antenna. The sky's the limit in transmitter work, literally as well as figuratively.

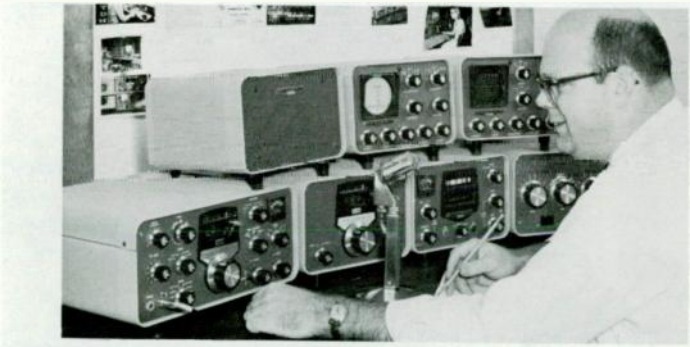
KITS VS. FACTORY-BUILT EQUIPMENT

Many of the pros and cons of kit construction were given in Chapter 3. As mentioned there, transmitters, in general, are easier

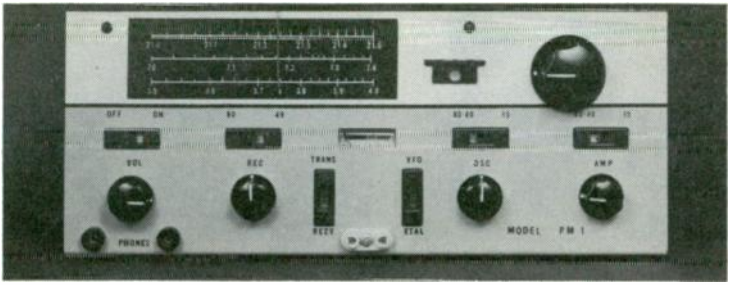
Although no longer made, the Heathkit "Twoer" is very popular for 2-meter AM work because it is very simple in construction and virtually foolproof in operation. Affectionately known as the "Benton Harbor Lunch Box," it commands good prices as used equipment.

to construct than receivers. There are quite a few transmitter kits, and some transmitters are available in both kit and factory-assembled form. The difference in price is appreciable although money saving is not the usual reason some hams "roll their own." They do it because the job is intricate and interesting, a challenge to their skill; also, because they learn a great deal about equipment design and construction. Some kits are relatively simple and designed specifically for beginners; others are quite complicated, take a lot of time and know-how, and should not be attempted unless you have considerable experience.

Ready-made transmitters are, of course, a great convenience. Many new hams, anxious to go on the air the minute their licenses arrive, prefer them because of their impressive appearance and



This very professional looking amateur station is strictly a home-assembled screwdriver/soldering iron job, made from Heathkits. The happy operator is Alan Robertson, K8BLL, Benton Harbor, Mich. Left to right, on table: SB-102 five-band transceiver, SB-640 external linear master oscillator, SB-630 station console, SB-200 kilowatt amplifier. Top: SB-600 speaker, SB-620 signal analyzer, SB-610 monitor scope. Never a dull moment in the life of this DX worker!

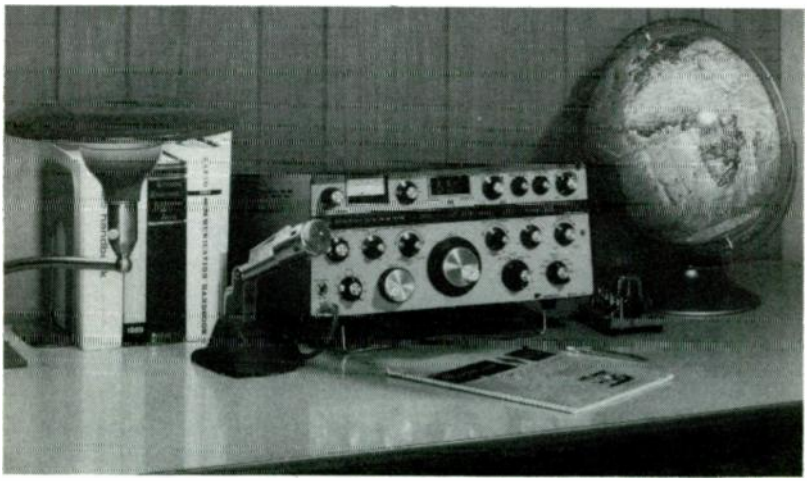


The Ten-Tec "PM" series low-power CW transceivers use modular construction, are reliable because they are relatively simple, and are especially appealing to beginners because of their low prices. The model shown covers 80, 40, and 15 meters. Only power supply needed is an inexpensive lantern battery.

their reliability. It's a great thrill to unpack a new transmitter at two o'clock some afternoon and work your first station at four!

POWER LIMITATIONS

The FCC limits ham transmitters to a maximum power input of 1,000 watts DC (one kilowatt) to the plate circuit of the final-amplifier stage. A full one-kw transmitter, popularly known in the game as a "gallon," makes a very strong signal on the ham bands.



Enough knobs to satisfy you? It's the Signal One CX7, probably the most sophisticated transceiver on the ham market. This unit includes: all bands from 10 through 160 meters; digital frequency readout (no dials to watch!); electronic keyer; teletypewriter capability; and many other advanced features.

Aside from its cost (a consideration that doesn't seem to bother hams!), such a rig cannot be used safely in some homes and in most apartments for the simple reason that the AC power lines in them aren't heavy enough.

Consider the arithmetic of the situation. As a rough rule, a transmitter draws at least twice as much primary power as the rating of the final-amplifier stage alone. A minimum demand of about 2,500 watts for the transmitter and a few accessories means a line current of almost 30 amperes at 115 volts, even at a reasonably low power factor. This is just twice the normal 15-ampere fused capacity of individual branch circuits.

Most manufacturers of high-power equipment provide primary connections for both 115 and 230 volts, and recommend strongly that the higher voltage be used because it cuts the line current in half and minimizes voltage drop in the lines. Many homes already have three-wire, 115/230-volt service, although the branch circuits may all be 115 volts. It is a simple matter to run a separate 230-volt circuit from the main fuse box to the radio shack in the same manner as heavy-duty lines for air conditioners, kitchen ranges, water heaters, etc. are run. If the house has only two-wire, 115-volt service, the contemplated purchase of an expensive gallon

David Marks, W2APF, Albany, N.Y., is the ham fraternity's roving ambassador. First he works amateurs in odd corners of the world, and then he takes off to visit them in person. Known everywhere as "Uncle Dave," here he is with XZ2KN, Tara Singh, of Rangoon, Burma. He has made more personal contacts of this kind than any other ham. His home "shack" is filled with souvenirs of his travels, many of them both exotic and expensive.

A companion for the SB-303 receiver, the Heathkit SB-401 transmitter offers full SSB and CW operation, and includes a built-in AC power supply. An interesting assembly project, but not for beginners.

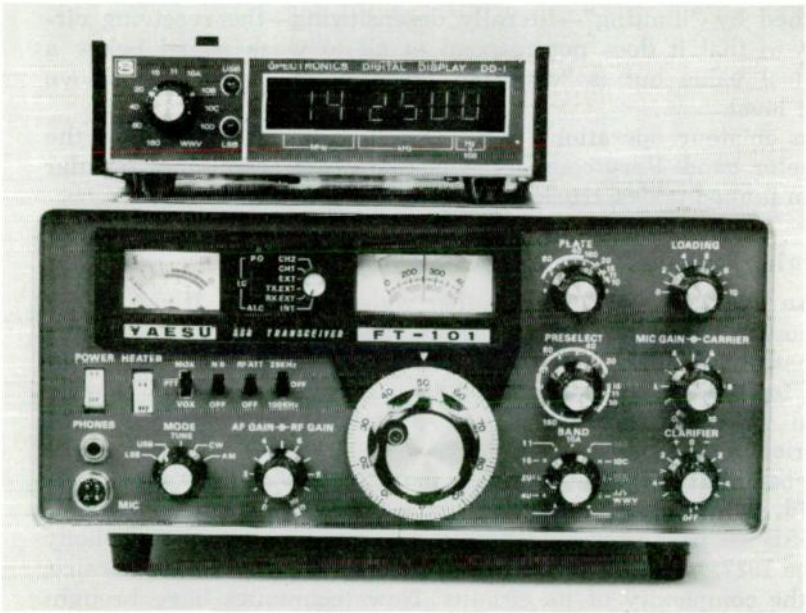
transmitter is a good excuse for replacing it by a new service of adequate capacity. Local utility companies are happy to furnish free engineering advice in this connection, for the obvious reason that the customer's bills will be higher! The utility brings a new line into the house from the nearest distribution transformer and installs a new meter, at little or no cost. The rest of the installation, from the meter through the house, is the owner's responsibility. Anyone who can afford a one-kw transmitter will not be burdened by the relatively small extra cost of these circuits.

Transmitters rated at about 400 to 500 watts are about as big as you can run safely in a home or apartment without burning up the place. A typical unit rated by its manufacturer at 435 watts input draws 12½ amperes at 115 volts. This is equivalent to the load of a standard electric iron. Although 500 watts is only half of the FCC allowance, it is still considered "high power" in ham circles. The majority of hams run much less: 10 to 50 watts at first, and then 100 to 150 watts.

TYPES OF TRANSMITTERS

The CW- (continuous-wave) type transmitter is the simplest. It generates single-frequency radio energy, which is interrupted by a hand key to form the dits and dahs of the code. A CW signal occupies only a very narrow space on the air.

The Swan Model 270 SSB transceiver is a complete station in one package, needing only a power source and an antenna. With its self-contained AC/DC power supply, it is equally suitable for fixed and mobile use.



Direct frequency readout from both the Yaesu FT-101 and the Collins "S" line transceivers is available with the Spectronic Digital Display, shown here on top of the FT-101. A simple connection to the existing set is all that's needed.

When voice facilities are added, a CW generator becomes a "phone" transmitter. Voice signals superimposed on the narrow CW carrier cause it to change in amplitude and also to broaden out both above and below its basic frequency. For example, if an operator's speech varies up to 2,000 hertz, a 14.3-MHz carrier widens to 14.302 MHz at one extreme and to 14.298 MHz at the other. The two variations from the carrier frequency are called *sidebands*. This general method of operation is called *amplitude* modulation or AM, and is used by all standard broadcasting stations in the 550 to 1600 kilohertz band; also by some stations in the aviation, weather, and public-safety services. AM equipment is relatively easy to build, adjust, and maintain.

The other general method of operation is called *frequency modulation* or *FM*. In this type of modulation, the amplitude of the carrier remains constant and the frequency is changed by the superimposed voice signals. FM is used mainly for high-fidelity broadcasting, but it is also advantageous for relatively short-distance mobile communication because it is less susceptible to noise interference than AM. In the absence of signals a properly adjusted FM receiver appears to be absolutely dead, but it comes to life loud and clear when they do arrive. This trick is accomplished by "limiting"—literally desensitizing—the receiving circuit so that it does not respond at all to weak signal below a critical value but is "captured" readily by strong ones above that level.

In amateur operations, FM is limited almost entirely to the 2-meter band. Very compact, solid-state transceivers are popular from junked taxies, trucks, police cars, etc. See Chapter 12.

Single Sideband Operation

An AM signal occupies a rather wide bandwidth. It can be cut almost in half, however, by the simplest expedient of eliminating either of the sidebands. Intelligibility is not affected in the slightest, for the reason that the two sidebands carry absolutely identical voice information. It is also possible to squeeze out the carrier, either partially or fully, so the method is called *single sideband suppressed carrier,* or, more generally, just *single sideband,* or *SSB.*

SSB has been used for long-distance commercial radiotelephony since 1927, but until recently had no amateur application because of the complexity of its circuits. New techniques have brought this system within the reach of all hams. Several manufacturers now offer single-sideband equipment for amateurs. A SSB transceiver available in kit form is shown on the following page.

The Heathkit HW-100 SSB transceiver is a lower-priced version of the popular SB-102, with many of its technical features and somewhat simpler construction. A good project for the general-class operator.

It should be pointed out that SSB transmitters are amplitude modulated, and therefore should be considered AM equipment. However, in ham parlance AM specifically means conventional double-sideband modulation, as distinguished from SSB.

SSB transmitters contain many more circuit elements than do AM jobs; therefore, they cost more. Most SSB or AM rigs can be operated on straight CW if the modulator section is switched off. Some SSB models include optional AM facilities, but the superiority of SSB is so marked that few owners of these sets ever bother to switch over to AM. With most SSB transmitters the operator can select either sideband to suit interference conditions. In some sets, only upper sideband transmission is used on 10, 15, and 20 meters, and only lower sideband on 40 and 80 meters. This arrangement conforms with the arbitrary operating practices on SSB. However, a free choice of sidebands is more flexible and is, therefore, more desirable.

From the standpoint of hams living in crowded areas served by several television stations, an extremely important feature of SSB is its virtual freedom from "TVI"—the tendency to create intereference in TV receivers. Most AM transmitters are very bad in this respect because they radiate many spurious signals (harmonics) that are multiples of the widely varying carrier and its two sidebands. These show up on the picture tube as herringbone patterns or in the sound as muffled but understandable voice. Extensive shielding of the transmitter and filtering of its circuits

are usually necessary to alleviate the trouble. With SSB, however, one sideband and all or most of the carrier are done away within the transmitter itself, and it is a comparatively simple job to clean up the remaining signal that is transmitted.

Some older type AM transmitters, available second hand at bargain prices, can be made to work on SSB by the addition of outboard SSB converters. The resulting combination is likely to be critical in adjustment and operation, and is not always the bargain that the price tags would indicate. If you are a newcomer to the ham game, you'd do better by buying modern equipment.

The Legal Limit

If their pocketbooks and power lines can stand it, many hams add power amplifiers, generally called *linears,* to the medium-power transmitters with which they start their stations. These units punch out very strong signals, but they must be handled and operated with care for a number of reasons. First of all, they run on very high voltages and with enough current capacity to knock over a horse. You must know the circuitry intimately, and you must think three or four times before you touch any exposed metal part—even if the unit is turned off! The filter capacitors in high-power amplifiers are likely to retain charges for several seconds after the line switch is pulled, so watch out! Also, the powerful concentration of radio-frequency energy on the operating table, along the transmission line to the antenna, and around the antenna itself can produce some eerie effects. A neon bulb touched to the metal trim of the table glows brightly, lamps in some rooms flicker dimly in accordance with voice modulation, or sparks meet the wife's fingertips when she touches a water

The Hallicrafters SR-400 "Cyclone" (center) is a high-grade transceiver shown here in a fixed installation. At left is optional variable-frequency oscillator, then combined AC power supply and speaker; at right, electric keyer.

faucet. None of these are really dangerous—just disturbing. Still further, strong signals, even if they are thoroughly clean of harmonics, can bludgeon their way into nearby radio and TV receivers by an action known as *impact excitation.* In areas where a 100-watt transmitter can be on the air day and night without causing TVI, a full 1000-watt transmitter can quickly make its owner highly unpopular with his neighbors. If you live in an apartment house, be smart and stay on low power; if you live on a farm, shoot the works!

Frequency Coverage

The most widely used transmitters have the same frequency coverage as ham-band receivers; that is, 10 through 80 meters.

Designed primarily for the novice operator but of interest also to the brass-pounders, the Heathkit HW-16 is a CW transceiver. It covers the first 250 kilohertz of the 15, 40, and 80 meter bands, and can be used on 75 watts by novices or on 90 watts by generals. Easy assembly job.

There are also transmitters for 6 and 2 meters. Some of these cover both bands, while others cover only one of the bands. Equipment for the still shorter bands is generally of special construction, quite unlike that of conventional units.

There is a trend toward the manufacture of equipment for only a single band within the 10-80 meter range, apparently to satisfy operators who like to concentrate on one band and work it to the limit. The 20-meter model is the most popular, probably because 20 is the most reliable DX band. Of course, a single channel set is much less complicated than a five-band job.

Combination Transmitter-Receivers

A piece of equipment in which a single set of tuning elements is used for both transmitting and receiving is called a *transceiver.* (Tranceiver is a variation on this spelling, but the pronunciation

The boxing glove on top of the Swan 700CX is meant to show that this transceiver packs a real punch —700 watts worth. It covers the 10-, 15-, 20-, 40-, and 80-meter bands on SSB, AM, and CW. A high-quality station in one package.

is the same.) The audio elements also play a dual role; they act as the modulation section for transmission and as the audio amplifier for reception. Compact physical construction is possible for transceivers; therefore they are favored for mobile and other applications where space is limited.

In a true transceiver the transmitting and receiving frequencies are the same at any one dial setting. If you hear another operator

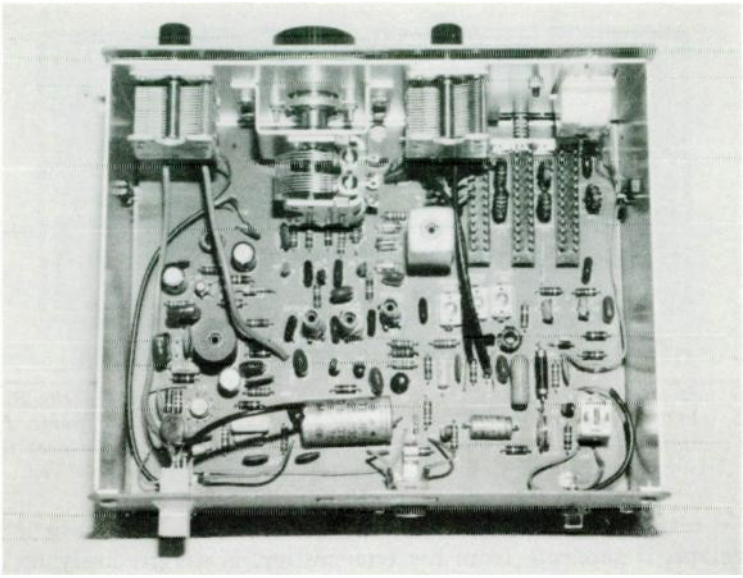
The handle on the end of the Henry Radio "Tempo One" transceiver means that the unit is compact enough to be portable. This is a full SSB set, with choice of an AC power pack for fixed-station use and a DC power pack for mobile use.

The advantages of SSB are extended to the 6-meter band in the Swan 250, which is devoted exclusively to coverage of 50 to 54 megahertz. It is particularly effective for mobile use because a small antenna serves well. An external speaker and AC or battery power pack are required.

on a transceiver and you call him, he will hear you only if his receiver, if separate from his transmitter, is set precisely on his own frequency. If both stations use transceivers they lock together automatically, which is one reason for their growing popularity. A transceiver owner cannot work crossband; that is, send on one frequency and receive on another.

Some transceivers have built-in dual power supplies for both 12 volts DC and 115 volts AC, making them quickly adaptable for either automobile or fixed service. Some have no built-in supplies at all, but require separate outboard units. The continuing development of various solid-state devices suitable for communications purposes is resulting in dramatic reductions in both the size and the weight of transceivers, transmitters, power supplies and related equipment.

Of clean, modern design, te Ten-Tec Triton II is a high-performance transceiver foe SSB and CW. AC power supply and speaker is shown at left.



Very Low-Power CW

An old game resurfaced in ham circles in the early 1970's. It's called "QRPing," from the international Q signal meaning "decrease power." The general idea is to see how much DX can be accomplished with little power. Normal transmitters run all the way to 1000 watts, but the adventurous QRP boys consider anything more than 2 or 3 watts excessive. Equipment of this rating is usually referred to as "flea power" or "peanut whistle."

Manufacturers were quick to recognize a trend. A Ten-Tec transceiver covering 15, 40, and 80 meters is illustrated on page 86. Directly above on this page is the Heathkit HW-7, designed for 15, 20, and 40 meters. It can be used as a fixed station with an AC power pack, and it is completely portable when energized by two six-volt lantern batteries, shown sitting on the cabinet.

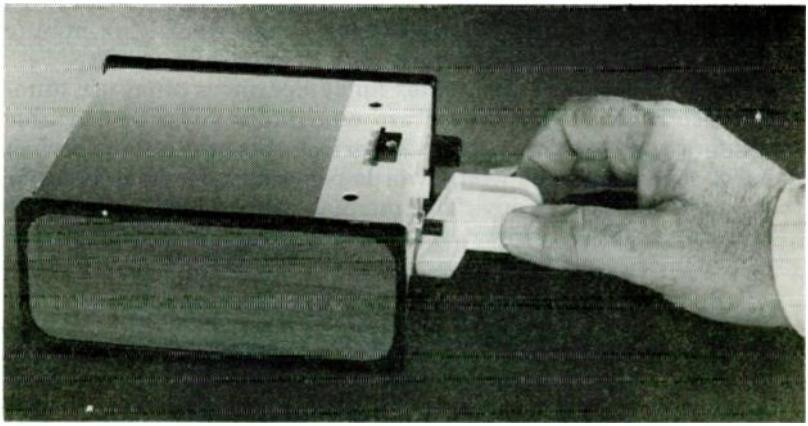
All the components of the Heathkit HW-7 are assembled on a printed circuit board. Circuitry is all solid state. Complete unit is only a little larger than a common cigar box.

TRANSMITTER ACCESSORIES

Few accessories are included in the base price of a transmitter or transceiver. A key never is, because the preferences of operators differ greatly. Some low-power AM and FM transceivers, particularly the portable types, include both speaker and microphone, which are often built onto the front panel. On the other hand these items are rarely if ever furnished with larger fixed-station equipment. Like a key, a mike is a rather personal item.

Most SSB gear depends on high-quality quartz crystals for accurate frequency control, so these are always included. However, they are extra in most AM/CW transmitters and transceivers.

