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The FUN of HAM RADIO

Join the world-wide fraternity of Amateur Radio operators. What you need to know to become a Ham. Tells about receivers, transmitters, and antennas. How to learn the International Morse code.

The FUN of HAM RADIO

by Robert Hertzberg, W2DJJ

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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 means to arouse interest in people who may have heard of ham radio, but know little about how to get going in the field.

All the phases of ham radio are explained in this volume—from the various types of licenses, and the requirements and procedures for obtaining them, to painless methods for learning the code. Chapters are devoted to receivers, transmitters, transceivers, and auxiliary equipment. Kit equipment is covered and its advantages and disadvantages are explained. Different types of antennas are shown—both fixed and mobile types.

In addition, such subjects as operating procedures, the organizations of amateur-radio hobbyists, and where to purchase equipment are included. The chapter on electronics as a career will be of particular value to young men.

Here's hoping that this book will arouse your interest to the point where you will soon start the process of obtaining a license.

Here's to happy QSO's and lots of DX.

ROBERT HERTZBERG, W2DJJ

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CHAPTER 1

THE INTERNATIONAL FRATERNITY

With a good shortwave receiver, you can readily tune in what is undoubtedly the largest nonprivate communication network in the world. This is operated by *radio amateurs*, not for pay or profit, but for service to the public, for the advancement of electronics, and for the thrill of direct conversation with other amateurs in all walks of life in every corner of the globe.

After your first few minutes at the dials, you will probably ask, "Why do these people call themselves *hams?* This doesn't sound very elegant." The origin of the term is a complete mystery. What is definite, though, is that amateur radio operators *always* refer to themselves as hams, and the hobby they pursue is always *ham radio*. Only a rank outsider uses the more formal expression.

SITTING IN ON THE WORLD

The appeal of ham radio is universal and knows no limitations of age, background, or status. The common denominator is an interest in the complicated equipment used for receiving and transmitting and the desire to *work DX*—that is, to communicate over great distances. In the course of a day's tuning, you are quite likely to hear a retired Army general, a high-school student, a

one-time United States senator and presidential aspirant, a housewife, a building janitor, a royal head of state, a physician, an overseas GI, and a business executive, all addressing each other by their first names. In fact, the first thing a ham does when he establishes contact

Richard M. Jones, of Bellwood, Ill., is typical of the bright, keen teenagers who find ham radio an instructive as well as interesting hobby. He was only 12 when he qualified for an FCC license and was issued the identification call WN9LLS. He was coached by his father, who is K9ZNZ.

with another ham is to say, "The handle here is Barry," or whatever his name happens to be. "Handle" is merely ham lingo for "name."

Hams do not broadcast music or any other form of entertainment, and they do not compete with any commercial communication system. They talk only to each other, in pairs, or in groups. The latter group conversations are often called *round-robins*. The fact that anyone with a suitable receiver can hear what's going on

does not change the essentially personal nature of their conversations.

Hams who have been active on the air for as long as half a century still get a big kick out of working DX. There is something almost supernatural about sitting in your own "shack" (that is, radio station), and talking with fellow hams one thousand or several thousand miles away.

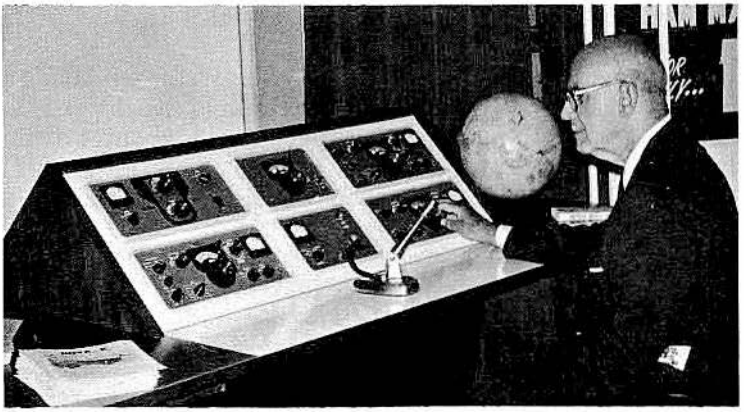
Ham operation is more than mere conversation. Years ago, learned scientists said that the short radio waves were useless, but avid ham experimenters showed how they could be developed and put to practical application. The pioneering work of these experimenters made possible today's television, radar, and scores of assorted communication services.