You have to read into the fine print of some specification sheets and catalog pages to discover that many transmitters do not include power supplies. The cost of such units can easily be a large percentage of the prices of the transmitters themselves. There are advantages to separating the power supply from the remainder of the transmitter: (1) Because it requires no adjustment, the supply can be hidden away under a table or in the trunk of a car, and the transmitter can be made light and compact. (2) All power supplies tend to run quite hot. Removing this heat from the transmitter chassis greatly simplifies the problem of circuit stabilization. (3) With a choice of battery or AC supplies and the



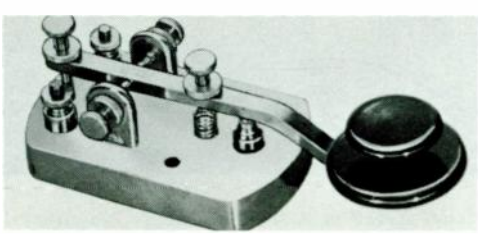
The Ten-Tec Model KR40 is a "squeeze keyer," a favorite station accessory for advanced operators. Press one paddle and it makes dits; press the other and it makes dahs, all electronically at speeds adjustable from 6 to 60 words per minute.

provision of suitable connector plugs and jacks, one transmitter/receiver combination or a single-package transceiver can be shifted between mobile and fixed operation in a matter of minutes. (4) AC supplies are not critical in themselves, and perfectly good ones can sometimes be assembled from salvaged components that accumulate over a period of time in a ham's junk box.

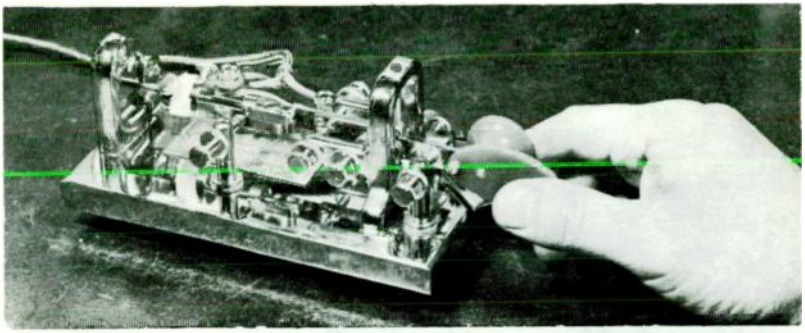
The straight hand key hasn't changed in design or appearance since the Civil War. Because it's simple and easy to use, you should start with this type. Later, you may want to try a semi-automatic key known variously as the "speed key," "side swiper," or "bug." The second term is derived from the side-to-side motion of the operator's fingers, as distinguished from the up-and-down tapping motion used with a straight key. The third term is derived from the appearance of the trademark of the original semi-automatic key, which bore the trade name *Vibroplex*.

A speed key is *semi*automatic. When you press with your thumb against the left side of the protruding handle you set a short metal reed into vibration. Fitted with contact points, this produces a series of dits at a speed determined by the position of a sliding weight. The vibration and the dits continue for several seconds if you keep your thumb against the handle. Actually, only a very short pressure is needed, since the longest dit character is the number 5, with five dits. To make dahs, you relax your thumb and *tap* the other side of the handle with your first finger. To make dit-and-dah characters, you wiggle your fingers back and forth. This technique is slightly tricky and takes practice. However, learning is not too difficult because half of it is the same as straight-key operation. Twenty-five or thirty words per minute with a straight key is hard work, but is easy with a bug.

Hams who consider themselves fancy operators often use automatic electronic keyers. These are essentially adjustable double oscillators; one section produces perfect dits, the other perfect dahs, at speeds up to 60 wpm (words-per-minute), which is faster than most hams can copy. The manual control is a paddle key



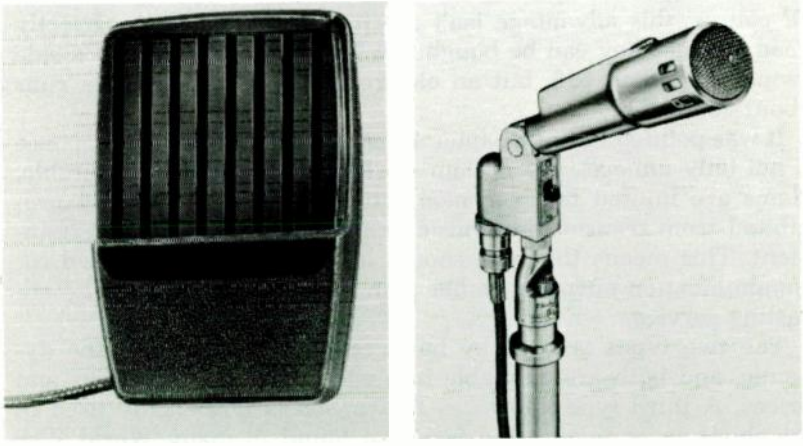
The Johnson Model 114-320 (about $5.00) is a straight key of rugged construction.



The proper method of fingering a semiautomatic key. The thumb is on the dit lever and the first finger is on the dah knob. The chrome-plated Vibroplex has a heavy cast-iron base that keeps it steady on any surface.

that looks very much like a bug but is quite different in that it has identical left and right finger positions which make only momentary contacts, like a hand key or the dah side of the bug. Press it with the left thumb, and the electronic unit spews out dits; press it with the first finger, and it spews out dahs.

Learning to use an electronic keyer, after you have mastered either the straight key or the bug, is like trying to talk Italian after you have spent four years studying French. You can expect to become thoroughly balled up, and you won't be able to produce intelligible Morse until you've devoted considerable time to retraining yourself. The effort is worth the trouble, because the



Representing microphones used by hams. Left: Electro-Voice Model 721, ceramic type, costs only about $5.00. Right: Electro-Voice Model 664, a more rugged dynamic type, costs about $60.00.

The "Cantenna" is a dummy antenna (actually a large resistor immersed in oil) used during adjustments on a transmitter when it is desired not to send out live signals. It is generally used with a coaxial switch (center object) so that the transmitter can be connected quickly to one of several actual antennas or to the dummy. This is an invaluable arrangement for experimental work.

precise length and spacing of the signals is beautiful to the ears. Of course, this advantage isn't obtained for nothing; a perfectly good straight key can be bought for less than a dollar and a side swiper for about $16, but an electronic keyer with paddle runs about $50 to $100.

It was pointed out in Chapter 4 that high-fidelity audio response is not only unnecessary in ham work but downright undesirable. Hams are limited to voice modulation and are specifically prohibited from transmitting music or any other form of entertainment. This means that you should look for a mike designed for communication purposes rather than for public-address or broadcasting service.

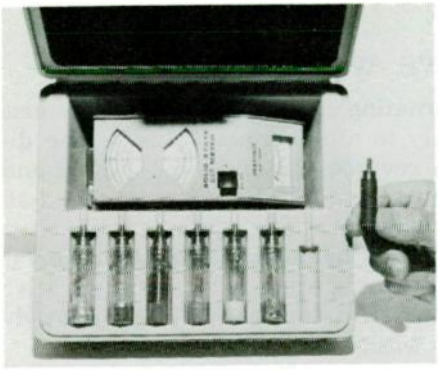
The two types favored by hams are the ceramic and the dynamic, and both are available in a wide variety of qualities and prices. A third type known as the carbon is universally used in telephone instruments, and was also found in many World War II field radio sets. Surplus military mikes of this model can be bought very cheaply. However, they are poor bargains because they require a source of low-voltage DC, which is not usually on

tap in conventional ham transmitters. The ceramic and dynamic mikes generate their own current when spoken into, and are therefore much simpler to use.

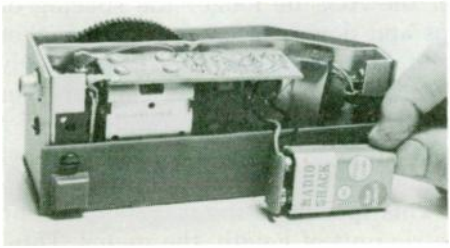
A little accessory that is very useful for checking and adjusting transmitters and antennas is the "dip meter." This is calibrated in terms of frequency from 1.6 to 250 MHz. Containing two transistors and a handful of other parts and powered by a self-contained 9-volt battery, it is particularly valuable for work on antennas and mobile equipment.

In effect a dip meter is a combination receiver-transmitter. It can respond to signals from equipment or it can inject signals of its own into the latter, as conditions require.

The term "grid-dip meter" is often heard in ham operations, but it applies only to older forms that used vacuum tubes. The term "dip meter" specifically means a solid-state instrument. A typical one, made from a Heathkit, is shown below.



Above: Heathkit Model 1250 Dip Meter has plastic carrying case for outdoor use. Right: Coils for wide frequency spread plug into top edge of chassis. Dial is thumb operated. Below: Standard 9-volt transistor battery is self-contained.



7

The Antenna Radiates the Signals

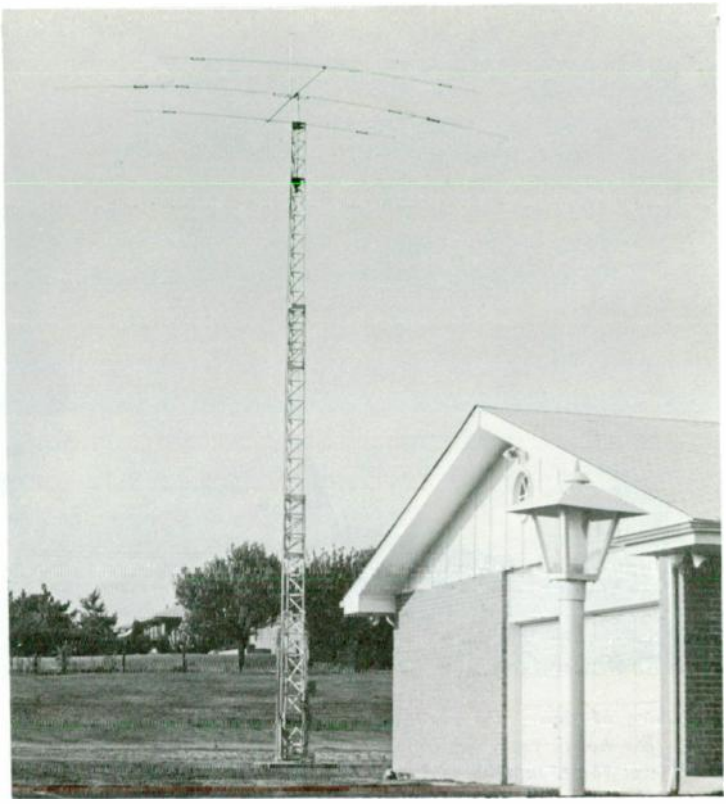
Before a study of transmitting antennas is begun, a clear understanding of the terms frequency and wavelength is necessary. The two terms are different ways of describing the same alternating current, each being more convenient than the other for some purposes.

FREQUENCY VS. WAVELENGTH

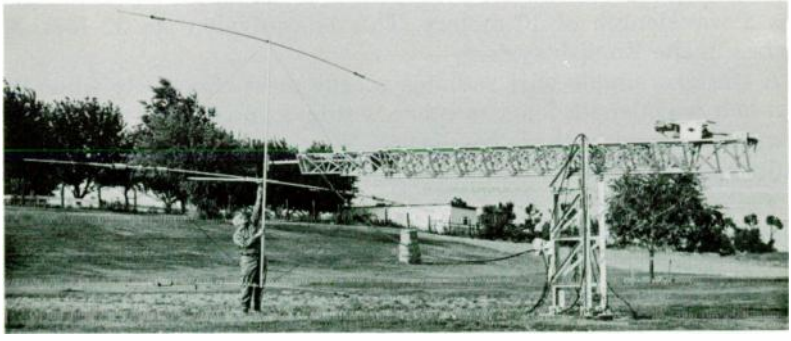
As you probably know, alternating current is so called because it starts from zero, rises evenly to a maximum value in one direction, falls off to zero, then reverses its direction of flow and goes through exactly the same rise and fall. Each flow is called an *alternation,* and two complete alternations comprise a cycle. It is common to refer to one alternation as *positive* and the other as *negative,* but this is slightly misleading because the word negative infers uselessness. Actually, the two alternations are absolutely identical in their ability to do work.

The rate at which complete cycles of AC are produced is called the *frequency.* Frequency is expressed as so many *hertz.* A hertz is one cycle per second. The high frequencies used for radio signals makes the use of multiplier prefixes desirable. For example, 600,000 hertz per second is easier to write and say as 600 kilohertz per second, or simply as 600 kHz. Going still higher, 2,000,000 hertz becomes 2 megahertz, or 2 MHz.

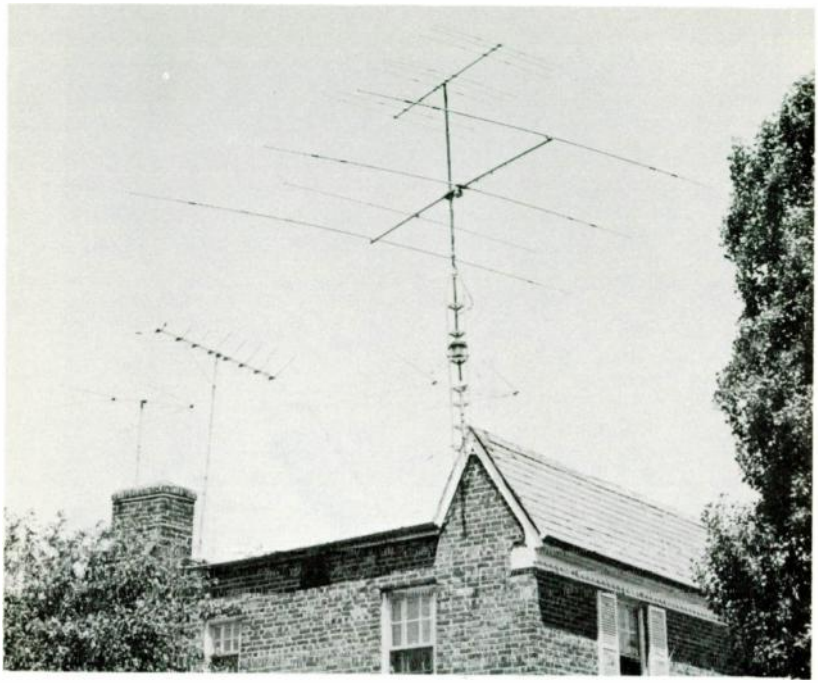
The lower the frequency of the AC, the longer the spacing or time interval between the ups and downs of current; the higher the frequency, the shorter the distance. Since we know fairly definitely that the speed of electricity is 300,000,000 meters per second, we have only to divide this figure by the frequency of a current to determine the separation between successive up or down points as impulses move along wires or away from a radiating body such as an antenna. This spacing is the *wavelength,* and is always expressed in the metric unit of length, the meter. Thus,



This beautiful 50-foot Tristo tower is next to the garage of Carl Mosley, WØFQY, St. Louis, Mo. How did he get that elaborate antenna in the air?



By pressing a button, that's how! Tower sections not only telescope but the lowered assembly tilts over, to permit easy and safe adjustments on antenna proper, as Carl demonstrates. He is manufacturer of popular line of ham antennas bearing his name. Tower is entirely self-supporting.



The presence of three TV antennas on the roof didn't discourage the owner of this house from adding a 15-foot tower topped off with an 8-element beam for 6 meters and a 4-element beam for 10/15/20 meters. Beams are turned by rotator motor halfway up the tower. There is still no interference with television reception.

a radio signal having a frequency of 30 MHz (30 million hertz) has a wavelength of 10 meters. This is equivalent to 32 feet, 8 inches in the English system.

A straight, simple wire radiates energy most effectively when it is a *half* wavelength long; in other words, it must be designed for a specific wavelength or frequency. Why a half wave and not a full wave? Because a half wave represents the time-distance of one alternation of the AC cycle, the two alternations are identical except for polarity, and only one alternation occurs at a time. There are full-wave and multiple-wave antennas, but they are somewhat tricky to adjust. The half wave, in several variations, is more flexible for ham purposes. In actual practice, nearby objects affect an antenna's characteristics and performance and may require changes in its construction; also, they alter its ability to work slightly above and below its theoretical fundamental frequency.

The physical relationship between the half-wave antenna and the operating wavelength now becomes evident. For the popular 2-meter band, a half wave is only one meter long; that is, a few inches more than a yard. For 10 meters, it is 5 meters, or 16 feet 4 inches; for 20 meters, 32 feet 8 inchees; for 40 meters, 65 feet 4 inches; for 80 meters, 130 feet 8 inches. The *meter* designations for the ham bands are approximate, and are rounded off for convenience. For example, the "40"-meter band, more specifically defined by the FCC as 7000 to 7300 kHz, runs from 41 to 42.8 meters.

The "meter" designations for the various ham bands, and their frequency range, are given in Table 7-1.

Table 7-1. Ham Bands

Band	*Frequency (MHz)*
80 Meters	3.5—4.0
40 Meters	7.0—7.3
20 Meters	14.0—14.35
15 Meters	21.0—21.45
10 Meters	28.0—29.7
6 Meters	50—54
2 Meters	144—148
1¼ Meters	220—225
¾ Meters	420—450

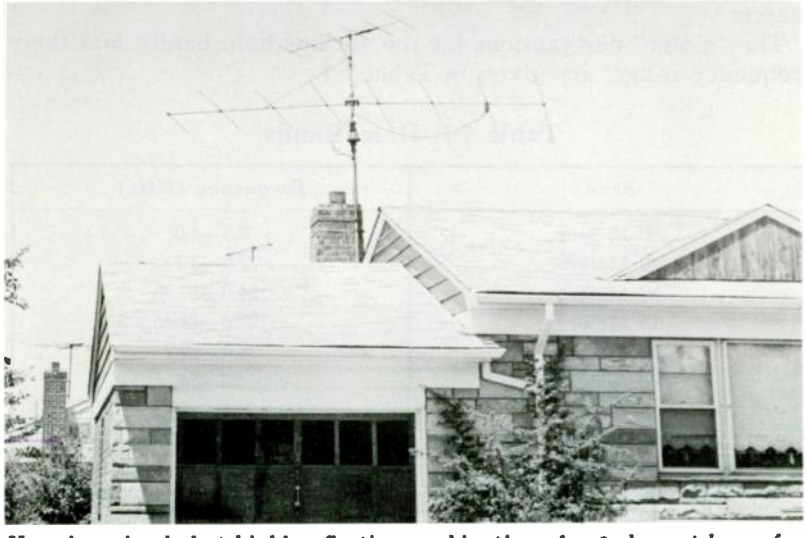
THE BEAM ANTENNA

An ideal half wave in free space tends to radiate more energy at right angles to its length than off its ends. This directional effect is readily increased by the addition of one or several wires parallel to the antenna and placed on one side or both sides of it. These extra wires are not usually connected to the antenna proper, which is known as the driven element, but they may be in certain instances. Depending on their length and spacing, the extra wires act either as reflectors of the signals from the driven element (in the same manner as a polished bowl behind a lamp), or as directors, for the purpose of pushing as much of the energy as possible in a desired direction. Such an arrangement is called a *beam,* and is usually mounted on a tower or mast with an attached rotator to swing it around a full circle. In practical beams, the elements are not wires but lightweight aluminum tubing.

The greater the number of reflectors and directors aiding the driven element, the greater the concentration of signal energy

along one path. This is equivalent to an enormous increase in *effective* radiated power for a given transmitter. The advantage is real, not merely theoretical.

The mere dimensions of basic elements for 40 and 80 meters make full-size beams for these bands somewhat impractical. For the shorter bands the elements are of reasonable size, and can be handled and erected without special equipment. Individual beams for 10, 15, and 20 meters usually have three elements. Some have four or five, a few have only two. Even a two-element beam is



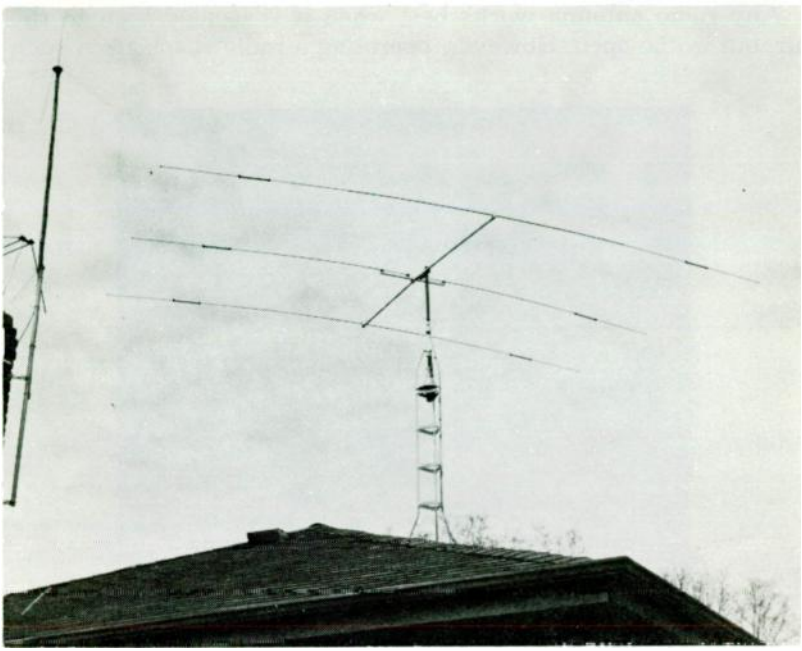
Here is a simple but highly effective combination of a 6-element beam for 2 meters (top of the pole) and an 8-element unit for 6 meters. In spite of its size and because of its light weight, this array is easily supported on the chimney and turned by an inexpensive TV rotator.

better than a naked half wave (also called a *dipole*), and it is cheaper and lighter than the multi-element antennas.

Because it is expedient to shift from one band to another to take advantage of changing atmospheric conditions, by far the most popular of all beams is a three-element job that is made to work interchangeably on 10, 15, and 20 meters. The interchangeability is made possible by the addition of critically positioned coils called *traps* in each element. While the performance of individual antennas for each band is somewhat better than that obtained from the three-band jobs, the convenience afforded by the three-band model more than outweighs the extra performance.

For the 2-meter and shorter bands, the elements are so small and light that they can be piled on almost without limit. On 2

meters, it is common to hear hams using beams with six, eight, ten, twelve, and even more elements. On these high bands, still further *gain* (that is, increased effective radiated power over that possible with a dipole) is obtained by stacking several beams side



Probably the most widely used tower-and-antenna cambination to be found in the United States. The 15-foot tower supports the Mosley TA-33 beam. The objects near the ends of the horizontal elements are traps that permit the antenna to work on 10, 15, and 20 meters. The driven element is in the center; the reflector and director are on either side. The antenna mounted on the end of the vertical stick at the extreme left is a 2-meter ground plane antenna. It consists of a 19-inch center wire and four radials.

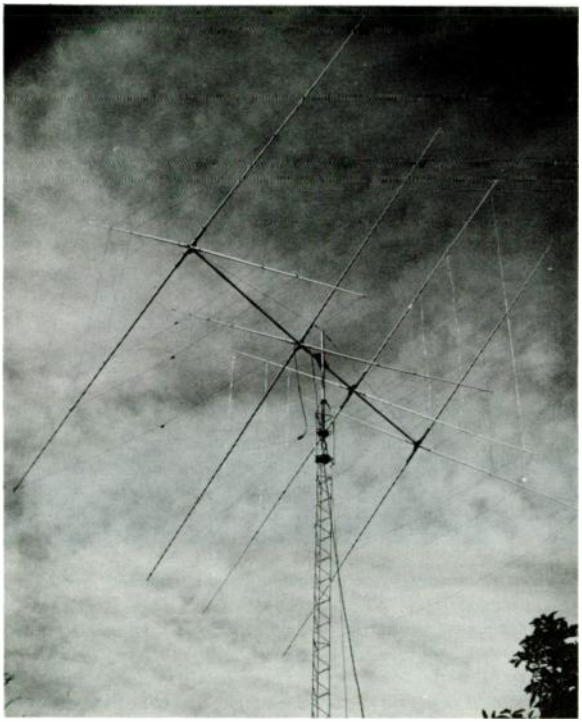
by side and/or one over the other, and energizing them by the transmitter in such a manner that the elements radiate, reflect, and direct in unison. This is called *phasing* and becomes more difficult and critical as the number of elements and beams is increased.

On the fractional-meter wavelengths, which are the playground of experimentally inclined hams, radio waves begin to have some of the properties of light waves. A small radiator element can be placed at the focal point of a large reflector dish, usually made of open wire mesh or "hardware cloth." Even with

very low power, such an electronic searchlight can shoot signals over great distances.

FEEDING THE ANTENNA

Any radio antenna works best when it is located high in the air, out in the open. However, operating a radio shack from such



A "quad" is an unusual antenna of wire strung on a flat rectangular frame. Here is a 4-element assembly made by Skylane Products, Temple Terrace, Fla., 33617. Aerials of this type have high gain and are noted for their low angle of radiation, which means good DX transmission.

a position would be most uncomfortable! It is necessary, therefore, to provide a transmission line of some sort to carry the signals from the transmitter to the antenna. There should be minimum loss of energy and little or no incidental radiation to spoil the directional pattern of the antenna proper in this feeder. These requirements are best met by coaxial cable; therfore virtually all modern ham gear is designed for it.

Coaxial cable or *coax*, as it is called, consists of an outer tubular shell of tinned copper wire braid, with a single inner conductor of either solid or stranded copper wire. The latter is insulated from the shell, in most cables, by a solid but flexible core of a plastic material. An extensive variety of plugs, jacks, and other fittings is available for making connections to the ends of the cable. The outer braid of most coax is covered by a plastic sheath to keep water from seeping in.

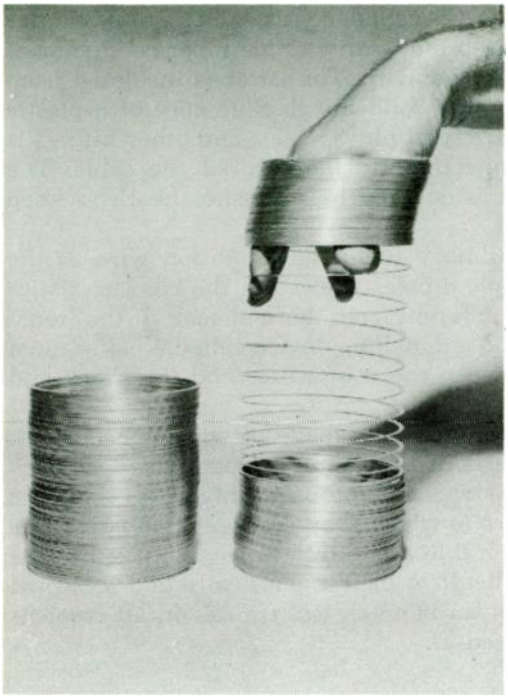
It is possible to use ordinary twin-lead television wire as the transmission line for simple dipoles. However, the characteristics of this material are quite different from those of coax. If the transmitter is intended for coax, a matching device called a *balun* must usually be connected between the transmitter and the shack end of the twin-lead.

At one time, considerable use was made of open line feeders; it is still seen in many parts of the country. Open-wire lead consists of two parallel bare wires, kept uniformly several inches apart by slender insulators to which they are tied or molded. The transmission losses in open line are extremely low, but it has the disadvantage of being difficult to handle physically and to adjust electrically. A coax-fed beam is much less trouble in all respects than any other type of lead-in.

HANGING THE SKY WIRE

Any antenna installation, especially the beam type, is much more of a physical than an electrical undertaking. It is easy enough to bolt a few aluminum tubes to an aluminum boom on the ground or on a roof, but the assembly becomes a real tiger to handle when you attempt to climb with it to the top of even a short supporting structure. You not only need three or four hands but also the ability to remain calm while the sky around you swings and sways—or at least you imagine that it does. It is normal for most people to become slightly dizzy at heights; therefore it is sheer suicide to go clambering over roofs and towers without adequate preparation and safety measures. Even a seemingly light 2-meter beam can become hard to manage in a breeze, and most larger beams can be put up safely only on dead-calm days.

If the roof of your house is readily accessible and you can stand comfortably near the chimney, make a modest start by using an 8- or 10-foot length of TV mast as support for a beam. With the assistance of one other person, you can readily walk the entire assembly up against the chimney and then secure it with regular TV chimney straps or brackets. The straps are preferable because



What's this "thing" doing in a chapter about antennas? It belongs, because it is a clever antenna that adjusts automatically to any band between 20 and 80 meters. "Slinky" is its name and it consists of a continuous helix of coated metal 4 inches in diameter and stretchable to 60 feet. It was developed originally for field use, but is also great for attics, small backyards, etc.

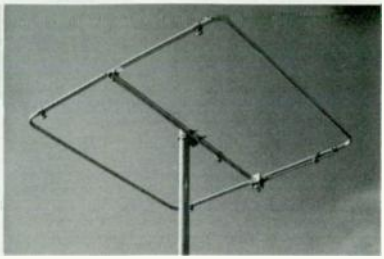
they can be tightened quickly with a wrench and do not require preliminary drilling of holes in the brickwork.

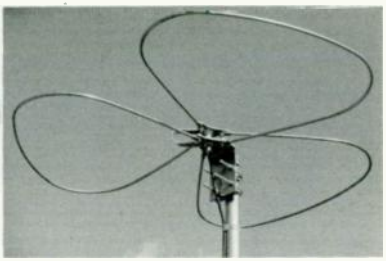
If the roof is flat or only moderately pitched, an unguyed three-legged steel tower about 15 feet high is a safe project for three strong men. Plan its position very carefully so that it can be laid out flat with two of its legs loosely bolted to hinge plates, which, in turn, are secured to the roof itself. It is then easy to assemble the beam and its rotator to the top section. To keep the boom from hitting the roof during this operation prop the tower up with a box or a chair. With one man pushing, another pulling, and the third keeping the cables clear you can hinge the entire tower upward to its vertical position. Put in all remaining leg bolts, and the worst part of the undertaking is over.

Beyond about 15 feet, towers become too heavy and cumbersome for most roofs, and should be planned instead for ground mounting. The foldover type is by far the safest and most sensible one for a man who doesn't relish the idea of being a week-end steeplejack. With this design, the top folds down within easy reach of the ground; you can do any work on the beam in perfect safety. When you're finished, you merely crank the structure to the vertical position at any height you care to buy.

EXTENT OF DIRECTIONAL EFFECTS

The radiation from a beam is strongest in its directed position, but this does not preclude the possibility of appreciable radiation from its back or off its sides. You will frequently hear strong signals from stations whose beams, according to the operators' remarks, are pointed away from you. However, if you work one of these stations, the owner will surely swing his antenna toward you, and you will notice a startling increase in strength.





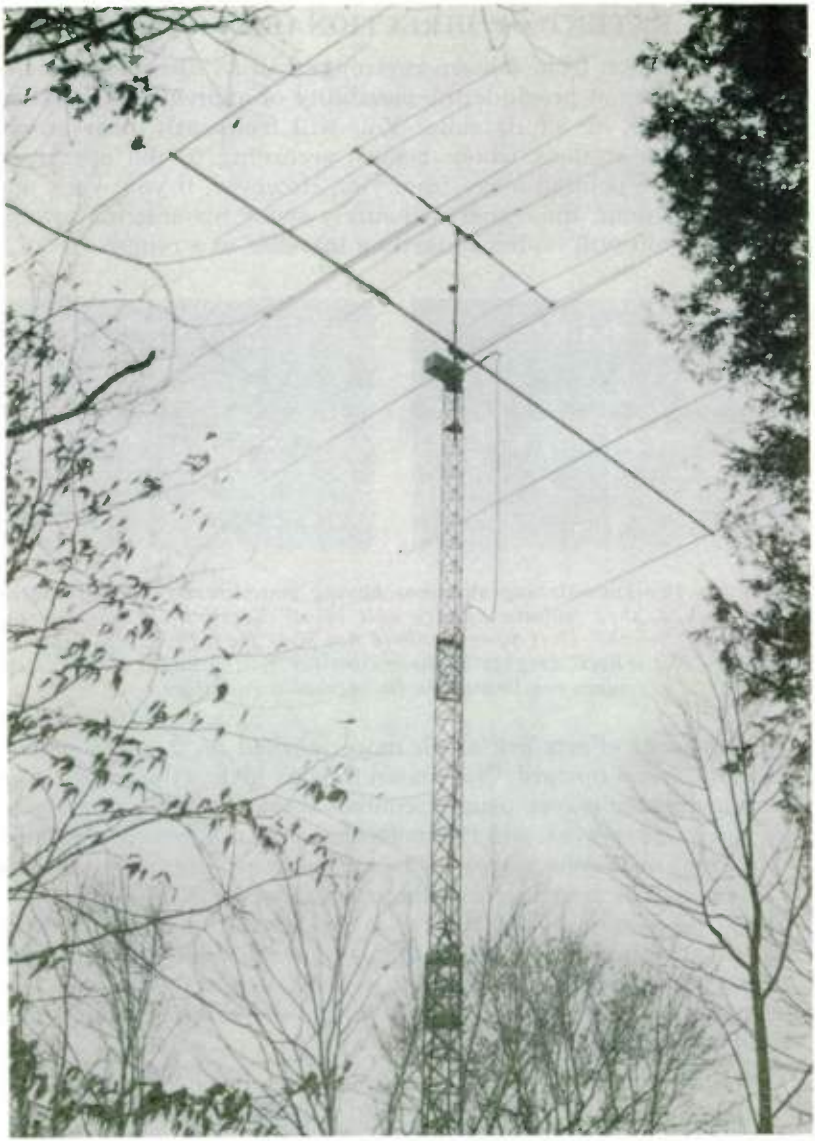
Here are two eye-catching antennas having omnidirectional characteristics; that is, they radiate equally well in all directions. These are the Cushman "Squalo" (left), available in five sizes for 6 through 40 meters, and the "Big Wheel" (right) in three sizes for ¾, 1¼ and 2 meters. Both types can be stacked for increased radiation.

Directional effects are much more marked on 2 and 6 meters than on 10 and upward. The reason for this is that the beams used for the shorter waves usually contain more elements than those for the longer waves, and the more elements, the more directivity.

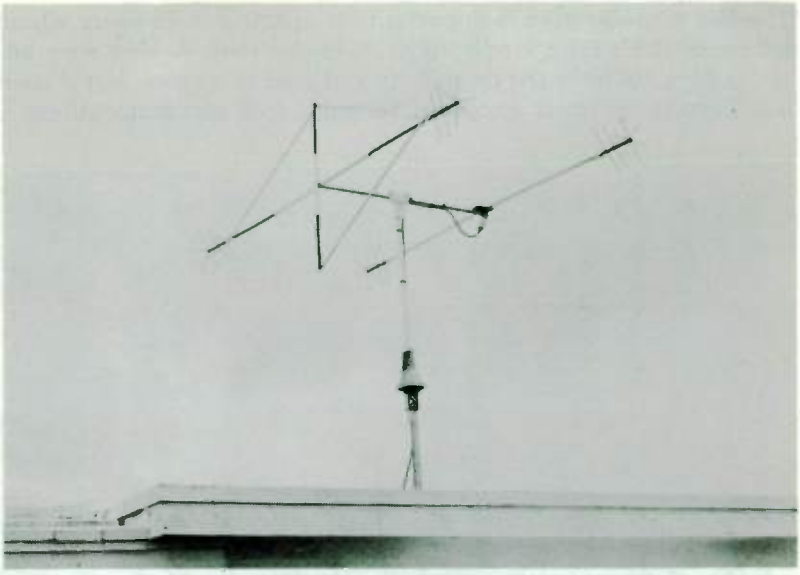
On rare occasions your own beam, for receiving, may give the loudest signals from a particular station when it is pointed precisely 180 degrees away from what should be the correct setting. Before you climb up on the roof and start rebuilding the antenna, consider the possibility that the signals are arriving from the transmitting station the long way around the globe. This has been known to happen!

WIRE ANTENNAS

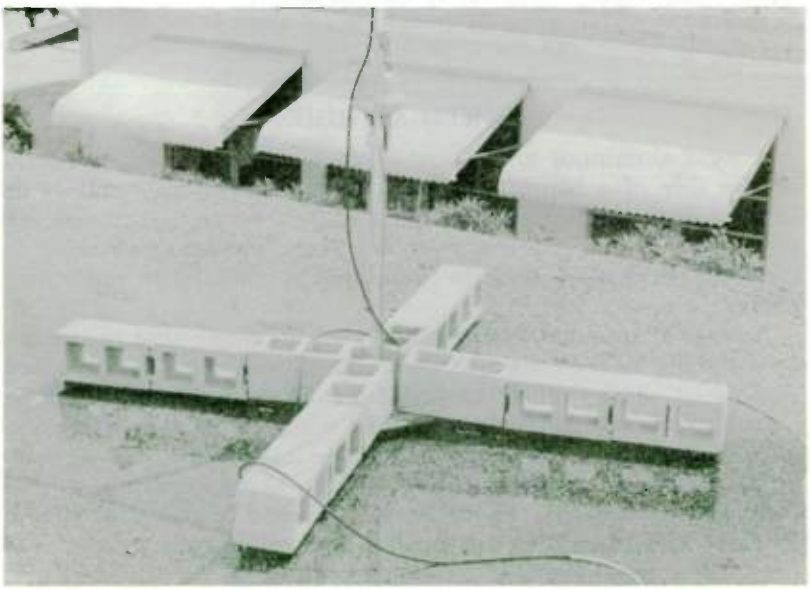
For 40 or 80 meters, a simple straight wire is usually quite satisfactory; about 65 to 66 feet for 40, 130 to 133 feet for 80. These antennas can be trapped, in the same manner as beam elements, to work quite well on several bands. Long wire antennas are very useful because they cost relatively little, are easy to suspend between house and tree or other supports, and are inconspicuous.



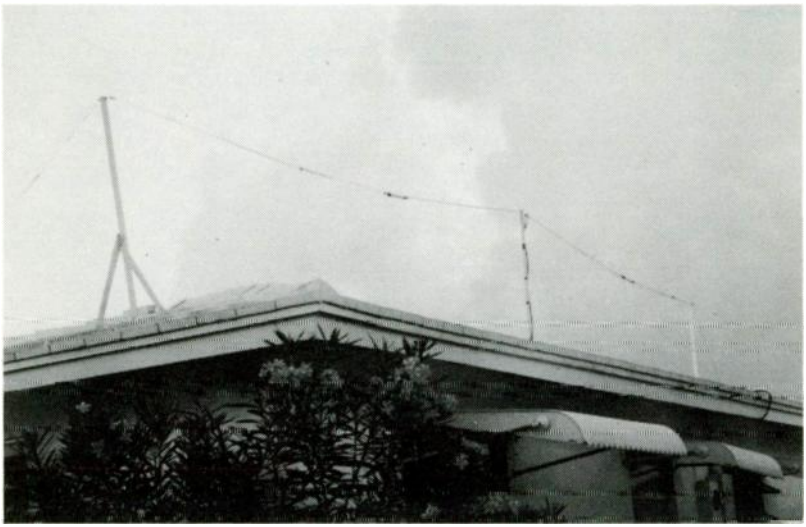
This photo shows the "dream-of-a-lifetime" antenna of Nat Schnoll, W2PN, of Upper Saddle River, N.J. A three-section telescoping tower rises 71-feet high and is topped by a ten-foot mast. On the latter are two horizontal booms. The lower one is 43-feet long and holds a full-size, five-element beam for 20 meters. The upper one is 26-feet long and holds two separate three-element beams, for 10 and 15 meters. Little wonder that W2PN is one of the world's leading DX operators!



From the street this "Mini-Beam" appears to be growing out of the roof, but there isn't a single hole in the latter. The pipe is attached to a 2-foot square wood center platform, to which are bolted four legs made of 2 × 4's 4-feet long and held down by concrete building blocks. The beam is 10 feet above the roof. The whole structure is an easy one-man job to assemble and to move for experimentation.



The last consideration is important for apartment dwellers whose landlords don't take kindly to holes in the roof! A long wire antenna does not have the directivity and gain of a beam, but if used intelligently, permits excellent long-distance communications.



With the addition of a "trap" in each of its halves, a simple wire antenna works well on 10, 15, and 20 meters. Coaxial cable at center goes to station. Supports are curtain poles on brick-weighted wood bases, held down by end guy wires to eaves of house.

VERTICAL RODS

A rigid aluminum tube about 30 feet long, mounted vertically on the side of a house, and fitted with an adjustable coil at its base, makes another simple and easily installed multiband antenna. It is even more convenient than a horizontal wire in crowded residential districts because it is confined to one's own property.

A vertical antenna is generally omnidirectional; that is, it radiates equally well in all directions. Its pattern may be disturbed slightly by nearby reflecting surfaces such as aluminum siding on a house or metal foil insulation in the walls, but the effect is comparatively minor. Like a dipole, the vertical has no built-in gain, but its own features make it very popular. Many hams use regular beams for the bands from 20 meters down and verticals for 40 and 80 meters. A coaxial switch in the shack makes the proper connections between the transmission lines and the transmitters.

8

Going Mobile

Not content to leave their radio equipment at home in the ham shack, many hams have equipped their cars, boats, and planes. What better way to travel than to have a friendly local ham guide you through a strange city? Also, what could be more enjoyable on a hot summer afternoon than sitting on a cool lake and talking to a fellow ham?

HAM SHACK ON WHEELS

Morton B. Kahn, formerly W2KR, Great Neck, N.Y., and now W4KR, Boca Raton, Fla., has long had a low-power transceiver in

Morton B. Kahn, W4KR, presses the button on his hand mike and his mobile transmitter is on the air. The unit suspended from the dash is his own design. Mort has worked many foreign countries on 20-meter phone.

his car. One day, while inching his way through midtown New York traffic he thought he'd check the functioning of a new tube that he put into the transmitter the night before. He flipped the switches and as he watched the meters on the panel he spoke into his hand microphone just to activate the circuits.

"Hello CQ, hello CQ, CQ, CQ, this is W2KR mobile, William 2 King Roger mobile, on 20 meters, in New York City. Is this thing working, I wonder? "

Half a second after he released the mike button the speaker on the dashboard came to life.

"Hello W2KR mobile, calling William 2 King Roger mobile, this is DL4HA, Dog Love 4 How Able, in Germany. You're putting in a swell signal over here, old man. How do you read me? W2KR mobile, this is DL4HA. Over."

Thrilling? Enough to make your scalp tingle! Unusual? Not altogether. When conditions are favorable you can work all around the world with flea power and a buggy-whip antenna flapping on your rear bumper. Conditions must have been good that day for Mort, because he repeated the performance, in reverse,

The Collins KWM-2 is a popular SSB transceiver for mobile use. Covers 10 through 80 meters; separate power pack. Note combined microphone and earphones. It leaves operator's hands free for driving and tuning.

Bill Halligan, W9AC, Chicago, is the founder of the Hallicrafters Company, so his car naturally is fitted with a Hallicrafters transceiver.

when he retraced his route through Manhattan a few hours later. The ignition systems of passing trucks were creating a shower of interference in the receiver, but out of the uproar came a fairly good signal.

"Hello CQ, hello CQ, CQ, CQ, CQ. Calling stateside. This is CN8EY, CN8EY, Charley Nan 8 Easy Yoke, in Morocco, Africa. What say some one please?"

Morocco! Mort glanced at the walls of the canyon formed by the surrounding skyscrapers. "What can I lose?" he mused to himself as he reached for the mike. "Hello CN8EY, CN8EY, calling Charlie Nan 8 Easy Yoke in Morocco, this is W2KR mobile; William 2 King Roger mobile, William 2 King Roger mobile, in New York City. How're we doing there, feller? Over." He learned soon enough how he was doing.

"Hello W2KR mobile, this is CN8EY. Thanks for the call, Mort. I've heard you on the air often and I'm glad to work you . . ."

Fifteen minutes later Mort had to cut the contact because he had reached his destination. Neither station had missed a word.