In their modest way, without subsidies of any kind, hams continue to contribute to the art of communications. They even participate in the fantastic space program by building special ham satellites, which are carried aloft by space vehicles of the U. S. Air Force. Called *Oscars,* these satellites weigh only about 35 pounds. A particularly successful one was Oscar III, which received ham transmissions on one frequency and automatically retransmitted them on another. Hurtling high over the earth, it bounced signals into areas that previously could not be reached with conventional transmissions.

SERVICE IN EMERGENCIES

Ham radio's lack of privacy is an asset rather than a liability. In an emergency, a call for help, no matter how distant, is almost sure to be picked up by someone. Every year, the lives of critically ill people in remote places are saved, because hams are able to relay urgent requests for special medicines to the sources of supply. The international airlines cooperate in this praiseworthy effort.

During domestic disasters, such as storms, floods, fires, earthquakes, etc., hams generally furnish most of the communications for the relief agencies. Using their own equipment and working long hours, their only rewards



In this attractive arrangement, the units of a powerful ham station are mounted at an angle for comfortable observation and adjustment. The gear is made by Collins, and is being operated here by George Bailey, W2KH.

are citations from mayors or governors and the satisfaction of performing a vital public service.

So important and effective is this work that the Federal government sponsors the *Radio Amateur Civil Emergency Service,* better known as *RACES,* which is intended to provide auxiliary communications for civil-defense purposes in time of war.

HAMS ARE LICENSED

The right to own and operate amateur stations is granted to their citizens by most countries of the world, in accordance with international agreements, which are modified every few years to meet changing conditions. In the United States the responsible agency is the *Federal Communications Commission (FCC),* which establishes all ham regulations and issues all "tickets," as licenses are known. In most other countries this is a function of the post-office departments. Ham operation is even permitted in the Soviet Union, where private privileges of any kind tend to be rare.

An ordinary desk makes a convenient operating table for Neil Mishalof, WA2HVR, of Seaford, N. Y. The "On-the-Air" sign lights up automatically when Neil actuates the transmitter and is a hint to visitors that they should be quiet while he speaks. The cards on the wall are confirmation of contacts he has made in many parts of the world.

THE ASSIGNED BANDS

If operators of various types of radio stations chose their own settings for their transmitters, mutual interference would make communication extremely difficult. This was actually the situation in 1912, when the government was forced to step in and police the rapidly growing army of both commercial ship-to-shore and amateur installations. Today, the settings or *frequencies* of all classes of transmitters are assigned by the FCC. Should an operator purposely or inadvertently step out of line, the legitimate users of the frequencies he blocks will complain promptly and loudly.

The terms "frequency" and "wavelength" are two ways of specifying the same location of a transmitter on the air. Frequency is the rate at which complete cycles of alternating current are produced, and is stated as *cycles per second* (*cps*) or in short form merely as cycles. Radio transmission requires rather high frequen-

cies, so it is more convenient to use larger units such as the *kilocycle* (*kc*) for 1000 cycles, and the *megacycle* (*mc*) for one million cycles. Thus, the frequency of 7,250,000 cycles can be expressed as 7250 kc or 7.250 mc.

The lower the frequency of an alternating current, the longer the spacing or time interval between the successive up and down points of the current; the higher the frequency, the shorter is the spacing. This distance is called the *wavelength*. Because the speed of radio waves is known to be 300,000,000 meters per second, it is quite easy to convert from one measurement to the other. For all radio work, dial settings are now invariably given in terms of frequency, so conversion from frequency to wavelength is more frequently required than the reverse. Simply divide the speed of the radio waves by the frequency and the answer is the wavelength in meters. For example: The wavelength equivalent to 30 mc is 300,000,000 divided by 30,000,000, or 10 meters.