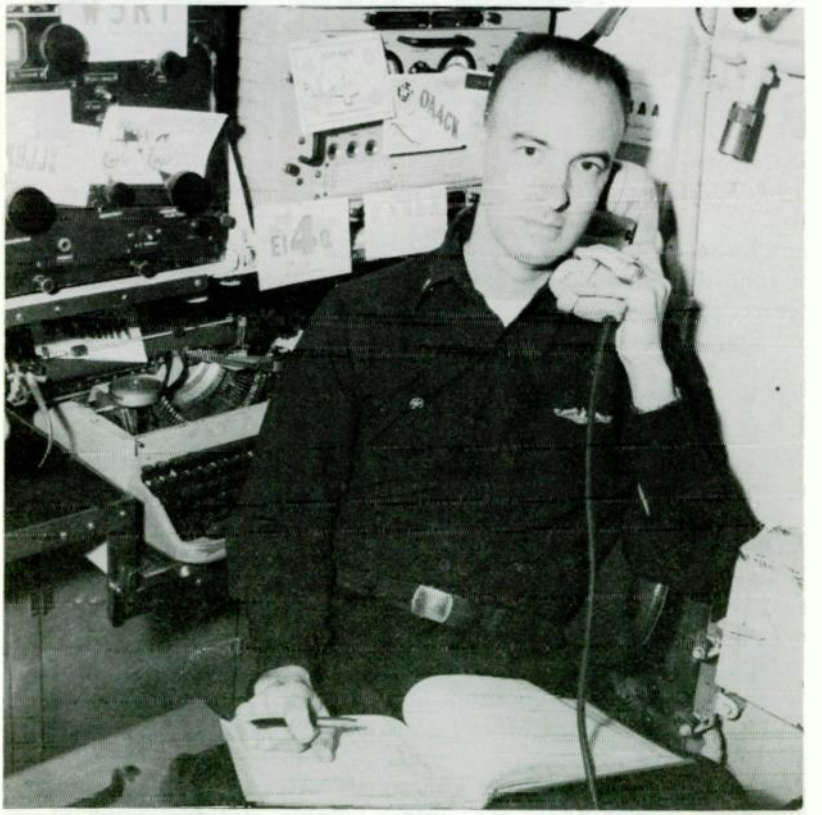
Mobile radio is so exciting and so full of challenge that many hams have turned their cars into veritable stations-on-wheels. Every drive becomes an adventure, and every hilltop offers a new opportunity for interested local and DX operation. The privilege of mobile hamming is available to all amateurs within the re-

strictions or provisions of the various classes of licenses.

The most popular mobile bands are 10, 15, and 20 meters. The 10-meter segment tends to be erratic, but when it does open up, because of changing atmospheric conditions, you can work all around the globe with very low power. The 40-meter band is subject to interference from foreign broadcasting stations. The 80-meter band is good for medium-distance domestic communication.

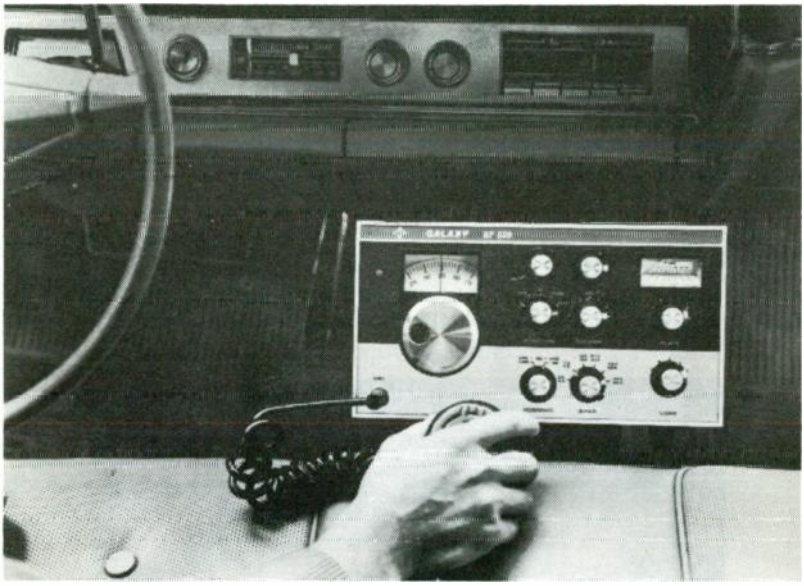
BOAT AND PLANE MOBILE

It is not generally known that mobile ham stations may be operated in boats and airplanes as well as in automobiles. The FCC regulations in this regard are rather simple:



This is a mobile ham shack. Where's the steering wheel of the car? There isn't any, because this isn't a car. Believe it or not, it's a submarine, the U.S.S. Cutlass, and its skipper, Commander J. Dan Reilly, USN, W4NMK, operates regularly UNDERWATER with a submerged antenna!

(1) The installation and operation of the station must be approved by the master of the ship or the captain of the plane.
(2) The ham equipment must be separate from and independent of any radio equipment aboard the ship or aircraft.
(3) The ham equipment must satisfy safety regulations applicable to electrical apparatus, as promulgated by the appropriate government agency.
(4) The ham station must not interfere with other radio equipment aboard the vessel or plane.
(5) The ham equipment must not constitute a hazard to life or safety.



The Galaxy GT500 is a compact but powerful SSB transceiver covering the bands from 10 through 80 meters. Here it is installed under the dash for mobile operation; 12-volt power supply is separate. With an AC power unit it works just as well in a fixed installation.

On a very rare occasion you might hear a mobile station in a plane, and if you do you can be pretty certain the latter is a privately owned job. The commercial lines, of course, wouldn't dream of allowing a passenger to operate a mobile rig ten feet from a plane's several sensitive receivers. The main value of the regulations is that they open a whole new field of ham radio for the hundreds of thousands of owners of personal pleasure boats. Since the owner of a small boat is also the "master," he can do

anything he wants in regard to a ham station. The installations on some boats are very elaborate, even including beam antennas.

One big feature of mobile operation afloat is relative freedom from noise interference. It's an uncanny experience to listen on a high-gain receiver while you're anchored in a quiet cove and to note the absence of the usual racket caused by passing cars, leaky power lines, elevator switches, thermostat controls, loose electric bulbs, etc.

PHONE OR CW

Most mobile operation in cars is on phone, but you can also work CW with all its advantages when you are in a stationary position. Some experienced operators even work CW while in motion, although this sort of thing can be a traffic hazard. They use surplus army knee keys, which were designed for just this purpose, and they pound away merrily while they drive. One ham in Chicago operates mobile CW every morning on the way to work, and he has rolled up an impressive number of DX contacts with a transmitter taking no more than *five* watts.

Mobile Equipment

The most popular mode of mobile operation is SSB, for the simple reason that it is also the favorite for fixed-station operation. It follows that the bands covered are the popular ones from

The Heathkit "Single Banders" are SSB transceivers giving individual coverage of 20, 40, and 80 meters. DC and AC power supplies make them suitable for either mobile or fixed operation.

You can bet that her "CQ, mobile" calls get plenty of answers! Mrs. Shirley Hargreaves, K2BPT, Clifton, N.J., enjoys using her Polytronics PC-6 transceiver because it looks pretty and puts out a strong signal.

10 through 80 meters. All mobile equipment of recent vintage is of the transceiver type, to enable the driver to operate the rig safely with one hand. Rapidly disappearing into home-station junkboxes are AM converters that work through the AM broadcast receiver in a car, AM transceivers, separate AM receivers and transmitters, and similar obsolescent equipment. (Two-meter FM transceivers are in a special category; see Chapter 12.)

Some five-band SSB transceivers use only tubes, some use both tubes and solid-state devices, and some are all solid state. Some have loud speakers built in, some use separate ones. Some do not include power supply, but offer a choice of 12-volt units for car operation and 115-volt packs for AC operation.

All these transceivers are intended for mounting under the dashboard. To prevent them from interfering with the driver's accelerator and brake foot, they usually have to be centered over or moved slightly to the right of the hump for the transmission housing. In this position, they are likely to eliminate the leg room needed by a passenger occupying the center area of the front seat. Most drivers do not consider this a serious shortcoming, since three-abreast seating up front is generally a risky arrangement anyway. If the car has two bucket seats, the problem doesn't arise.

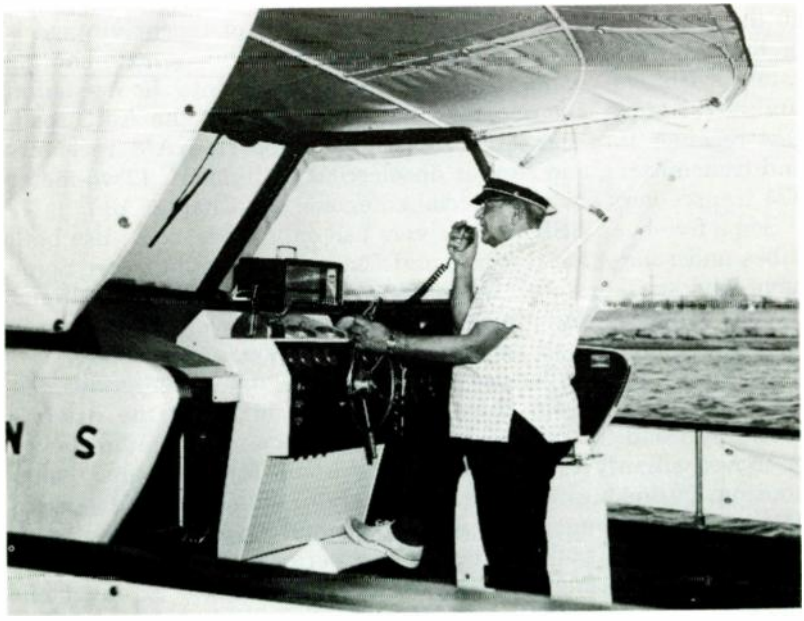
If the car already has a broadcast receiver, its speaker can readily be connected via a single-pole, double-throw toggle switch to either the broadcast receiver or the ham unit.

All mobile equipment is designed for push-to-talk operation by means of a switch on the hand microphone.

THE POWER PROBLEM

Transceivers using tubes alone, or some tubes and some transistors, draw as much as 25 amperes at 12 volts when transmitting. Not many automobile electrical systems can handle this extra load. If the normal capability of a system is stretched a little too much, you can readily find yourself with a dead battery or a burned-out generator. It's smart to check the owner's manual that came with the car, or with a local dealer's service manager, to determine the safe limit of the electrical system in your particular vehicle.

The problem is only a minor one with most solid-state transceivers because they operate on much lower current levels. In the receive position, a typical unit draws only about half an ampere, which hardly causes a car ammeter to flicker; in transmit, the current is around five to seven amperes. Such a load does not strain the battery-alternator combination even of small foreign cars.



"Hamming" afloat is a real joy, as well as a real comfort in times of emergency. And to do the job properly you must of course wear a white "skipper's" cap!

The size of the battery is not very important. What is important and significant is the rating of the alternator, expressed by the number of amperes of current it can deliver safely and continuously. The battery is needed mainly for starting purposes; once the engine is running it merely "floats" across the alternator line. If the total current requirement of the load (i.e., ignition, lights, heater, radio equipment, etc.) exceeds the maximum output of the alternator, the balance must come from the battery. Of course, the higher the rating of the battery, the more current it will supply, but it won't last very long because it isn't being charged properly by the overworked alternator.

When the headlights, tail and instrument lights, heater fan, ignition system, and broadcast receiver are on, as they would be during the winter months or night driving, the total current requirements will be close to the rated capacity of the alternator. Any additional short surges of current, such as that required should you decide to push in the cigarette lighter, will be furnished by the battery without difficulty.

Suppose now that you add a transmitter that may require as much current as the entire car electrical system. The total load now doubles, and it may go higher. Obviously you are inviting disaster. You stand a fair chance of running down the battery if the transmitter is operated for a long period of time. You might get by during daylight, when the heavy load of the lights is off, but even then you'd be stretching your luck. Getting stuck with an immobilized car can be mighty awkward, and if you're smart

The simplest mobile antenna is a flexible 8-foot whip.

you won't risk it, no matter how keen you are about working some of those DX stations that roar in.

A quick question is probably forming in your mind. "What's to prevent me from installing a larger alternator in my car?" Nothing chum, nothing except money. Let's consider what such a change entails in a typical car. If the car is a standard-sized model and is equipped with air conditioning, it is likely that a larger alternator is not available. However, if the car is not equipped with air conditioning or is a smaller model, a larger alternator is probably available. When replacing the alternator, it is usually not necessary to change the regulator. The best bet would be to go to a dealer who specializes in automotive electric service. He could probably install a heavy-duty alternator on an exchange basis for around $50. A surprisingly large number of hams do install these bigger power plants because it enables them to operate day or night, winter or summer. Here's a good tip: Perfectly good heavy-duty alternators, salvaged from wrecked taxis, police cars, etc., can often be picked up at bargain prices from auto salvage yards.

The adoption of six-cell ("12-volt" but nearer to 14) batteries doesn't alleviate the power problem. If a transmitter takes an input power of 240 watts, it doesn't make any difference if you provide it from a 2-volt generator-battery at 120 amperes, a 6-volt battery at 40 amperes, a 12-volt battery at 20 amperes, or a 24-volt battery at 10 amperes. The electrical system can get just as overloaded on one combination as another if it happens to be too small for the job. American automobile manufacturers went to 12-volt batteries because copper wire is expensive. At 12 volts the current load for any particular power drain is half what it is at 6 volts; therefore the wires can be half the cross-section area. Insulation is no problem, and needn't be any better for 12 volts than for 6 volts.

Saving the Battery

Most older cars are equipped with generators rather than alternators. The advantage of an alternator over a generator is that it will charge the battery at idle speed. Therefore, if your car is equipped with a generator, you will find it highly advisable to transmit only when the engine is turning over at a pretty good rate. If the car is in motion at all, the regulator will bring the generator into play. If you expect to remain stationary for more than a few minutes, speed up the engine by means of the accelerator when you press the mike button to transmit, and release your foot when you change to receive. During warm weather this technique will minimize engine overheating. The general idea is to save the battery for starting purposes. Even a new battery in good

Bumper mount eliminates the need for cutting holes in the body of the car.

condition won't have enough pep to turn over a stiff engine after a long and pleasant DX contact. Many hams with high power mobile rigs carry a spare, well-charged battery in their trunk, just in case!

If your car is equipped with a generator, it would be a good idea to consider replacing it with an alternator. It will also be necessary to replace the voltage regulator. This will probably cost a little more than replacing a standard alternator with a heavy-duty alternator as mentioned previously. At the same time, it would be wise to install a heavy-duty battery.

The dashboard ammeters in older cars are calibrated only approximately, and are hardly more than indicators of "charge" and "discharge." In most newer cars there is no ammeter at all, but only a red pilot light to show "discharge." Since it is important to know what goes on in the car's electrical system, you should install a good zero-center ammeter reading up to 50 or 100 amperes. Mount it on the underhanging lip of the dashboard. Like the heavy-duty alternator, these meters are often available from the automobile salvage dealers at low prices.

Get into the habit of checking the battery in your car at least once a week, by means of a hydrometer. If it doesn't seem to build up to 1.260 or 1.270, which represents a pretty full charge, give it an occasional overnight boost with a charger. Inexpensive dry-

disc rectifiers for the purpose are sold by radio and automobile dealers everywhere.

Auxiliary Power Source

A picnic in the country becomes doubly enjoyable if you park your car in some quiet, secluded spot, preferably on a hill, where reception and transmission are both good. However, if you let the engine idle fast, to power the transmitter and conserve the battery, it is likely to overheat.

Hams who go in for mobile in a big way often invest in a one-cylinder gasoline-engine-driven 12-volt generator. Small enough to be carried in the trunk and to be handled by one man, this generator runs most of a day on a couple of gallons of fuel. Setting it up and clipping its leads into the car takes about five minutes. You'll often see one chugging away at ham field days, model airplane meets featuring radio control, sporting events where hams provide the point-to-point communications, etc. Generators of this type are widely used in rural areas, camps, etc., as a primary source of power.

For use at the events mentioned above, hams often carry their regular home-based, AC-operated equipment, set it up under tents or other shelter, and power it from generators that put out 115 volts AC. This is known as "portable" rather than "mobile" operation. The arrangement is very popular because it frees the car for its normal transportation purposes. A typical portable generator with an output of 350 watts weighs only about 14 pounds and is the size of a small suitcase. A larger unit is rated at 1250 watts, weighs 65 pounds, and can be carried by one strong man or two weaklings.

Some generators produce 12 volts DC at about 10 amperes in addition to the AC. This can be very useful for running battery-operated model transceivers or for charging car batteries.

Most small and medium size AC generators have rope-pull starters, as on outboard engines for boats. Some larger models can be started electrically by means of jumper cables to a car. Once the generator unit is running, the jumpers are disconnected and the car is free again.

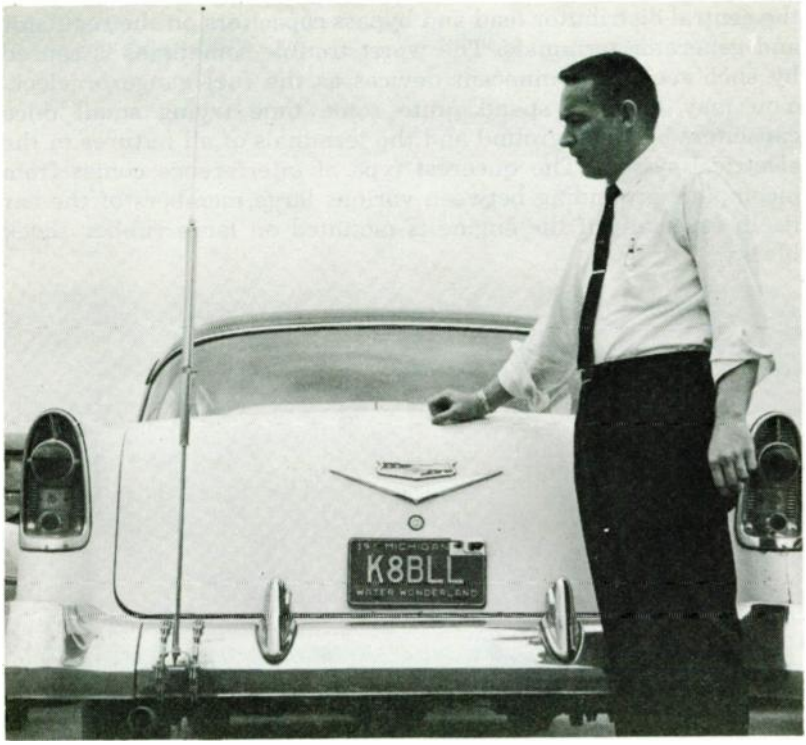
THE INTERFERENCE PROBLEM

In older cars, interference created by the electrical system can make reception on the ham bands very difficult, although it usually doesn't show up at all on the broadcast band. The ignition elements usually get most of the blame, but actually ignition interference is rather easy to cure by means of a suppressor resistor in

the central distributor lead and bypass capacitors on the regulator and generator terminals. The worst trouble sometimes is caused by such seemingly innocent devices as the fuel gauge or clock. You may have to spend quite some time trying small mica capacitors between ground and the terminals of all fixtures in the electrical system. The queerest type of interference comes from incomplete grounding between various large members of the car itself, especially if the engine is mounted on large rubber shock blocks.

This Mosley MA-3 antenna works on 10, 15, and 20 meters without switches or adjustment—a great convenience in mobile operation. The owner of this car didn't mind making a hole in the body to put antenna in the clear. Result: He works world-wide DX with a 50-watt transceiver!

At high road speeds, in dry weather, the friction of the tires against the road bed generates old-fashioned static that sounds like a thunderstorm. This interference is noticeable even on the broadcast band. Sometimes it can be eliminated by injecting "anti-static" graphite powder into the tubes of the tires. Hams have been known to borrow an idea from large fuel trucks; they attach



This bumper-mounted coaxial-type 2-meter antenna belongs, obviously, to K8BLL, Alan Robertson, Benton Harbor, Mich., but onlooker is K8ADS.

a short length of chain to the bumper and let it trail on the ground. The static charges that otherwise would run all over the car are thus grounded off, literally.

Late model cars are gratifyingly "clean" of internal interference because the bonding operation between chassis members is carried out in manufacture and is quite thorough. It is not unusual now to find the engine block connected to the fire wall by a length of one-inch wide copper braid. There is also often a wiping contact arm where the hood closes against the body.

SAFETY

Mobile radio is fun, but so is living. When traffic conditions are bad, leave the rig off and concentrate on driving. Save mobile operation for the open road where there are fewer distractions. Another person in the car is, of course, a great help in keeping the log and making minor adjustments on the transmitter. Ideally, let

someone else drive so that you can devote full attention to your operating. Remember also that all the rules that apply to fixed stations apply to mobile as well.

MOBILE EQUIPMENT

Ham shacks on wheels are becoming so popular that some manufacturers are concentrating on mobile gear. Representative examples of mobile equipment have been pictured throughout this chapter. As for other types of equipment, consult the free manufacturers' or distributors' literature for complete descriptions, prices, and specifications for a specific piece of equipment.

Bird cage? No . . . "halo"-type antenna for 6 meters, on station wagon of K8EGR. Vertical pipe is a support, not part of the radiating system.

MOBILE ANTENNAS

A simple 8-foot whip antenna is a quarter-wave long at 10 meters; in combination with the metal body of the car, it acts as an efficient radiator. For the 15 meter and higher bands, a straight whip becomes impractical, because it hits against trees, overhead wires, etc. The usual expedient then is to insert loading coils in a short whip to make it work as a longer one. These coils can be found at the base or at the center. If two loading coils are carefully located at critical separations, a single antenna can be made to work without adjustment on three bands, usually 10, 15, and 20 meters.

No wonder K6OHJ is happy! He drives a Corvette fitted with a mobile rig and a Webster Band-Spanner antenna. The cut-away view shows the internal inductance adjustment, for precise setting to desired frequency.

In the Webster *Band-Spanner* center-loaded whip the loading coil is wound directly on the fiber-glass support column. A whip of fixed length is arranged to slide in and out of the open neck of the column. Its lower end carries a circular contactor that touches against the exposed turns of the coil on the inside. Raising or lowering the whip, plunger fashion, enables the user to adjust the antenna very accurately. The range of variable inductance introduced by the loading coil covers 10 through 80 meters.

A completely different approach is represented by the Mark Mobile *Heliwhip.* The designers felt that ordinary whips are too long, too unwieldy, and too conspicuous, so they produced a much shorter one, made of *Fiberglas.* This insulating material is only the

What's a picture of a living room-ham shack doing in the mobile chapter? Answer: This is not a living room. It's the salon of the 83-foot ocean-going yacht "Compromise" and the all-National equipment is the maritime mobile station of Peter Schweitzer, W2DMQ.

support for the actual radiator element, a spirally-wound wire of variable pitch. A *Heliwhip* for 6 meters is only three feet long; for 10 to 15 meters, four feet; and 20, 40, or 80, six feet. There is also a three-band (10, 15, and 20 meters) *Heliwhip* six feet long.

Mounting a mobile antenna is a simple mechanical operation. If you don't mind making a hole in the body, the best place is the flat part of the rear deck or a fender. Excellent results are also obtained from whips mounted on the rear bumper. A variety of mounting hardware is available to facilitate the job.

9

How to Be a Good Operator

After you pass your license test and before you put a transmitter on the air, you must take a little time out to acquaint yourself with ham operating procedure and practices. This is necessary whether you start with CW or phone, and doubly important for CW because you have to express yourself by tapping a key instead of merely talking into a microphone. Many a ham who rushes on the air with a new license and new equipment gets himself into an awful stew during his first contact when he finds that he just can't understand what the other fellow is saying. This is very frustrating and can take all the fun out of the contact.

The formal rules are prescribed by the FCC. In addition, common use is made of many informal abbreviations and expressions which are special to the ham game and are utterly incomprehensible to outsiders.

THE MEANING OF *CQ*

By far the most commonly used and heard expression on the ham bands is *CQ*. This combination of letters is the ham's way of announcing to anybody who happens to hear him that he is on the air and is anxious to make a contact. The origin of the signal is somewhat vague. It is probably a contraction of *CQD*, the distress call used in the early days of radio before the adoption of the international distress signal *SOS*. CQD was popularly interpreted to mean "Come Quick Danger," and of course operators hearing it would give it their concentrated attention.

CW OPERATION

In CW work certain special signals are required to make the intention of a transmission specific and unmistakable. One that is used in every call is the intermediate *DE*, which is taken from French and means "from." It is placed between the call letters of

the called station and the call letters of the calling station. Military stations usually use the letter V for the same purpose.

There are five ending signals, the applications of which are illustrated later in this section. The single letter *K* terminates a CQ call and a transmission to a station with which definite contact has been made. It says, in effect, "Go ahead. I'm finished for the moment, and I expect an answer."

Good operating is made easier if you can read all the dials on your equipment without either eye strain or neck strain. A series of blocks under the front edges of receivers and transmitters bring the panels up to easy viewing angle. Open space on table is handy for log sheets, Call Book.

The signal *di-dah-di-dah-dit*, which is represented in print as $\overline{\text{AR}}$[1], is used at the end of a call to a specific station before contact has been established. For instance, if you heard a station send CQ, you could call it, follow with DE and your own call, and $\overline{\text{AR}}$ as the termination. The $\overline{\text{AR}}$ is also considered a sort of invitation to other operators to call you in case the station you called does not come back to you. $\overline{\text{AR}}$ is used at the end of a formal message, as distinguished from the usual "rag chewing" in which hams engage.

$\overline{\text{KN}}$ is a variation of "go ahead." It is used at the end of a transmission when an answer is wanted only from the station called,

[1] The overscore indicates that the dots and dashes are sent with uniform spacing, and are not separated into two letters.

and no other. *K* by itself really has the same significance, but under some conditions it isn't strong enough to discourage other stations from joining a contact. $\overline{KN}$ is particularly useful after directional CQ's, during emergency communications, etc. The *N* added to the *K* is like making a warning sign read "POSITIVELY No Smoking."

$\overline{SK}$ is the same as "good bye." It means that you are finished with the station you have been working and that you are ready for any other business that might present itself. If you are finished completely for the evening, sign off in addition with *CL*. This is not a manufactured signal like $\overline{AR}$, $\overline{KN}$ and $\overline{SK}$, but is sent as two separate letters and is short for "closing."

Don't bother to write down ending signals. Just follow their meaning.

Special Signals and Punctuation

The letter *R* used by itself is the signal of receipt. It means, in effect, "I have received and I understand all of your last transmission." Don't send *R* and then ask for repeat of transmission.

A string of *V*'s is the standard test signal. Use it when you are tuning up the transmitter. Other operators hearing the *V*'s will know what you're doing and will not waste time trying to call you.

$\overline{AS}$ is another useful signal. It means "wait," and is not to be acknowledged by the receiving operator. You might be hunting a fresh pencil or lighting a cigarette; send a few $\overline{AS}$'s to let the other chap know you're still with him.

$\overline{BT}$ is a dash, a separating signal between the call letters of a transmission and the words or message you want to send. It is something of a stalling signal too. If you haven't quite decided what to send after finishing one thought, tap off a couple of $\overline{BT}$'s. They represent a shorter interval than $\overline{AS}$ and help to keep the contact alive. The $\overline{BT}$ is frequently used instead of the period between words of the usual rag chew.

As mentioned in Chapter 2, the period and the comma are rarely heard in informal interchanges among hams. However, they exist and you are at complete liberty to use them any time you think they will clarify the meaning of something you want to send. The question mark, on the other hand, is in very common use, particularly in conjunction with the *Q* signals. The question mark also has the meaning "repeat," in the sense of a request when an operator misses part of a transmission and wants it sent again.

Abbreviations

The passion for abbreviation in CW operating has been carried by some hams to the point of absurdity. Instead of simplifying the

exchange of intelligence, which is the basic intention, the practice confuses beginners and old-timers alike and leads to many requests for repeats. In most cases, less total time would be consumed on the air if the whole words were sent in the first place.

For your guidance in decryptographing some of the gibberish you're likely to catch on the air, there follows a list of frequently heard abbreviations, with comments attached to some of them. If an unknown one is thrown at you, don't hesitate to ask the other operator to switch to English!

Abbreviation	*Meaning*
AA	All after.
AB	All before. (These two are used with the question mark to get a repeat of sections of a message. They are followed by the nearest words of the text, as identification.)
ABT	About.
ADR	Address.
AGN	Again.
BCI	Broadcast interference.
BCL	Broadcast listener. (Always used in a slightly contemptuous sense to distinguish a mere receiver owner from a ham.)
BK	Break. (This signal is usually used to interrupt or break the other operator's sending, so that you can tell him something important.)
BN	Been. (Or "between," used like AA and AB for getting repeats of message text.)
C	Yes. (This is baffling. If the simple three-letter word is to be abbreviated at all, why not be logical and make it Y? The C is probably a carryover from old telegraph practice, when it was used to mean "correct" after an operator queried the spelling of a word.)
CK	Check. (Refers to the word-count of a formal message.)
CL	Closing down station.
CLD	Called.
CLG	Calling.
CUL	See you later. (This is a compound abbreviation, the C and "see" being the same phonetically.)
CU AGN	See you again.
DX	Distance. (An old ham abbreviation that got into the popular language during the radio boom of the late 1920's and early 1930's.)
FB	Fine business. (A common expression of approval or praise.)
FREQ	Frequency.
GA	Good afternoon. (Also sometimes improperly used instead of K.)
GB	Good bye.
GE	Good evening.
GG	Going.
GM	Good morning.
GN	Good night.
GND	Ground.

Abbreviation	*Meaning*
HI	This is not a greeting, like "Hi, there!" but is best described as a Morse laugh. It's a short way of expressing amusement.
HR	Here or hear.
HV	Have.
HW	How.
MSG	Message.
N	No.
NCS	Net control station.
ND	Nothing doing.
NIL	Nothing, or I have nothing for you.
NR	Number.
NW	Now.
OB	Old Boy.
OM	Old man. (Regardless of his age, every male ham is automatically an OM. It's a friendly, fraternal form of address.)
OP or OPR	Operator.
PSE	Please.
RPT	Repeat.
SKED	Schedule.
TFC	Traffic.
TMW	Tomorrow.
TNX-TKS	Thanks.
TT	That.
TU	Thank you.
TVI	Television interference.
UR-URS	Your, Yours.
VY	Very.
WA	Word after.
WB	Word before.
WRD	Word.
WL	Well, will.
WX	Weather.
XMTR	Transmitter.
XTAL	Crystal.
XYL	Ex-young lady. (Wife!)
YL	Young lady. (Male hams don't mind being called "old man," but imagine any female ham, or any female for that matter, *not* objecting to "old lady" or "old woman"!)
73	Best regards. (This is an old telegraphic sign-off.)

THE INTERNATIONAL "Q" CODE

The first great use of radio was of course on ships at sea. Its rapid and widespread adoption gave rise to a serious language problem. How, for instance, could the Spanish operator of a freighter bound for Seattle send and receive vital navigational information to and from the American operator on shore? To meet this situation, one of the early international radio conventions adopted a series of three-letter signals, all starting with *Q* and having the same meanings in all languages. While designed primarily for maritime use, many of them are sufficiently general

to be valuable also for ham purposes. With their aid, you can exchange enough intelligence with another ham in Brazil, let us say, to make the contact an interesting one.

Each Q signal has both an affirmative or answer meaning and also an interrogatory meaning, the latter being formed merely by the addition of the question mark after it. You'll find a complete list in the Call Book. Reproduced here with comments are the signals having definite amateur applications. The comments in parantheses are the author's.

Abbreviation	*Question*	*Answer*
QRG	Will you tell me my exact frequency?	Your exact frequency is . . . . . kHz.
QRH	Does my frequency vary?	Your frequency varies. (Before telling this to a ham, make sure it's not your receiver that's drifting.)
QRJ	Do you receive me badly?	I cannot receive you. Your signals are too weak.
QRK	What is the legibility of my signals?	The legibility of your signal is . . . (In ham practice, the answer to QRK? is usually expressed according to the R-S-T scale, described in this chapter.)
QRL	Are you busy?	I am busy (or I am busy with . . .) Do not interfere.
QRM	Are you being interfered with?	I am being interfered with. (QRM has gotten to be a common abbreviation for "interference.")
QRN	Are you troubled by atmospherics?	I am troubled by atmospherics. (That is, "static.")
QRO	Shall I increase power?	Increase power.
QRP	Shall I decrease power?	Decrease power.
QRQ	Shall I send faster?	Send faster.
QRS	Shall I send more slowly?	Send more slowly.
QRT	Shall I stop sending?	Stop sending.
QRU	Have you anything for me?	I have nothing for you.
QRV	Are you ready?	I am ready.
QRW	Shall I tell . . . that you are calling him on . . . kHz?	Please tell . . . that I am calling him on . . . kHz.
QRX	Shall I wait? When will you call me again?	Wait. (or wait until I have finished communicating with . . . I will call you at . . . o'clock, or immediately).
QRZ	Who is calling me?	You are being called by . . . (QRZ? is very useful after you call CQ and can't

Abbreviation	*Question*	*Answer*
		quite get the call of an answering station.)
QSA	What is the strength of my signals?	The strength of your signals is . . . (Comment on QRK also applies here.)
QSD	Is my keying correct; are my signals distinct?	Your keying is incorrect; your signals are bad. (If more hams used this signal, instead of being polite liars, CW operation would improve greatly.)
QSL	Can you give me acknowledgement of receipt?	I give you acknowledgement of receipt. (This somewhat duplicates the simple R for "received." See last paragraph, this chapter.)
QSM	Shall I repeat the last telegram I sent you?	Repeat the last telegram you have sent me. (Why send "pse rpt ur last msg," as some hams do, when QSM says all this in three letters?)
QSO	Can you communicate with . . . direct (or through the medium of . . . ?)	I can communicate with . . . direct (or through the medium of . . .) (Hams invariably refer to a successful contact with another station as "a QSO.")
QSV	Shall I send a series of V's?	Send a series of V's.
QSY	Shall I change to transmission on . . . kHz without changing the type of wave?	Change to transmission on . . . kHz without changing the type of wave. (Changing frequency is thus often called "QSYing.")
QSZ	Shall I send each word or group twice?	Send each word or group twice.
QRRR	This is a special signal, and if you hear it keep off the frequency except to listen, unless you are in a position to help. It is the official ARRL land distress call, for emergency use only. It is the equivalent of SOS as used by ships at sea, and must receive the same attention and priority.	

SIGNAL REPORTING

Every ham wants to know how well he is being received, so one of the first things he asks, after making a QSO, is QRK? The answer to this question is an estimate expressed in the R-S-T system. R stands for readability, and ranges from 1 for "unreadable" to 5 for "perfectly readable." S stands for signal strength,

and ranges from 1 for "faint signals, barely perceptible," to 9 for "extremely strong signals." T is for tone, and 1 means "extremely rough hissing note," 9 for "purest DC note." Since there is no standard method or yardstick for measuring or judging any of these characteristics, any signal report is only a friendly approximation on the part of the receiving operator. Two people listening to the same signal on the same receiver often will not agree on an R-S-T report.

Hams generally tend to inflate the value of a signal, to make the other guy feel good. Sometimes they make themselves sound slightly foolish, as when they say, "Ur sigs FB hr OM RST 489 QRM bad QSZ." Translated, this means, "Your signals are fine here, old man. Readable with practically no difficulty, strong, purest DC note, but interference is bad so send each word twice." Don't give this type of report!

THE FIRST QSO

By this time perhaps you're itching to warm up your transmitter and go on the air. Let's assume that you have a novice license and will work initially on CW, which is a good way to get experience. You have pencils, a pad of paper, a Call Book, etc. You have a choice now: Send your own CQ and fish around for an answer, or listen for a CQ from another ham. Be a sport and start the ball rolling yourself. A CQ must be fairly long, to give other hams the chance to tune into it. By "long" is meant a full minute. If this doesn't sound like much, try timing it against the sweep second hand of a clock. The best system is call-three-sign-three, like this:

CQ CQ CQ DE WN1ABC WN1ABC WN1ABC CQ CQ CQ DE WN1ABC WN1ABC WN1ABC

(Keep repeating, and at the end of the minute finish with K.)

Luck is with you, and you hear your own call letters coming back at you: WN1ABC WN1ABC WN1ABC DE WN4XYZ WN4XYZ WN4XYZ wot say OM? $\overline{AR}$

You thumb through the Call Book hurriedly. "Wow, he's in Florida!" Now what are you going to say to him? Here's a suggestion:

WN4XYZ WN4XYZ DE WN1ABC WN1ABC R $\overline{BT}$ Tks for the call OM This is my first QSO and am sure happy $\overline{BT}$ ur RST 479 hr in Manchester N H $\overline{BT}$ Hw WX down there? WN4XYZ DE WN1ABC K

Note that the call up at the beginning can now be reduced to two-and-two, since your signals are already tuned in. Also, the identification of both called and calling stations is repeated once at the very end of the transmission. The terminating signal is now *K* because contact has been made. The answer might be:

WN1ABC DE WN4XYZ R $\overline{BT}$ Wl OM FB Glad to be ur first QSO Wl send QSL card $\overline{BT}$ WX hr plenty warm went swimming this morning Hws skiing up there HI $\overline{BT}$ nice signal hr in Miami RST 469 QRM as usual WN1ABC DE WN4XYZ K

If conditions are good you'll gossip back and forth for maybe ten minutes, and then:

WN4XYZ DE WN1ABC R $\overline{BT}$ Wl OM my XYL says chow is ready so must QRT Hope to work you agn and tnx for invite to see shack 73 $\overline{SK}$ WN4XYZ DE WN1ABC CL

The reply will be short:

WN1ABC DE WN4XYZ R Good appetite 73 to XYL too $\overline{SK}$ WN1ABC DE WN4XYZ

Now you can pull the switches, but before you leave the radio table don't forget to enter the required data in your log book. The time of starting and finishing, call of other station, frequency and power used, and signal reports are all entered. You'll really enjoy dinner now!

As you listen more and more, you'll realize that the "end of work" signal $\overline{SK}$ is somewhat abused and misused. $\overline{SK}$ means that you're finished, through, terminated, wound up; you not only don't expect but don't want further conversation other than an acknowledgement. If the other chap ignores the $\overline{SK}$, you can be polite and go along with him, but if you have to do something else you may have to just turn off the set. If the other guy decides to end the QSO, take the hint from his 73 and $\overline{SK}$ and do likewise.

PHONE OPERATION

The basic procedure used in CW work applies to phone too, but of course is simpler because you can talk naturally. Only a few standard expressions are needed, as follows:

The equivalent of CQ is "Calling any two-meter phone, calling any two-meter phone." (Use appropriate frequency or wavelength figure.) A variation is, "Hello CQ, CQ, CQ, calling any two-meter phone, calling any two-meter phone."

The intermediate signal is merely "this is" or "from." Following a CQ, "this is" leads into your own call letters a little better.

"From" is usually used in a short-form call after contact has been made, as illustrated later. In any event, the sequence of call letters must be preserved: first the call of the called station, then "this is" or "from," and then the call of the calling station. The reverse form, "WN1ABC calling WN2DEF," is contrary to FCC regulations.

The ending signals are "go ahead" or "over," and "signing off" or "out". The first two mean, "My transmission is ended and I expect a response from you." The second two mean, "This conversation is ended and no response is expected." "Over" and "out" are part of a compromise United States-British military procedure developed during World War II and still largely used.

The universal voice signal of receipt or acknowledgment, understood even where American isn't, is "Okay." You will hear a great many hams using the word "Roger" in the same sense as Okay. This is a funny case. "Okay" had been used previously in U. S. military voice procedure, but the British objected to it as not "proper." As part of the compromise, then, the phonetic

An open U-shaped arrangement of equipment on a desk top puts everything within comfortable reach of the operator. He is Morton B. Kahn, W4KR, Boca Raton, Fla. His assistant, Caesar, is a real radio hound!

equivalent of the telegraphic signal of receipt, the letter R, was chosen; this was Roger in the World War II phonetic alphabet, and it stuck.

Phonetic Alphabets

In voice operation, it is often difficult to distinguish between *B, C,* and *V,* between *D, P,* and *T,* and other letters. The FCC says in its regulations, "When using telephony, phonetic aids to identify the call sign of the station may be employed." Unfortunately, the FCC does not prescribe an official phonetic alphabet, which the game sorely needs. Hams are free to use anything they like, and the result on the air is often confusion rather than clarification.

Probably the most generally used phonetic alphabet is the one that grew out of the aforementioned United States-British militarg agreement. Hundreds of thousands of men and women in the services were trained to use it for ordinary telephone communication as well as radio, so the carryover to ham operation was more or less natural. More recently, a new international alphabet was adopted by the military services and commercial airlines. The

Table 9-1. Phonetic Alphabets

Letter	*Old Military*	*New International*	
		Word	*Pronunciation*
A	Able	Alfa	AL-fah
B	Baker	Bravo	BRAH-voh
C	Charlie	Charlie	CHAR-lee
D	Dog	Delta	DELL-tah
E	Easy	Echo	ECK-oh
F	Fox	Foxtrot	FOKS-trot
G	George	Golf	GOLF
H	How	Hotel	HOH-tel
I	Item	India	IN-dee-ah
J	Jig	Juliet	JEW-lee-ett
K	King	Kilo	Key-loh
L	Love	Lima	LEE-mah
M	Mike	Mike	MIKE
N	Nan	November	No-VEM-ber
O	Oboe	Oscar	OSS-cah
P	Peter	Papa	Pah-PAH
Q	Queen	Quebec	Keh-BECK
R	Roger	Romeo	ROW-me-oh
S	Sugar	Sierra	See-AIR-rah
T	Tare	Tango	TANG-go
U	Uncle	Uniform	YOU-nee-form
V	Victor	Victor	VIK-tah
W	William	Whiskey	WISS-key
X	X-ray	X-ray	ECKS-ray
Y	Yoke	Yankee	YANG-key
Z	Zebra	Zulu	ZOO-loo

two are given side by side in Table 9-1, with the words of the new international alphabet spelled out phonetically for clarification. The stress is on the capitalized parts.

The numbers are spoken in the usual fashion, except that 9 is "niner" and the cipher is "zero," never "oh." To distinguish zero from the letter O (Oscar), particularly as used with the call signs of stations in the tenth district, it is usually written as Ø.

Voice Distress Signal

The international voice distress signal is the word "Mayday." It's the phonetic equivalent of the last word of the French expression *Prière de m'aider*, which means "Please help me." In every sense, Mayday means the same as SOS. It's used mainly by aircraft, and also by small vessels equipped with ship-to-shore radiophones.

On the Air With Phone

Phone operation is just talking, so it should be easy. Wrap yourself around the mike and see what you can do. Again start with a general call:

"Hello CQ, CQ, CQ, calling any 20-meter phone, local, or DX. CQ, CQ, CQ, calling any 20-meter phone, calling any 20-meter phone, calling any 20-meter phone. This is W2DUX, William 2 Dog Uncle X-ray, in Hamville, Long Island. CQ, CQ, CQ, calling any 20-meter phone. This is W2DUX, William 2 Dog Uncle X-ray, William 2 Dog Uncle X-ray. What say someone please. Over."

Do not say "Charlie Queen" for CQ, as CQ by itself is the most often heard and easily recognized expression on the air. Talk slowly and distinctly for about a minute, and tune around for an answer. You might hear:

"Hello W2DUX, W2DUX. Calling William 2 Dog Uncle X-ray, William 2 Dog Uncle X-ray. This is W2GLP, William 2 George Love Peter, W2GLP, William 2 George Love Peter, in Sunnyside, Long Island. Do you read me, old man? W2DUX, this is W2GLP. Go ahead."

Now you pick it up:

"W2GLP, W2GLP, William 2 George Love Peter. This is W2DUX. Thanks a lot for the shout. Just got this rig working and you're my first QSO. Handle here is Paul. You're putting in a very strong signal. Anxious to know what this thing sounds like. Will you please give me a check? W2GLP from W2DUX. Over."

Since contact has definitely been established, the call-up is shorter than initially, and elaborate use of the phonetic alphabet is no longer necessary because the stations have identified themselves correctly.

A standard office desk and a matching swivel chair provide solid comfort for Carl Mosley, WØFQY, St. Louis, Mo. Equipment (left to right): Mosley CM-1 receiver, speaker, Viking Ranger transmitter, BC-221 frequency meter, Viking one-kilowatt amplifier. Carl rattles a mean "bug" and uses phone too. Northern pike, on wall, represents his other hobby.