Hams use wavelength to identify most of their assigned operating bands in general terms. For example, the lowest band in common use runs from 3.500 to 4.000 mc and is usually called "80 meters." Actually, the spread is from 75 to 85.7 meters. The bands open to most United States hams (see Chapter 5) are as follows:

Wavelength Band in Meters	*Frequency in Megacycles*
160	1.8 to 2
80	3.5 to 4
40	7 to 7.3
20	14 to 14.35
15	21 to 21.45
10	28 to 29.7
6	50 to 54
2	144 to 148

Above 148 mc the bands are specified more accurately by their frequency rather than by their wavelength. The

following are devoted mainly to short-range experimental work rather than to "rag chewing," the term for ordinary conversation. All figures are in megacycles: 220 to 225; 420 to 450; 1215 to 1300; 2300 to 2450; 3300 to 3500; 5650 to 5925; 10,000 to 10,500; 21,000 to 22,000; and everything above 40,000. The last five or six bands require highly specialized equipment and are not of much practical use—at least not now. The same thing was said about 1500 kc years ago when hams were told they had to stay above this frequency, and look at the state of the shortwave art today!

Most of the ham bands are far removed in terms of frequency from public radio services, such as the following:

A-m Broadcasting—535 to 1605 kc.
Maritime Mobile—2000 to 2035 kc.
TV Channels 2, 3 and 4—55.25 to 71.75 mc.
TV Channels 5 and 6—77.25 to 87.75 mc.
F-m Broadcasting—88.1 to 107.9 mc.
TV Channels 7, 8, 9, 10, 11, 12, and 13—175.25 to 215.75 mc.

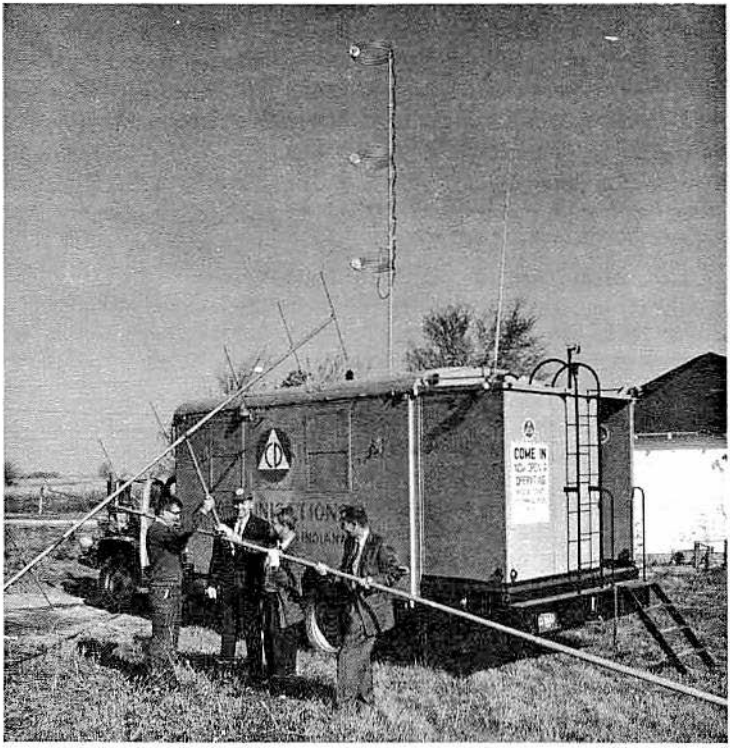
The nearest ham band to the a-m broadcast band is 1.8–2 mc, but this is not used very widely and in fact most ham receivers and transmitters don't even tune to it. TV Channel 2 is a bit close to the 50-54 mc band, so to avoid possible interference in TV receivers in areas served by a channel 2 station many hams stay off this frequency during evening hours.

PHONE VERSUS CODE

The word "conversation" appears all through this chapter, and in its usual sense means the exchange of spoken words. This is called "phone" operation. However, not all hams use it. Many prefer the dits and dahs of the International Morse Code, for several reasons: (1) it is a lot more fun than talking, which they can do any time, and it represents a new skill; (2) the transmitters for the purpose are much simpler and cheaper

than those required for phone, and (3) the signals are much less susceptible to interference, and, in effect, carry much greater distance than phone for the same power.

Hams never refer to this second type of operation as code; they always call it *cw*. This is the abbreviation for



The Civil Defense Organization of Madison County, Ind., uses this large truck as its mobile communications center. It is manned entirely by local hams, who are directed by Charles R. Jones, K9TZJ, of Anderson, Ind. Here some of the boys are erecting the knock-down antennas for 2 and 6 meters. The inside of the van, a converted Army photographic vehicle, contains several complete ham stations, an air conditioner and a coffee maker. A separate gasoline-engine driven a-c generator makes the station completely independent of outside power lines, which are out of commission in most disasters.

continuous waves, which describes the kind of signal sent out by the transmitter. Beginners in the ham game would do well to start with a simple c-w rig (transmitter), and work up to phone as they acquire technical and operating know-how.

CHAPTER 2

THE RECEIVERS USED BY HAMS

After listening to ham stations on a friend's receiver you will undoubtedly start to think of acquiring one of your own. If you visit a dealer in amateur supplies, or thumb through a ham catalog, you will probably be confused by the variety of available equipment and by its price range. Here is some information that may help you to make up your mind.

A do it-yourself receiver with the professional look, the Knight-Kit R-100A. This covers 540 kc through 30 mc, with calibrated bandspread on 10, 15, 20, 40, and 80 meters. A printed-circuit board minimizes the need for critical alignment after assembly.

BUILD OR BUY

If you have had some experience in electronic construction, perhaps with a hi-fi amplifier or a vacuum-tube voltmeter, you might consider building your own receiver from one of several kits on the market. However, multiband shortwave sets are not particularly easy projects. They contain a considerable number of critical controls, which really cannot be adjusted prop-

Here is an excellent 12-tube ham-band receiver incorporating many features, the Lafayette HA-350. In addition to covering the usual five bands (10, 15, 20, 40, and 80 meters), it has a position for the reception of WWV, the Bureau of Standards station that transmits calibrating signals.

erly without the aid of a test instrument called a *signal generator*. Because of variations in home-done wiring, even many factory preadjusted items require careful touching up.

To get a quick start in the ham game, it is usually a better idea to buy a standard factory-made receiver and to save your construction efforts for a transmitter, or several transmitters. You will never run out of combinations of tubes and circuits to try on the air. A curious thing about amateur radio equipment is that transmitters

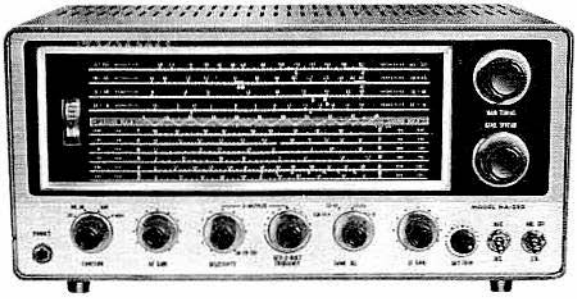
are generally easier to put together *and to adjust* than receivers, although the mere word "transmitters" gives some people the idea of complication and difficulty. With a reliable receiver at your disposal, you can have all the live code practice you want any time you turn it on, and you can familiarize yourself with ham operating practices and lingo as you listen.

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 measurement 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 that is 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 ones have as many as a dozen knobs and dials, all of which affect 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 major elements of receiver design.