"W2DUX from W2GLP. All okay, Paul. Handle here is Al, Able Love. You won't have any trouble getting out with that transmitter. Good loud signal, but I think you're overmodulating a bit. On your next transmission you might try turning down the audio gain a little, and I'll be glad to give you another report, Paul. W2DUX from W2GLP. Over."

This can go on for an hour. Finally you decide it's time to quit.

"W2GLP from W2DUX. Well, Al, you've been a great help and it's been a pleasure working you. Have to shut down and take the wife shopping, so if you have nothing further I'll be pulling switches. W2GLP from W2DUX. Over."

"W2DUX from W2GLP. Glad to be of help, Paul. You run along. Will see you some more. W2DUX, this is W2GLP, William 2 George Love Peter, signing off and clear."

"So long, Al. W2GLP, this is W2DUX signing off and pulling switches."

Note the difference in sign-offs. By identifying himself with phonetic words and saying ". . . and clear," W2GLP is indicating to others who might be listening that he is remaining on the air

and would welcome other calls. The last phrase ". . . and pulling switches" means that you're positively going off the air. Also note that the call-up is omitted from the last transmission, because of its brevity.

Break-in Procedure

There are times when you'll hear two other stations with great strength and clarity and you'll be sorely tempted to try to cut in and make it a three-way conversation. This can be done if it's done carefully. Wait patiently for a moment when both stations are silent, then turn on your transmitter quickly and snap out, "Break break."

If one of the other operators hears you and is willing to be interrupted, he'll say, "Who's the breaker?"

With this invitation, you proceed. "W6PXH, this is K2DUX. Thanks for letting me in. Want to let you guys know you're pounding in like a ton of bricks here. . . ." Once you've been accepted, you carry on normally.

If the other operator hears you but isn't quite ready for you, he'll say, "Stand by the breaker." This is your cue to keep quiet and wait until he returns eventually with, "Now who's the breaker who wanted in?"

There is the possibility that your interruption isn't welcome, in which case the other chaps will discourage you by not answering at all. The one kind of communication you should never interrupt is phone patching.

Traffic Handling

Since by definition an amateur station is one operated as a hobby, it follows that hams are prohibited by law from transmitting messages for other people for pay. Within the United States and to its possessions and territories, and to scattered military establishments, they can handle "third party" traffic just for the fun of it, and many do. Most such messages are of the innocuous "love and greetings by amateur radio" type, and if they take a week to go 500 miles no one suffers any inconvenience.

Third-party traffic between the United States and many foreign countries is prohibited altogether because it is considered unfair competition for the commercial communications services. Look in any of the monthly ham magazines for current lists of "open" and "closed" countries.

The Phone Patch

One of the truly great public services performed by ham radio is the almost daily hooking-up of service men overseas and their

A phone patch puts telephone hook-ups on the air, a great stunt for letting service personnel overseas talk to their families stateside. This Heathkit unit Model HD-15 connects to the line without upsetting the characteristics of the ham equipment.

families at home, usually by way of the 20-meter phone band. This is accomplished at the domestic end with the aid of a *phone patch*—a simple coupling device between the ham rig and the telephone. While phone companies are usually fussy about their instruments and strongly dislike extra connections on the lines, they more or less overlook phone patches, for a good reason: they are responsible for many calls that otherwise would not be made at all.

Let's take a common situation. An American soldier in Germany visits a ham station run by GI's—probably a MARS unit —and asks if there's any chance of getting a call through to Louisville, Kentucky. "We can try," is the usual answer. The operator goes on the air:

"Hello CQ Louisville, Kentucky or vicinity only, for a phone patch. CQ Louisville, Kentucky or vicinity only, for a phone patch. This is DL4ABC, Dog Love 4 Able Baker Charlie, in Germany. CQ Louisville, Kentucky or vicinity only, for a phone patch. This is DL4ABC, Dog Love 4 Able Baker Charlie, in Germany. Over."

These directional CQ's always get attention because hams know how important they are to homesick lads in strange lands. If conditions are good the answer might be:

"DL4ABC, DL4ABC, Dog Love 4 Able Baker Charlie. This is W4DEF, William 4 Dog Easy Fox, William 4 Dog Easy Fox. I read you loud and clear here in Louisville and will be glad to work a phone patch. DL4ABC from W4DEF. Over."

"W4DEF, W4DEF. This is DL4ABC. Thanks, old man. Here's the dope: Corporal Johnny Jones calling his mother, Mrs. Mary

Jones, phone number BLuegrass 9-3568. Got it? W4DEF from DL4ABC. Over."

"DL4ABC from W4DEF. Okay. Stand by while I call."

The ham in Louisville quickly calls the number. "Mrs. Jones? This is Bill Williams, on Derby Road. I'm an amateur radio operator, and I'm talking to a station in Frankfort, Germany, where your son Johnny is standing by to talk to you."

The usual reaction to this sort of thing is consternation, delight, or hysteria, or a mixture of all three. A wise parent or wife will compose herself and be cheerful.

"It's extremely kind of you to go to this trouble, Mr. Williams."

"Not at all, Mrs. Jones. I have to switch back and forth, as only one of you can talk at a time. He'll talk first. I may have to cut in to keep you from getting mixed up, but don't mind. Now please wait and take your cue from either Johnny or me."

Shifting to his ham mike, "Hello DL4ABC, DL4ABC. This is W4DEF. All set at this end. Johnny, take it away!"

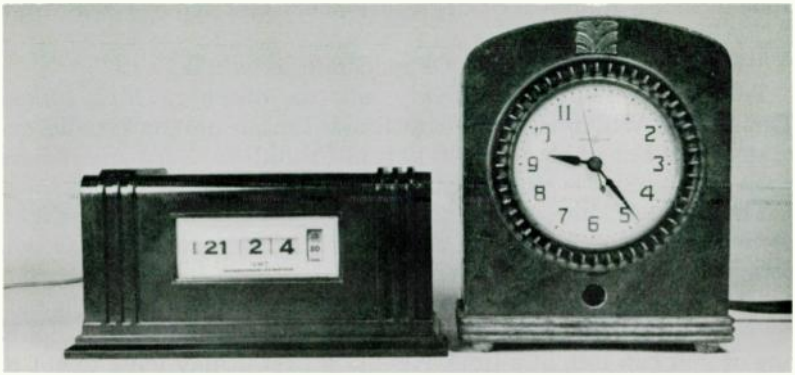
"Hello mom, how are you and pop? I'm feeling fine . . ." Magic words worth more than anything.

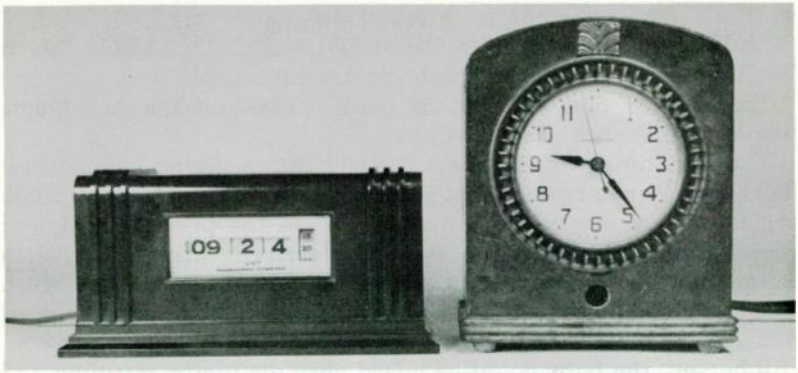
The first time you tune accidentally into a phone patch you'll feel slightly embarrassed, but you'll also feel proud that ham radio can do such a marvelous job of it. One of the prize hook-ups of recent times was between a newly arrived airman in North Africa and his young wife in a tiny town deep in the Southwest. She had given birth to a son shortly after her husband had shipped out. As she spoke softly into the phone, obviously fighting to control herself, the baby could be heard very distinctly, gurgling and making other little sounds. This went on for about fifteen minutes before the band pooped out. It is doubtful if there was a dry eye in any of the numerous ham shacks around the world where the conversation was picked up.

KEEPING TIME

There was once a popular song entitled "When It's Night Time in Italy It's Wednesday Over Here." The international time situation isn't quite that bad, but you'll find it confusing until you learn to use only Greenwich time in your dealings with hams in Europe, Asia, and the Antipodes.

When association between even adjacent communities was limited, time was a matter of purely local concern. Towns, cities, and whole countries set their clocks any way they wanted, with the high-noon sun as the approximate standard. With the development of improved means of travel and electrical systems of communication in the last century, the need for an international





These two pictures show how the 24-hour time system eliminates confusion. The round 12-hour clock in both scenes reads 9:24, but you can't tell just by looking at it whether this represents morning or evening. There's no doubt with the digital-readout clock on the left, a Numechron-Tymeter. 0924 can mean only morning, and 2124 can mean only evening, anywhere.

time base of some kind became self-evident. Because time was of prime importance in navigation at sea and Great Britain was the leading sea power of the 19th century, an astronomical observatory in Greenwich (actually a borough of London) was selected as the starting point for calculations. The imaginary line that runs through Greenwich from the North to the South Poles was established as the "zero" meridian. The earth was scored off, like an orange about to be peeled, into 24 segments, each representing 15 degrees of longitude: 12 zones to the east of Greenwich and 12 to the west. For each 15 degrees east, the local time is one hour ahead of the time in Greenwich; for each 15 degrees west, one hour behind. Thus, 75 degrees or five zones west of Greenwich, in which are found such cities as Boston, New York, Washington,

Detroit, Miami, Havana (Cuba), and Lima (Peru), local time is five hours earlier than Greenwich.

Because local times are often subject to modification, such as advances of one or two hours to give "daylight saving" time, radio schedules are invariably stated only in terms of Greenwich time, which does not change.

The confusing duplicate figures 1 through 12, AM and PM, used in ordinary time telling, were eliminated in the Greenwich system, and a 24-hour numbering sequence was adopted instead. In the original Greenwich Mean Time (GMT) concept, the day started at noon, not at midnight. In 1925 it was decided to move the starting point back to midnight, in accordance with civilian practice, and the designation of the system was changed to Greenwich Civil Time (GCT). However, the term Greenwich Mean Time and its abbreviation GMT are still universally used, it being very unusual to find GCT in print or to hear it mentioned on the air. You can be pretty sure that any reference to GMT is intended to mean the 24-hour system that starts just after midnight.

All GMT times are expressed in four digits, the first two representing the hour and the second two the minutes past the hour. The conventional morning hours from midnight through noon are thus 0100, 0200, etc., to 1200. The first hour past noon is 1300, and the sixth hour plus 34 minutes past noon is 1834. It is impossible to confuse 2:00 AM with 2:00 PM if they are expressed in the 24-hour system, because the first is 0200 and the second is 1400 hours. When using these figures verbally, spell them out as completely as possible, and always add the letters GMT to show that you're talking about time and not something else like frequency. Account for all four digits: "zero two zero zero GMT" for 0200; "twenty-two forty-six GMT" for 2246. Since there are only 24 hours in the day it would appear to be wrong to say "thirteen hundred" for 1300 GMT, or "zero eight hundred" for 0800 GMT, but this usage is widely accepted because it does not cause confusion.

A MUST FOR THE SHACK

As soon as you start to work foreign hams you will want to add a 24-hour clock to your shack. The ham catalogs show a variety of sizes and types, mostly electric but some spring driven. One style has a regular round face, with the circle marked off from 1 to 24 instead of 1 to 12. Another has four revolving side-by-side wheels with the rims of the first imprinted with the number from 1 to 24, the second 0 to 5, the third 0 to 9, and the rim of the

fourth from 1 to 60. A quick glance gives you a direct reading of the time, down to seconds if you want it.

Hard-earned but unusual wall paper! The late Dr. Harold H. Riker, K2JHA, Flushing, N.Y., had a prize collection of QSL's as a result of his hamming on SSB. The cards on this wall are all foreign; the ones covered by his left hand are from France, Italy, Germany, and Sweden.

QSL CARDS

After working each other for the first time, most hams exchange QSL cards. These are usually regulation postcard size, 3¼ by 5½ inches. On one side is a description of the station, with the call letters printed in large, bold type. Numerous small printers who make a specialty of these cards advertise in the ham magazines. Many cards are very elaborate and make interesting wall displays, and the stamps alone on some of the foreign ones are worth having.

To prevent cards from going astray, make sure of the other fellow's name and address by looking in the Call Book while you are still in contact with him, and have him verify the listing. If you can't find a listing, ask him for all particulars and give him your pedigree in return.

Remember, when sending a card to a foreign ham, *don't* put a 5-cent stamp on the card and expect it to reach its destination. Check the postal regulations for the proper postage.

The "Second Op" is a very useful operating accessory. It gives beam headings, time differences, calls of all countries, etc. Available by mail from Publications In Electronics, 110 Highwood Circle, Oyster Bay Cove, New York 11771.

A flat map of the world gives no real idea of the relative positions of various countries. What you need for a ham shack is a globe like this 12-inch model from National Geographic Society, Washington, D.C. 20036. It's a real eye-opener!

10

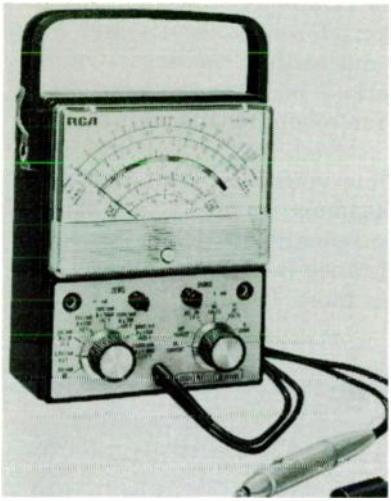
Test Equipment and Safety Measures

A multirange meter that measures DC and AC voltage and resistance is the most useful piece of test equipment for ham purposes (for all electronic test purposes, for that matter). Such meters are available in two forms. The first is known as a *multimeter* or volt-ohmmilliammeter, abbreviated VOM. It consists of a low-current range DC ammeter (a microammeter or milliammeter), an assortment of small resistors, a dry-disc rectifier, a couple of flashlight cells, and a selector switch with as many as eighteen positions. The switch throws the resistors into various series or parallel combinations with the meter, to make the latter read in millionths of an ampere (microamperes), thousandths of an ampere (milliamperes), or whole amperes; DC volts, or AC volts with the rectifier cut in; and resistance with the batteries connected in. A VOM is self-contained and requires no outside source of power. Connection between it and the circuit or device under test is made by a pair of long flexible wires, the free ends are fitted with heavy insulating handles. A good factory-made VOM costs about $40 or $50; a kit costs about $25 or $30.

The second type of measuring instrument bears the designation *electronic voltmeter*. In its modern form, it is entirely of solid-state design (usually incorporating field-effect transistors, or "FET's"); it is more versatile than the basic VOM; and it operates on self-contained batteries independently of the AC line. In its older form, it uses vacuum tubes and is therefore called a *vacuum-tube voltmeter,* or VTVM; and it works off the AC line. Both styles are available in both factory-made and kit forms, at a wide range of prices. The kits are easy assembly jobs.

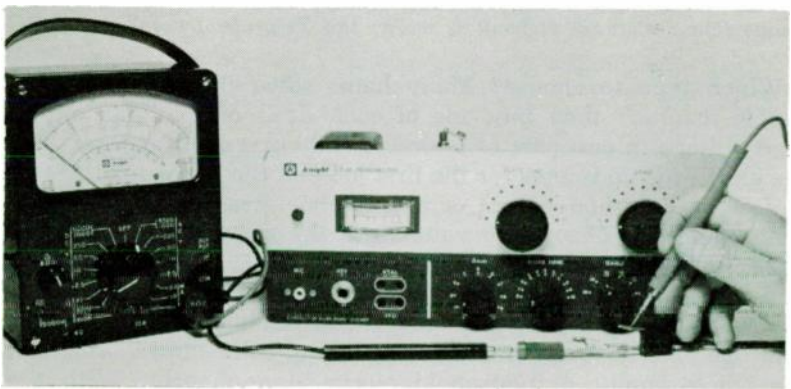
METER SENSITIVITY

Multimeters are described as having a sensitivity of so many *ohms-per-volt*. Small, inexpensive meters are usually 1,000 ohms-per-volt; the better grades, used for ham and TV-radio service



Representative electronic voltmeters popular with hams and technicians. Left: RCA Model WV-500B "VoltOhmyst" solid-state meter works on self-contained batteries. Right: Heathkit Model IM-1202 is an interesting multimeter with digital readout instead of a scale.

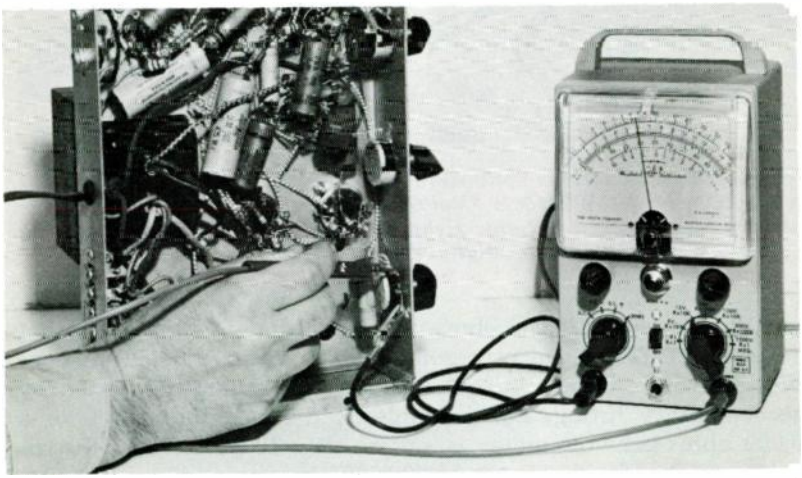
work, are rated at 20,000 ohms-per-volt. What this means is that the effective resistance represented by a meter when it is connected across a circuit is equal to the scale range multiplied by the sensitivity rating. For example, if the selector switch of a 20,000 ohms-per-volt meter is set to "DC 10 volts," the instrument acts as a fixed resistor of 200,000 ohms in addition to func-



A typical VOM application. Here the primary of a transmitter power transformer is being checked for continuity. One probe is clipped to one prong of line plug, other to second prong, and transmitter is turned on.

tioning as a 10-volt voltmeter. This relatively low value of resistance upsets the normal operation of some circuits and may cause the meter to give false or misleading readings. On the higher ranges the effect is less marked because the resistances are higher. On the 300-volt scale, for example, the value is 300 times 20,000, or 6 megohms.

The big advantage of the electronic voltmeter is that it has a high input resistance, usually 11 megohms, on all voltage ranges. It is extremely valuable for measurements in delicate circuits where the voltages are low. Its resistance ranges are usually better spaced out on the scale and are more flexible than those of VOM's.



A VTVM being used to check the resistance value of a volume control, and also its condition. Irregular meter reading, as control knob is rotated, means that resistance element is worn; this is probable cause of noise.

Which type to choose? Many hams solve the dilemma in a simple manner: they buy one of each! It is often important to read voltage in one part of a circuit and current in another; use the electronic voltmeter for the first job and the VOM for the second. It is often convenient or absolutely necessary to have separate meters to check two voltages at the same time, to see the effects of certain adjustments. For outside work, as on a mobile rig in a car, either a VOM or an FET meter is satisfactory.

With the meter set for resistance measurement, you can quickly spot open or short circuits in tubes, lamps, connecting cords, and the whole gamut of household electrical appliances. With the meter switched to AC, you can check power wiring and a variety of small transformers used for doorbells, toy trains, thermostat

contols, etc. With the various DC voltage ranges, you can get a **quick** picture of the condition of dry batteries used for flashlights, hearing aids, portable radios, and flash guns. The longer you own one of these meters the more applications you will find for it. It's a lifetime investment that will never go out of date.

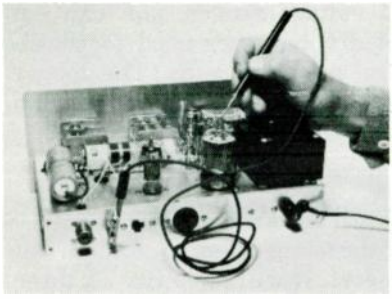
TRANSMITTER METERS

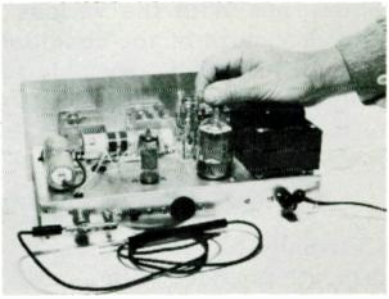
Virtually all transmitters, even the simplest ones sold in kit form, are provided with a milliammeter. It will have two or three scales and is switched into various parts of the circuit to show the currents in them. Some of the more elaborate transmitters have several milliammeters, which give simultaneous readings to facilitate tuning operations. Virtually no transmitters include voltmeters. If you want to measure the power input to the final amplifier, connect the minus lead of your VOM or FET meter to the chassis of the transmitter and the plus lead to either terminal of the milliammeter. Set the latter to read final-amplifier plate current and fire up the rig. Multiply the reading in volts by the reading in amperes and you have watts. Remember that a milliampere is 1/1000 ampere, so move the decimal point three places to the left when you make a notation of the plate current. For instance, 135 ma is .135 ampere. If the plate voltage is say 430, the power input is 58.05 watts.

DANGER—HIGH VOLTAGE

Make no mistake about it—even the smallest ham transmitter is dangerous to human life. It's dangerous in the same sense that a bathtub, a kitchen stove, or an automobile is dangerous. If you have any brains at all, you climb in and out of a slippery tub slowly and carefully. You open the gas cocks only if the pilot light is working or if you have a lighted match in hand. You apply the brakes gently when you're driving on an icy road. In other words, you're careful.

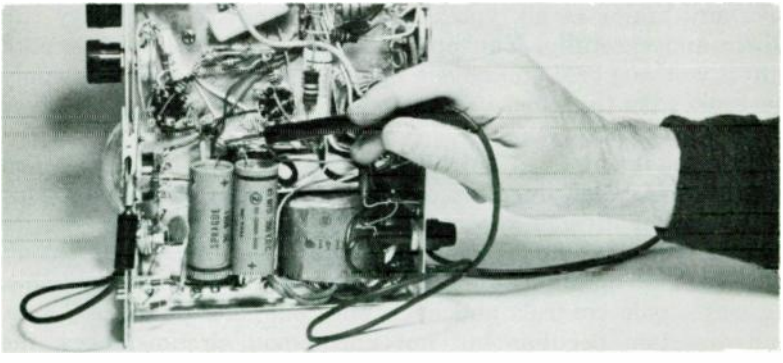
The fundamental rule of all electrical safety is: *Don't touch any exposed metal object on a receiver or transmitter with your bare fingers until you are sure it's "cold."* How can you be sure it's cold and not "hot" ? Not by looking, but by testing. Don't even trust the on-off switch of the equipment. Most such switches are single-pole controls and open only one side of the AC line. Under certain peculiar but not uncommon circumstances, the other side of the line may still be hot in relation to ground and to you too if you happen to insert yourself in the circuit. The next rule is: *Pull out the line plug.* But wait a second . . . you're not





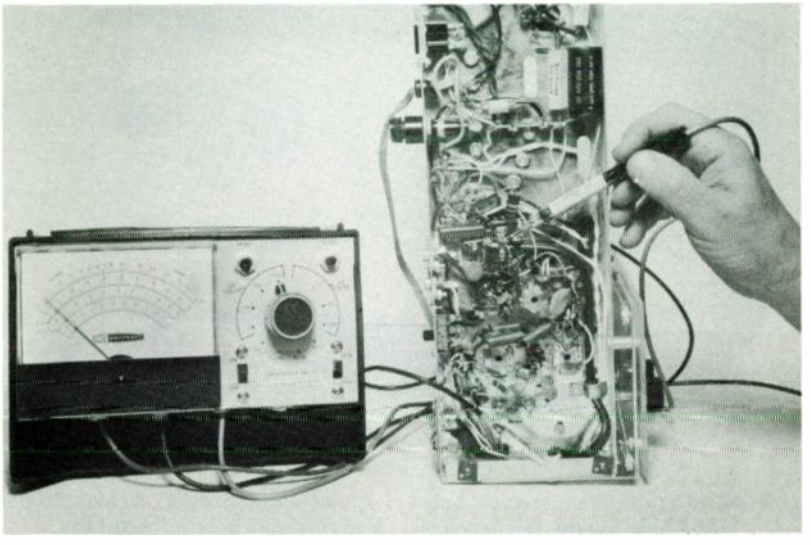
Wait! Before touching plate cap of transmitter tube, make sure it isn't hot. Clip one end of a single test lead to chassis and touch probe to cap as shown at the left. The plate cap can now be removed in complete safety.

in the clear yet. The large filter capacitors used in the high-voltage power sections of both receivers and transmitters can hold a heavy charge of electrons. In well-engineered equipment there are "bleeder" resistors in the circuit whose function is to dissipate any charges remaining in the capacitors after the power has been turned off. Because these resistors invariably are of high value, they cause the electrons to dribble off slowly, much as a small diameter pipe restricts the flow of water from a large storage tank. It can take the capacitors three to five seconds to discharge. In electrical practice that is a long time. If you turn the line switch off with one hand while you reach to make an adjustment with the other, you may be in for quite a surprise, a shocking surprise, in fact! You can see for yourself how slowly some capacitors discharge after primary power is removed. Merely connect



Bleeder resistors cannot always be trusted. Play safe and short-circuit all filter capacitors to chassis with a single test lead, before touching them.

your voltmeter between B+ and ground. Turn the equipment on for a minute, then turn it off. The meter needle will not snap back to zero, but will drift down lazily. The third rule of safety then is: *Discharge possible charged capacitors.* The easiest way to do this is with a test lead from your VOM or FET meter. Connect one end, by means of a clip, to the chassis, and tap the insulated probe at the other end to any or all terminals, soldering lugs, bare wires, and tube caps, that you expect to touch. The full discharge of the filter capacitors used in transmitters can be as loud and as startling as that of a .22 caliber cartridge. With the equipment disconnected from the power line and the capacitors emptied out, you can now stick your fingers anywhere. The only other caution you should observe relates to hot tubes, especially rectifiers.



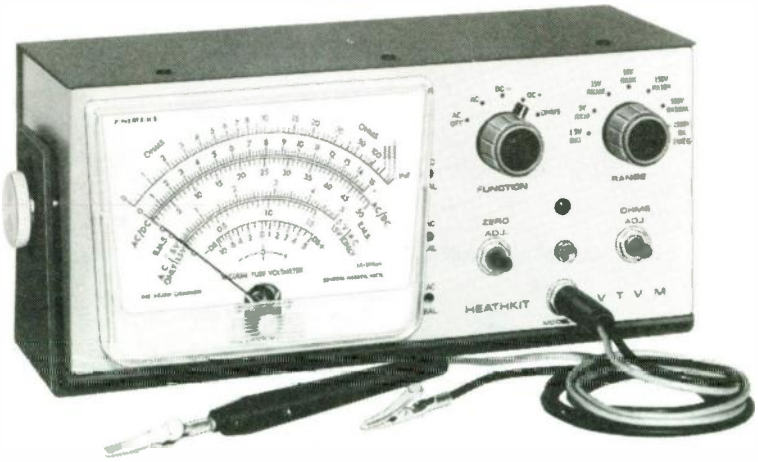
The proper one-hand method of making voltage checks in a live piece of equipment. The negative test lead is clipped into chassis and the positive probe is held near its end. This is sure way to avoid being shocked by DC. Instrument is Heathkit Model IM-17 solid-state (FET) voltmeter.

Bleeder resistors are known to burn out, and therefore bleeders are not to be trusted 100% as safeguards against capacitor shocks. In fact, because they are across the highest voltage in a set, they take a continuous beating and are more susceptible to trouble than many smaller resistors in other circuit positions.

High-grade capacitors can hold their charges astonishingly well for long periods. The author has good reason to know this! He turned off a transmitter one day, with everything apparently in

working order. Three days later, he reached in to change the final amplifier plug-in coil. The next thing he knew was that he was in a heap on the floor eight feet from the radio table, with a badly stung right hand and a lump on the back of his head! Sure enough, a large wirewound resistor, installed just to prevent such an accident, proved to be completely open.

Another good hint when working around high-voltage circuits is to keep one hand in your pocket. This way, you can not accidentally touch the chassis while your other hand may be in contact with a voltage.



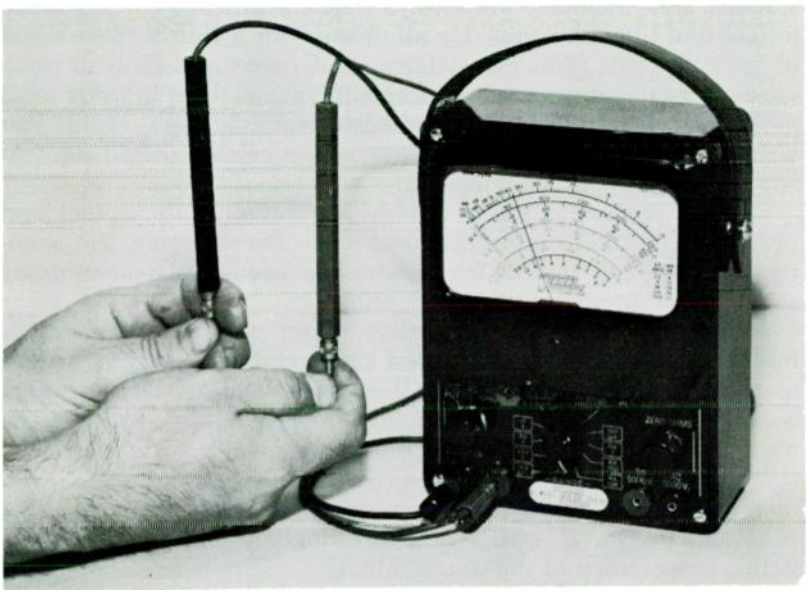
Horizontal-style vacuum-tube voltmeter, exemplified by Heathkit Model IM-28, is handy for bench use. Viewing angle is adjustable.

WATCH THE POWER LINES

Hams who show the proper respect for high-voltage DC sometimes make the mistake of underestimating the primary 115-volt AC line. If your hands have perspired or are damp or wet, and many times when they're bone dry, this much voltage can do serious damage and is often fatal. *Never* attempt to change or add wiring in outlet boxes, lamp sockets, extension cords, etc., without first removing the fuse in the cutout box. This may cause a bit of temporary inconvenience by darkening the room, but it's better to work by flashlight for a few minutes than to be encased in permanent darkness six feet under.

BODY RESISTANCE

Most people think of copper wire and other metals in general as good conductors of electricity. They overlook the fact that under the right circumstances the human body is a good conductor. You can make some interesting and significant investigations along this line with your VOM or FET meter set on one of its higher resistance ranges. Hold the end of one test lead between the thumb and forefinger of your left hand. Touch the other test lead to various parts of the left hand, the elbow, the shoulder, the neck, etc. Grasp the metal tip of this lead tightly and loosely with your right fingers. Try wetting the skin with plain water, soapy water, water with a pinch of salt in it. The meter needle will dance around crazily, and the readings may be as low as several hundred ohms, as high as several megohms.



How good a conductor are you? Here the resistance between the two hands is only about 350,000 ohms.

WHAT VOLTAGES ARE DANGEROUS

You can put your fingers directly on the terminals of a 22½-volt battery, and feel either nothing or only a very faint tingle. With a 45-volt battery you'll get a slight twinge. Most normal people start to get stronger reactions beginning with 50 or 60 volts. Just keep clear of anything higher.

11

The Organization of Amateur Radio

There are hundreds of ham radio clubs, scattered all over the country. Many of them have permanent "homes" containing meeting rooms, code practice tables, workshops, and elaborate club stations. New members are always welcome and are quickly made to feel that they "belong." By all means join a club if there's one in your vicinity. You can determine if there is a club in your vicinity by looking for announcements of meetings in your local newspaper or on the bulletin boards of radio jobbers, etc. If you write directly to ARRL headquarters (see below) they'll tell you where the nearest one is located.

Strongly-organized clubs can do a great deal to protect and promote ham interests on the local level. For example, the adoption of ham call letters for automobile license plates in many states is the direct result of club effort.

As an indication of the durability of ham radio as a hobby, it is interesting to note that the largest single club in existence, with a membership of about 10,000 in all call areas and in several foreign countries, is the Quarter Century Wireless Association. The only hams who are eligible are those who have held licenses continuously for a minimum of twenty-five years. There are regular meetings of chapters in many parts of the United States. Mrs. Ethel M. Smith, K4LMB, 2012 Rockingham St. McClean, Va., 22101, is secretary of the organization.

THE *ARRL*

Since 1914, the amateur radio enthusiasts of the United States have been banded in a single national organization called the American Radio Relay League, or ARRL. The word "relay" is part of the name because in the early days of the game, before the DX possibilities of the short waves were understood, messages between distant stations had to be retransmitted by a number of intermediate relay stations. Practically all active hams are mem-

bers or at least follow news of ham activities and developments in the league's publication, *QST*. At one time this was an official "Q" signal and meant "General call to all stations," so it is quite appropriate as a magazine name. The annual membership dues are $9.00 and include a year's subscription to *QST*. An interest in amateur radio is the only requirement for membership. Ownership of a station is not necessary, but the privilege of voting in

Sports events and parade traffic are handled with ease in Cleveland when Walter Ermer's ham radio corps assists police by providing auxiliary communications. Ermer, W8AEU (standing), is shown here during a sports car race discussing a traffic problem with George Flemming K8QPH.

elections is extended only to holders of valid amateur licenses. The headquarters of the ARRL are at 225 Main Street, Newington, Conn. 06111.

The league is divided into fifteen geographical divisions, each with an elected director and a vice-director. The officers of the ARRL itself are also elected individuals. No one commercially engaged in the manufacture, sale, or rental of radio apparatus is eligible for the positions, so the league over the years has been

able to live up to its stated purpose as a "noncommercial association of radio amateurs, bonded for the promotion of interest in amateur radio communication and experimentation, for the relaying of messages by radio, for the advancement of the radio art and of public welfare, for the representation of the radio amateur in legislative matters, and for the maintenance of fraternalism and a

During the Cuyahoga river flood sixteen families were rescued by Ted Posey (right), one of Cleveland's 300-man amateur radio emergency corps.

high standard of conduct." The league's representatives are familiar and welcome figures at FCC hearings and various other national meetings in Washington. They have also participated in many important international conferences pertaining to worldwide amateur activities.

PUBLIC SERVICE

Hams spend a great deal of their time on the air chewing the rag and adjusting their equipment. But when disaster strikes in the form of floods, storms, hurricanes, earthquakes, forest fires, etc., they perform brilliant public service by providing what is often the only means of communication in the stricken areas. Their extraordinary record for helping to save lives and property is recognized in official circles and greatly enhances their standing. In fact, the FCC has issued special regulations formalizing this

activity, which is popularly called RACES, for *Radio Amateur Civil Emergency Service.* Although the overall Civil Defense program of the country has been dragging its feet, because of public apathy, the radio facilities furnished by the ham fraternity are quite efficient and prove their value every time a public emergency arises. This is acknowledged in one of the annual reports of the FCC, which states:

The Cleveland police often use the ham emergency corps directed by W8AEU (right). Here police Lieutenant Michael Roth, himself a ham (he is K8KNJ) uses one of Ermer's home-made portable transceivers.

"Public service performed by 'hams' during weather emergencies such as snowstorms and hurricanes and also in times of fires, accidents, etc., is a continuing record. A large part of this service is through the Radio Amateur Civil Emergency Service (RACES) for the benefit of community civil defense organizations. RACES functions during peace to aid in times of natural disasters and emergencies. In wartime when other amateur activity must cease, RACES is the means whereby amateur activity may continue to furnish essential communication to help civil defense authorities."

CONVENTIONS AND HAMFESTS

Numerous conventions and hamfests are held by large clubs, state organizations, and ARRL divisions. These affairs usually include excellent technical talks, demonstrations of new equipment, displays by manufacturers or jobbers, code contests, fashion shows for the ladies, luncheons and dinners, etc. A national convention is held every few years. All are enjoyable, and give hams a chance to meet other hams they have worked on the air. The standard means of identification is a QSL card pinned to the coat or shirt.

One of the features of ham conventions is a flea market, which naturally attracts bugs—that is, radio bugs like the one who has his call on his shirt. This is no joke; he really is W4BUG!

12

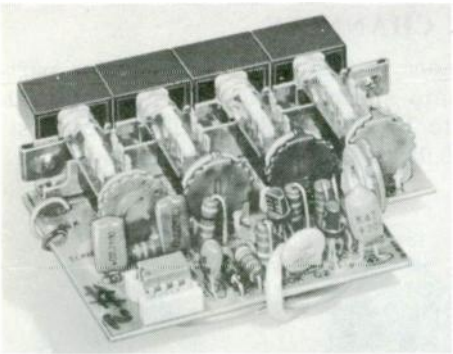
2-Meter FM

Short-distance voice communication with low-power AM (amplitude-modulated) equipment on the 2-meter band has long been popular with amateurs, as a change from long-distance operation with very high-power rigs. However, the mere shift from AM to FM (frequency modulation) has revolutionized this aspect of the ham hobby. In fact, 2-meter FM is virtually a whole new game, even for members of the Quarter Century Wireless Association.

2-METER CHANNELS

The most noticeable difference is that for FM the major part of the band is channelized into specific frequencies exactly 30 kilohertz apart, from 146.01 to 147.99 megahertz. Thus, the first channel is 146.01, the next 146.04, 146.07, 146.10, 146.13 and so on.

These are two examples of very low-power—only one watt—portable 2-meter transceiver. Above: The Drake Model TR-22C measures 5 3/8 inches by 7 1/2 inches by 2 5/16 inches and weighs less than four pounds. It has 12-channel capability and an over-the-shoulder carrying case. Right: Standard Communications Corp. Model 146 is hand-carryable. Antenna pulls out at top.



The Heathkit HW-202 transceiver, a 10-watt model, sits on the dashboard of an "RV" without obstructing the driver's view. Operating frequency is selected by push buttons. Left: Some repeaters can be activated only by certain audio tones. Four different ones are available from this little Heathkit generator, an accessory for the HW-202 transceiver.

Since all the channels start with 146 or 147, it is general practice to refer to them only by the numbers after the decimal point; for example, 34, 53, 94, etc.

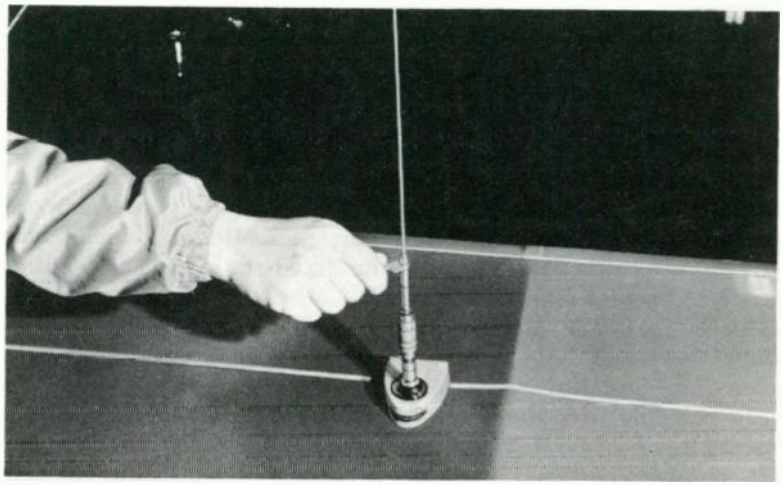
By means of quartz crystals, it is easy to adjust both receivers and transmitters to the channel frequencies. For complete coverage, 134 crystals are needed for the 67 available channels, but most hams find six or ten channels enough for local operation. More-flexible frequency selection is offered by a new device called a *frequency synthesizer,* in which only one crystal is used as the basic frequency-generating element in a rather complicated circuit.

2-METER EQUIPMENT

A typical 2-meter FM transceiver is a solid-state unit about the size and shape of an ordinary cigar box. It usually has a transmit power rating of 10 watts and draws only two or three amperes from the 12-volt battery of the car, recreational vehicle, boat, etc., in which it is installed. For fixed-station use, a simple AC-to-DC power supply is needed.

For both mobile and fixed operation, a simple whip antenna about three-feet long is usually quite adequate. Multielement beams give greater range, but this is not always desirable. For truly portable use, there are transceivers so small they can be carried in a coat pocket or sung from the neck like a camera. The self-contained batteries are generally of the rechargeable (NiCad) type. The antenna is most likely to be a little stub about six inches long. These rigs are of particular value for disaster work, athletic meets, large picnics, road races, and other outdoor and indoor events requiring close supervision.

Ham clubs put a lot of time and effort into the construction and operation of repeater stations. This association has received awards for the public service rendered by members. Exhibit was displayed at Florida convention. Note tiny transceiver on belt of Jim Hinchee, K4RMU.



Popular style of whip antenna for mobile 2-meter FM. Hole in body of car is not necessary. The base of the antenna clamps to back edge of trunk lid. Thin coaxial squeezes through rain gasket.

REPEATERS

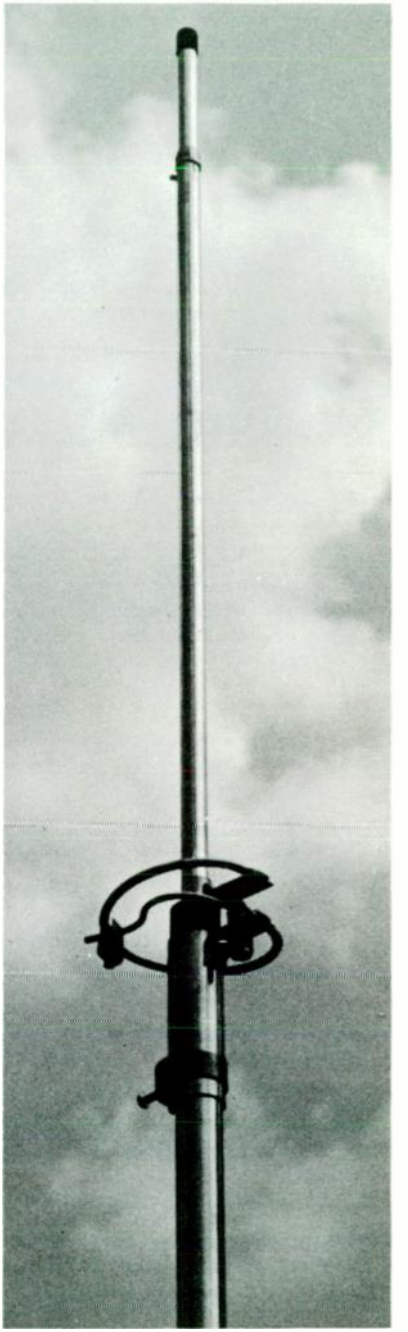
Two-meter FM was given a terrific boost with the appearance of "repeater" stations, most of them the property of ham clubs. A repeater is a combination of a receiver and a transmitter that picks up signals from two mobiles or portables, or from fixed stations under some circumstances, and retransmits them alternately *on another frequency* at high power from a high antenna. With this arrangement, solid communication between the field stations is possible over otherwise prohibitive distances.

The signal from the calling station, called the repeater *input,* and the repeater's own signal, or *output,* are always separated by 60 kilohertz. Different combinations are used in different parts of the country, but the nearest to a universal pair is 34/94; that is, 146.34 and 146.94 megahertz. Altogether, 54 channels are reserved for repeater purposes, and 13 for direct communication, or *simplex.* (Simplex means normal transceiver operation between two stations on one frequency.)