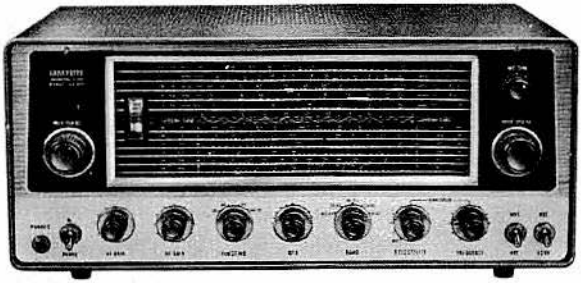
Available in either assembled or kit form, the Lafayette HA-230 is an 8-tube general-coverage set under $100. There are bandspread scales for the ham bands, and a logging scale for casual shortwave listening is included.

SENSITIVITY

Sensitivity is the ability of a receiver to pick up signals. A set is said to have a high order of sensitivity if it brings in weak stations. The terms *sensitivity, amplification,* and *gain* all mean the same thing and are used synonymously.

It is relatively easy to achieve very high gain by using a string of tubes or transistors as amplifiers. The first tube or transistor gives the signal a little boost, the second peps it up some more, and so on along the line. Some combinations of amplifiers are so sensitive that they respond to very faint electron movements within tubes and transistors in exactly the same way that they do to legitimate radio signals; that is, they amplify them, and the audible result in the set's speaker is a mixture of the desired radio signals and a background of unwanted circuit noise. For this reason, figures intended to show how much amplification a receiver possesses do not mean very

The Lafayette HA-63 is a modestly-priced 7-tube general-coverage receiver for the novice. A good feature is electrical bandspread on all frequencies, from 550 kc through 30 mc.



The Lafayette HA-225 is a professional quality 14-tube set with a somewhat unusual frequency range in five bands: 150-400 kc, 1.6-4.8 mc, 4.8-14.5 mc, 10.5-30 mc, 48-54 mc. There are separate bandspread scales for the ham bands, and a crystal calibrator assures accuracy of settings.

much unless they are qualified on the basis of how little internal noise the set generates at the same time.

The useful sensitivity of ham receivers is generally stated as the strength of a signal at the input connections needed to give a signal-plus-noise output at the speaker or earphones at a standard ratio above the noise output alone. The strength figure is in microvolts (millionths of a volt) and the smaller it is the better the expected performance of the set. The ratio is expressed generally as 10 db (db meaning *decibels*), a standard engineering unit for the measurement of sound intensities. There are other technical considerations in the calculation of sensitivity, but the microvolt number is at least a starting point.

You have to take manufacturers' claims at their face value, because you have no way of checking them. Typical figures may run from 0.1 to 1.0 microvolt. These do not necessarily indicate that one set is ten times "better" than another. They might merely mean that different manufacturers use different measuring equipment under different conditions, or they might mean that the figures

come from the manufacturers' advertising departments rather than the engineering departments.

SELECTIVITY

Because of the great number of ham stations on the air, receiver sensitivity is really less important than receiver selectivity. This characteristic can be defined as the ability to separate signals on closely adjacent frequencies. A set with a high degree of selectivity is said to be "sharp," or to "tune sharply." A set with a low degree is "broad," or it "tunes broadly."

In some receivers the selectivity is adjustable, from relative broadness to needle-point sharpness, to suit par-

For operation on 6 meters, Herbert F. Holtje, W2TQS, of Tenafly, N. J., uses the "Li'l Lulu" receiver, the small unit in the center of the photo above his call letters. He is adjusting the controls of the matching "Li'l Lulu" transmitter. These are products of Whippany Labs., Inc., West Caldwell, N. J. For the other ham bands, Bert has a Hammarlund HQ-150 receiver (far left) and a Johnson Ranger transmitter (under his right hand).

ticular operating conditions. A little broadness is often desirable; for instance, when you want to listen to two stations on very slightly different frequencies. If the receiver is fixed only for maximum selectivity, you may have to rock the tuning dial back and forth a fraction of a degree to keep up with the two transmitters.

Selectivity cannot be expressed in simple terms. A true picture of performance is given only in a curve that shows the relative response of the receiver at frequencies above and below the one to which the dial is set.

FREEDOM FROM DRIFT

In receivers using conventional tubes, the fairly large amount of heat generated by the latter can cause a minor problem known as *drifting*. When a cold set is turned on, stations are heard at certain settings of the dial. As the chassis warms up, it is usually necessary to retune slightly as capacitors, tube elements and other parts expand or change shape minutely. Some receivers settle down to complete stability in a few minutes; others might take as long as half an hour. In some sets, the filaments

High mechanical, electrical, and thermal stability are features of the Drake R-4. While this is essentially a ham-band receiver, the use of additional crystals extends the frequency range to include Citizens band, military, marine, and shortwave broadcasting stations. A 100-kc crystal calibrator is built in.

of two or three important tubes, or a separate chassis heater, stay warm all the time the line cord is connected, although the main switch of the equipment is off. These measures minimize drift time.

Heat is less of a problem in sets using transistors and other solid-state devices, because these have no filaments. However, audio power transistors do get appreciably warm, so they are usually mounted in ribbed metal pans, called *heat sinks*, to promote dissipation of excess thermal energy. This measure is intended more to protect the transistors themselves against internal damage than to reduce drift.

It is entirely possible for transmitters to drift in frequency for exactly the same reasons given for receivers. If some signals that you hear on the air vary, while others do not, you can be pretty sure that your receiver is not at fault.

SPREADING OUT THE DIAL

Practically all shortwave receivers include a feature known as *bandspreading*. This is an electrical or mechanical method of spreading sections of the tuning dial over a greater area so as to facilitate selection of a particular frequency. There is no way of separating two stations on the very same frequency* but bandspreading does help in most other circumstances.

Since all shortwave tuning tends to be fussy, because of the crowded conditions on most bands, the tuning controls themselves must be silky to the touch and absolutely free of backlash. In normal tuning procedure, you first hear a signal faintly or perhaps in distorted form. You turn the dial farther until it seems to peak, and you go a little beyond this to make sure further adjustment doesn't help. Then you turn the dial back to the previous peak spot. If the tuning mechanism binds or jerks, even in the slightest degree, you may lose the signal altogether as you jockey the dial.

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*Except when the single-sideband method of transmission is used.

A basic, low-priced ham-band receiver in kit form, the Heathkit HR-10 is a favorite with Novice and Technician license holders. Available as an accessory is a crystal calibrator that gives accurate check points every 100 kc on the scales.

TYPES OF RECEIVERS

There are two distinct types of ham communications receivers, the *general-coverage* or *all-wave* and the *ham-bands only*. The frequency range of the first is extremely wide. It usually starts at 540 kc (the bottom of the regular a-m broadcast band) and runs upward without gaps to about 30 mc, 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 assortment of other shortwave services. In some sets, separate bandspread scales are provided for the ham bands; in others, any portion of any band can be spread out for easier tuning. The big feature of the 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, and maritime bands, and on the domestic and international broadcasting channels.

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

This professional-looking receiver was made from a kit. It is the Heathkit SB-300, a ham-band job for the more advanced amateur whose primary interest is single-sideband operation. It takes in the usual 10- through 80-meter bands, and it also includes provisions for the simple plug-in addition of converters for 2 and 6 meters.

Choosing between the two types of receivers is a personal matter. Probably the best idea is to start with a modestly priced general-coverage job and to add the very best ham-band model you can afford at a later date. Don't under any circumstances discard the first receiver when you buy the second; the two supplement each other and keep you in touch with the entire world.