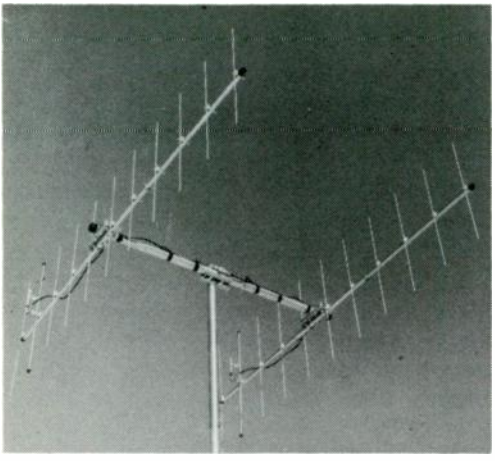
Repeaters can be either manual or automatic. In the first type, a club member is actually at the station or he can be at home with full remote control of the equipment by means of a radio link or a direct wire circuit. The usefulness of the installation obviously depends on the availability of volunteers for the job. Most repeaters are going automatic, with full 24-hour service. To activate such a repeater, the calling operator presses his mike button.

His carrier triggers a relay that turns the repeater on for a limited time, usually three to five minutes, after which it turns the repeater off. In a busy area, getting control of the repeater can be a hassle!

Some automatic repeaters offer mobile and portable 2-meter FM operators direct access to the country's telephone system, by way of a transmitter accessory that generates the same audio tones used on land lines. The applications of this "autopatch" facility can be sensational. Imagine getting through *directly* to the police in case of a real emergency! However, incoming calls on the land lines must be screened by an operator at the repeater; no operator, no calls from an irate wife looking for a delayed husband! In fact, most repeater operations with autopatch do not have provisions for incoming telephone calls.

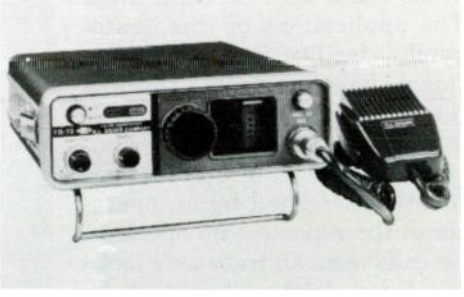


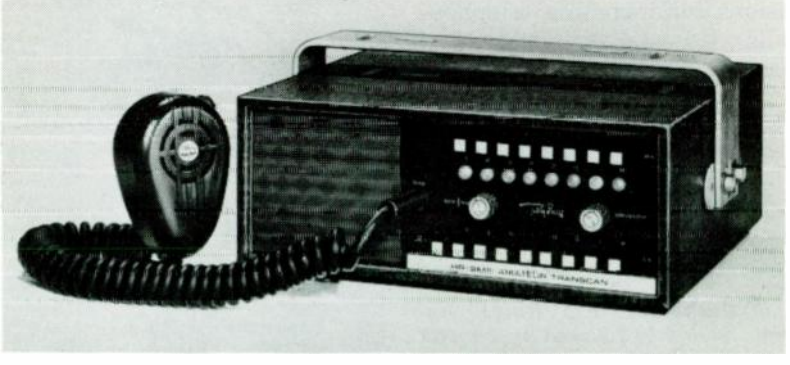
This Cushcraft "FM Ringo" antenna is widely favored by 2-meter operators because it is only 36 inches long, easily tuned by an adjustable top section, and mounts readily on TV-antenna mast sections.



This Cushcraft "Power Pack," containing 22 elements, is a highly directional beam that appeals to experimenters who want to learn how far they can work on 2-meter FM with the minimum of power.

With an output of 10 watts, the Drake TR-72 is suitable for either fixed station or mobile use. Covers 23 channels.





The Regency Amateur Transcan automatically scans any combination of 8 channels, locks on and listens, waits for a return signal, and resumes scan if no signal is received. Operates on 12-volts DC or 115-volts AC with optional power supply. Power output is 15 watts.

13

Electronics as a Career

Many young men take up ham radio as a hobby and become so engrossed in it that they decide to make electronics their life work. This is a smart move, because the electronics industry in its multiple ramifications offers almost unlimited opportunities to serious, diligent workers.

HOBBY INTO BUSINESS

Former and present hams are scattered throughout every level of the radio business: management, engineering, manufacturing, merchandising, advertising, television and sound broadcasting, and servicing. The history of the art is full of the names of hams who made good in a big way. Major Edwin H. Armstrong, whose invention of the regenerative, superregenerative, and superheterodyne circuits and of FM broadcasting easily rates him the title as "Radio's No. 1 Wizard," always spoke proudly of his pioneer amateur station of 1906 in which he started his famous research. Allen B. DuMont, whose name is synonomous with television and the development of the cathode-ray tube, was an active ham in the late 1920's while he was an engineer with various radio firms. The huge organization that he started was the direct outgrowth of a modest laboratory-shop he had in the basement of his home in Upper Montclair, N.J., in 1931. Sound broadcasting as we know it today had its beginnings in 1920 with 8XK, a ham station in the back yard garage of Frank Conrad in Wilkinsburg, Pa. This modest "shack" grew into KDKA—the station that made the United States aware of the new miracle of radio.

Conrad eventually became assistant chief engineer of the Westinghouse company, and at his death was mourned as the "father of broadcasting." The great Marconi himself, the man who literally electrified the world at the turn of the century by sending a radio signal across the Atlantic, was scarcely 20 years old

when he undertook his "wireless" experiments with odds and ends of equipment, just as many an aspiring ham does today!

HAM INTO ENGINEER

How does a ham become something more than a ham, career-wise? For a young man—or young woman for that matter—whose objective is engineering, the way is very clear: After graduation from high school, a sojourn of four years at a recognized college offering a bachelor of science degree, preferably in electrical engineering. The various courses offered by colleges

These three men are hams, but they are also highly trained field engineers who keep Raytheon's complicated radar systems around the world in working order. The shack belongs to "Pops" Karentz, W1YLB, center. At left is George Lucas, W1ZYS; at the right, Ray Churchill, W1BVI.

throughout the country are listed in their catalogs, which are obtainable upon request; they are also available in local high schools or public libraries. The catalogs show entrance requirements, tuition fees, etc.

For many years, college instruction in "electrical engineering" was devoted largely to power engineering, with little attention given to anything beyond 60-hertz AC. Today, however, a student can elect to take a great deal of communications-electronics in his junior and senior years. After graduation with a basic B.S. degree, he can take advanced courses in electronics at universities having

modern laboratories and other facilities. If his money, his eyesight, and his girl friend don't disappear along the way, he can work up to the degree of master of science (M.S.) or doctor of science (D. Sc.) and earn the right to be addressed as "Doctor Whoozis" in academic and engineering circles.

Oddly enough in spite of the size of the electronics industry and the great number of engineers occupied in it, there is no such thing as a degree in either "radio engineering" or "electronic engineering."

ENGINEERS VS. TECHNICIANS

By commonly accepted standards, an *engineer* is a college-trained B.S. (or better) who can undertake original design or research on components, materials, circuits, and complete pieces of equipment. While a degree is no guarantee of anything other than the fact that its holder got through school, it is the primary basis for selection of engineering employees by all radio-electronics firms.

There are thousands of men who are graduates of good vocational high schools, of military electronics schools, of private commercial schools specializing in electronics, and of the hard school of experience. Many of them know more about the practical side of radio than the holders of three degrees. Regardless of their background, they are not engineers; instead, they are classified as technicians. This is a broad term, but in the eyes of executives it distinguishes these men from the college group. For example, a help-wanted advertisement in the Proceedings of the Institute of Radio Engineers specifically reads: "Engineers—E.E. graduate with 3 years experience. Technicians—2 years technical school in communications and 3 years experience."

Technicians are in great demand for responsible jobs in factories, laboratories, sales organizations, radio and TV stations, service shops, etc. Some men are so competent that they are often called "engineers without degrees." However, make no mistake about it: on the pay, recognition, and social levels, technicians definitely rate below full-fledged engineers.

Many skilled technicians are entirely self-taught. A man can start as a ham at the age of 15 or 16. By studying the excellent "amateur handbooks" available for a few dollars and accumulating intensely valuable experience with receivers, transmitters, test equipment, etc., he often is a real "expert" by the time he reaches voting age. He probably has more savvy at this point than a college student of the same age just getting his degree. However, his lack of formal "book larnin" shows up painfully when the going

gets really rough. For example, he may be able to assemble, install, and repair a very complicated piece of equipment like a radar set, but he's lost if he tries to interpret certain readings. Radar is a matter of angles in space, and a man must know advanced trigonometry pretty thoroughly to solve the problems. Here is where an engineer steps in and earns his keep. He is able to solve it because he has had trig and a dozen other forms of difficult math drummed into his head all during his college work. It is generally conceded that mathematics is the dividing line between the true engineer and the technician. The slide rule is the symbol of the engineer, the soldering iron of the technician.

Some personnel executives are of the opinion that the emphasis on math in many colleges is too great, and at the expense of practical training in the laboratory, shop, or field. This tendency is probably the result of industry's demand for brainy characters who can use the higher forms of math to solve the fantastically complex questions that arise in connection with guided missiles, radar, telemetering, computing machines, color television, etc. This work is so advanced that engineers who took their degrees ten or fifteen years ago find themselves unable to cope with it. To keep their jobs, they take refresher courses at night, quietly and without telling anyone about it.

TECHNICIAN TRAINING

As a ham, you have picked up a fair working knowledge of equipment; now you want to advance into the professional side of radio. Suppose you can't afford to go to college, or feel that you are too old to start. Is there still a worthwhile career for you ahead? Most definitely, yes. There are excellent resident schools in several sections of the country where you can get concentrated, short-term instruction in one or several phases of electronics, up to almost the full engineering level. Upon completion of the course or courses, you are fully qualified to work as a service technician, factory-test man, field-installation man, radio-station attendant, etc. If you like to get around and have had any previous experience in selling, you will find large opportunities in the technical sales field. If foreign travel appeals to you, you'll be snapped up in an instant for installation, maintenance, and instruction work on American-made electronic equipment sold for both military and civilian purposes to numerous countries.

If you can't get away from home to attend an out-of-town school, you can do very well with correspondence courses. Many of the independent service technicians now in business got their training by mail, and good training it is. The lessons are carefully

organized into small units, and you can do them as slowly or as quickly as your learning ability permits. With most courses you receive actual equipment that you assemble and wire and then use for actual testing and measuring applications.

One very important feature of correspondence training is financial. You can pay for most courses as you go along, instead of having to dig into the family savings for a big chunk of money all at once. Many students of servicing courses pay them off with money they earn applying the lessons almost as soon as they complete them.

Even the correspondence courses can be pursued to a high level. You can take so much math and advanced theory that you finish up as a "practical engineer."

CAREER SWITCHING

Some men who take up ham radio as a hobby switch to electronics as a business even though they are well along in years and have been earning their living in completely unrelated activities. They usually prepare themselves for their new careers by taking correspondence courses or attending night school. The reason for these changeovers is simply the excitement, glamor, and prospects that the electronics industry offers. In spite of the startling developments in television, radar, two-way communications, etc., in recent years, the immediate future promises even more.

Highly successful shifts have been made by the most unlikely people. Files of most schools bulge with testimonials from ham students who have made good and are happier in their new vocations than they ever were in their old. The author knows personally of a stock broker who became service head of a large radio manufacturer; a furrier who now runs a prosperous high-fidelity sound business; a clothing salesman who is now purchasing agent for a radio distributor; a lawyer who is now a high-ranking electronics officer in the Navy; a retired brigadier general of the Regular Army who runs an appliance store; and a policeman who now specializes in auto-radio installations.

HAMS WHO HAVE MADE GOOD

Wherever you go in the electronic field, you are sure to find hams. An astonishing number of heads of firms maintain their calls and are active on the air.

For instance, there is Albert Kahn, K4FW, founder of Electro-Voice, Inc., for many years an outstanding manufacturer of microphones, speakers, and various high-fidelity sound components. Al

is now president of Ten-Tec, Inc., which specializes in inexpensive ham equipment for beginners. You'd think he gets enough radio during his normal working day, but that doesn't keep him from enjoying a hobby he has pursued since 1918. He runs a full kilowatt station down in Sevierville, Tenn., and has a well-deserved reputation as a fast man with a telegraph key.

Another "brass pounder" is Russell McFall, W3JAB. Appropriately enough, he is president of the Western Union Telegraph Company!

Albert Kahn, K4FW, president of Ten-Tec, Inc., at the controls of his ham station. With his right hand, he is operating an electronic keyer, which makes dots and dashes semi-automatically.

Another ham who has made good is William J. Halligan, founder of the Hallicrafters Company of Chicago. He was an active ham at the age of 14, and a licensed commercial operator at 16. He served as a brass pounder in the Navy in World War I, attended West Point for three years, and resigned to get married. He was a radio writer for a Boston newspaper and then a sales representative for various radio firms in Chicago.

During the depths of the depression in 1933, he started Hallicrafters with the object of providing hams with good receivers and transmitters at reasonable prices. The company had made a fine reputation for itself when World War II came along and skyrocketed its business to heights never dreamed possible. The production of high-grade amateur equipment was resumed at the end of the war.

William J. Halligan, W9AC, the founder of the Hallicrafters Co.

Bill has retired from the company, and divides his time between Illinois and Florida. He is still active on the air as W9AC.

Other hams who are or were presidents of the companies listed are:

Arthur Collins, WØCXX—Collins Radio Co.
Parker S. Gates, W9DZT—Gates Radio Co.
Barrie R. Barker, W3DGP—Barker & Williamson, Inc.
Herbert Johnson, W6QKI—Atlas Radio Co.
William Harrison, W2AVA—Harrison Radio Co.
James Millen, W1HRX—James Millen Mfg. Co.

On the engineering, laboratory, installation, and service levels there are more hams than you can count. Some men who let their licenses lapse years ago are still very much hams in spirit, and do

a considerable amount of short-wave listening even if they are prevented by circumstances from operating transmitters.

WHAT INDUSTRY THINKS OF HAM RADIO

Statements for this book have been made by three very prominent people in the electronics industry in the following paragraphs.

Arthur A. Collins, WØCXX, founder of Collins Radio Co., states:

"Many of the leading engineers in the communications field today trace their interest back to their first ham activities and attribute valuable experience to this pursuit. It is perhaps significant that a large number of persons like myself who spend our whole work-days in an atmosphere of radio and electronics still turn to amateur radio as a rewarding, as well as relaxing, activity during our leisure hours."

Dr. L. R. Fink, formerly Manager of Engineering, Radio and Television Department, General Electric Company, states:

"Ham radio is probably the most useful hobby for a young man who plans to make a career in the electronics industry. Many of our leading engineers got their introduction to electronics through

their experiences as hams. The construction, maintenance, and operation of a ham rig gives a man valuable experience in trouble-shooting and electronic circuitry. It also gives him confidence, which means a definite edge over fellows without this experience.

"Many men who are classed as engineering assistants or lab technicians in our development laboratories find their day-to-day

Dr. L. R. Fink, Radio and Television Department, General Electric Co.

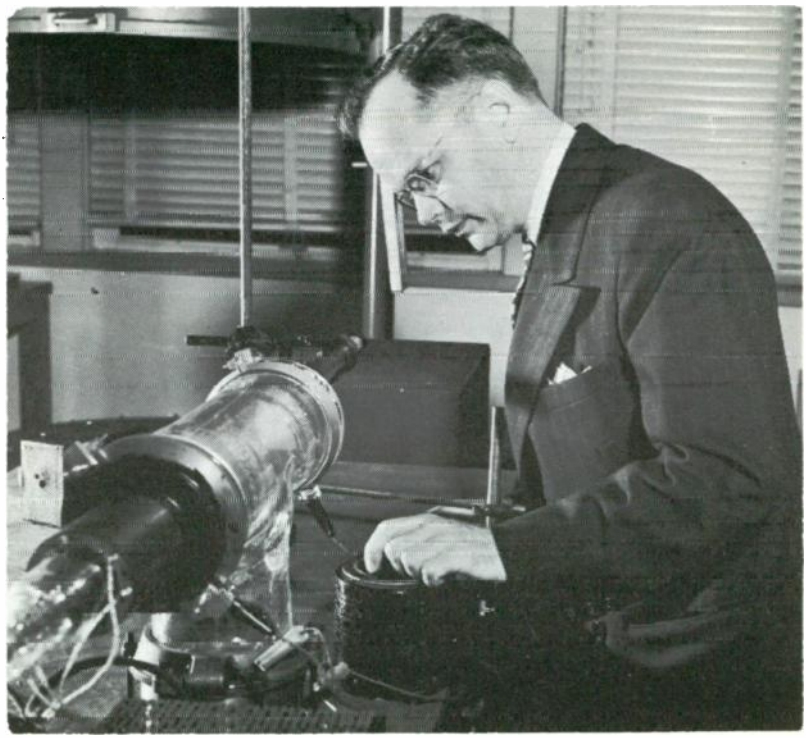
work gives them the same challenge and the same pride of accomplishment that they used to get from tinkering with their ham rigs. Some of our engineers whose administrative responsibilities keep them at a desk, find particular satisfaction in poking a hot soldering iron into their rigs at home.

"A vital part in the production of thousands of television sets is the troubleshooting of those which fail to pass regulation tests at the end of the assembly lines. Ham training is excellent background for these troubleshooters."

Dr. Elmer W. Engstron, retired president of RCA Corporation has this to say about the amateur radio hobby:

"Amateur radio is, in my opinion, an excellent foundation for the young man who intends to follow one of the numerous

branches of electronics as a career. Certainly the knowledge of electron tubes, circuits, and measuring instruments which he acquires while pursuing his hobby, should provide a good background for his later studies in college or vocational school. Rosters of radio firms almost invariably reveal one or more engineers,



Dr. Elmer W. Engstrom, retired president of the RCA Corporation.

designers, or sales representatives whose first interest in electronics was acquired through the assembly and operation of a ham station."

ELECTRONICS SCHOOLS

A complete listing of schools other than standard colleges and universities that offer specialized training in electronics in its various phases can be obtained from either *National Association of Trade and Technical Schools, or National Home Study Council*, 2021 L Street N.W., Washington, D.C., 20036. A letter addressed to either institution will assure you of the latest up-to-date catalog of resident or correspondence schools.

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The Radio Marketplace

Ham equipment is not sold by the same dealers who handle television and radio sets, but by merchants who are known in the trade as "electronic parts distributors," or "jobbers." Most of them carry large stocks of electronic components of all kinds, which are purchased by service technicians, students, experimenters, schools, and industrial firms, as well as amateurs. In some large population centers, there are dealers who specialize exclusively in ham gear.

To locate a source of supply near you, the first thing to do is consult the Yellow Pages of the local telephone directory. Look under "Radio Supplies and Parts"; this listing may be followed by the notation "Wholesale & Manufacturers" or Retail Outlets." Also look under "Radio." By making a couple of phone calls, you'll quickly find a store anxious to serve you. Practically all amateur equipment suppliers employ hams on their sales staff, and these men can be of great assistance to a newcomer.

Some of the larger radio distributors issue annual catalogs. Many of these run to several hundred pages, are veritable encyclopedias, and are well worth having. Check the advertising columns of any of the ham and electronics magazines for the names and addresses of firms that offer free catalogs.

Shortly after you qualify for your ham ticket, you will probably start to receive catalogs and literature by the boxfuls. The names and addresses of new licensees are a matter of public record, and are used by enterprising firms to obtain new customers.

HOW TO BUY

Except when the catalog specifically states "prepaid," published prices do not include the cost of shipping merchandise directly to the customer. Hams sometimes misunderstand this practice, but it is standard in the field. Obviously, if a jobber's store is within convenient distance, you can save money by shopping in person.

Many jobbers stay open one or more evenings a week to accommodate buyers who can't get away from their jobs during the day.

Small packages are sent most economically by parcel post, while large items must go by motor freight or express. Because of his experience in these matters, let the jobber recommend the method of shipment best suited for your merchandise and for your location in relation to his warehouse. There may be some charges for insurance and Federal taxes on shipping, but these are usually only minor.

TIME PAYMENTS

After reading the descriptive copy in catalogs, you may readily take a shine to some very fancy—and also very expensive—ham gear. The fact that you do not have all the ready cash may not lessen your infatuation. It might be welcome news to you, therefore, that practically all jobbers sell merchandise on credit. Banks and finance companies handle the transactions just as they do in the case of cars, houses, boats, etc.

Used gear at bargain prices is available at most dealers. This scene is the showroom of a typical large electronics supply house.

USED EQUIPMENT

There is a vast turnover of equipment among hams as they graduate from one type of station to another or as their interests change. Many jobbers have excellent bargains in "trade-ins." The classified advertising columns of the ham magazines are also full of tempting offers to sell or swap.

As a hobby, ham radio seems to be closely related to shooting and photography. It is interesting to read the classified ads and to note that receivers, transmitters, rifles, pistols, cameras, and enlargers are always for sale or wanted.

Index

So you want to be a Ham

Seventh Edition

Modern radiocommunications is one of the most fascinating technological advancements of our time. It has played a major role in making the world appear smaller than it is. An amateur radio operator, using only a small amount of power, can talk to fellow hams in distant countries. What better way is there to learn more about the world than to talk to someone who lives in another country thousands of miles away?

This book has been written for those who would like to become a part of this interesting hobby. It contains all of the information necessary to become a ham radio operator. This includes the requirements for the various types of licenses, how to obtain the license, discussions of the various types of equipment available, and proper ham radio operating procedures.

The seventh edition of *So You Want To Be A Ham* has been revised and updated to cover the most recent ham radio equipment and the latest licensing regulations. It has been written for the prospective ham by an active ham and, most important, in the language of the ham.

Robert Hertzberg was only 15 years old when he received his amateur license on December 17, 1919. The next day, using a buzzer transmitter and a crystal receiver, he worked his first station. It was only two blocks away, but he has never forgotten the thrill that it gave him. Over the years that followed, his equipment has progressed from crude spark to sophisticated sideband, and to this day he gets a kick out of every new contact, local or DX.

While in college, Bob received $5.00 from an early radio magazine for the description of a homemade code-practice oscillator. Almost immediately, he turned his interests toward tecanical journalism. During a busy career as both editor and writer, he has authored more than thirty books and countless magazine articles.

In the late 1920s, he helped organize and promote the Army Amateur Radio System. This led to a commission in the Army Reserves, to five years of active duty during Wold War II, and to eventual retirement as a Colonel.

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