Operating requirements on 2 and 6 meters differ from those on the other bands. Many hams favor entirely independent receivers and transmitters for these bands, or combination 2- and 6-meter units. Others find it more economical to use "outboard" converters ahead of their

The Clegg "Interceptor B," a product of Squires-Sanders, Inc., is a dual conversion 50-54 mc (6 meter) receiver, with a self-contained crystal-controlled converter for 144-148 mc (2 meters). It is designed for reception of a-m, c-w and single-sideband signals.

regular receivers, if the latter lend themselves to the purpose—many do not. The major trouble with the conversion method is that the receiver tends to pick up signals on the conversion frequency; these constitute interference with the injected 2- or 6-meter signals.

RECEIVER ACCESSORIES

Many communication receivers do not have built-in speakers. This is no great handicap, as a small, inexpensive speaker is entirely adequate for the reproduction of c-w and voice signals. As a matter of fact, many hams do not use speakers at all, but prefer earphones. These offer two important advantages: (1) They are much more sensitive than speakers, and by putting weak signals directly into the listener's ear they enable him to read cw or voice that would otherwise be undecipherable. (2) They give the operator complete privacy and enable him

The Squires-Sanders SS-1R is a high-performance receiver designed especially for the 10- through 80-meter ham bands. A slide-rule type of dial tells the operator precisely what frequency he is tuning. The reading is a combination of the nearest 100 kc of the band, plus a digital display that appears in a little window at the lower right corner of the dial plate.

to use his equipment without disturbing other members of the family. In ham lingo earphones are usually called cans because early models were large and cumbersome and looked like cans.

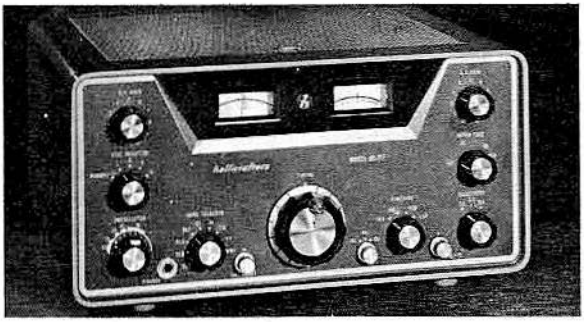
SELECTING A RECEIVER

By answering advertisements in the ham magazines, you can quickly accumulate a large pile of free literature, which you can drool over in your spare time between practicing the code and studying circuitry. Some of the dealer catalogs contain more the 500 pages, and are very instructive to a beginner in electronics, because they help to acquaint him with numerous receivers and transmitters, and with hundreds of accessories.

In the ham field, price is a very good basis for comparing various types and makes of equipment. Even if you don't understand all the technical terms used for describing receiver characteristics, you will find that competing manufacturers' specifications for sets in the same price class are almost identical. Regardless of make, the more money you are willing to spend the more you will obtain

The Hammarlund HQ-100A is a revised version of the famous HQ-100. One of the stand-out features of this receiver is the "Auto-Response" circuit, which makes possible a complete range of audio output, from the sharp response required in communications work, to the broad response necessary to high-fidelity broadcast reception.

in sensitivity, selectivity, ease of operation, etc. Once you fix a price limit, your choice of a set will probably be determined by its overall appearance.



The SX-117 receiver is a triple conversion ssb/cw/am receiver which can tune from 85 kc through 30 mc by the insertion of the proper crystals, and the use of the HA-10, low-frequency tuner. It contains a product detector for ssb and cw and an "envelope" detector for a-m reception.

Most dealer catalogs lump equipment by manufacturer rather than by price. Since the latter is such an important factor, the author has rearranged the listings of representative models in several ranges, for your guidance.

General Coverage—Up to $50

Only four sets in this low-price area are on the general market, and they are all simple kits that can be put together in an evening by anyone who can use a soldering iron and a screwdriver. However, only one is a modern *superheterodyne,* while the others are of the obsolete *regenerative* type, usually and unfavorably referred to as "squealers."

While these receivers do bring in signals, their selectivity especially is altogether inadequate for practical ham purposes. They are very poor investments for prospective operators who intend to obtain licenses and go on the air.

General Coverage—$50 to $100

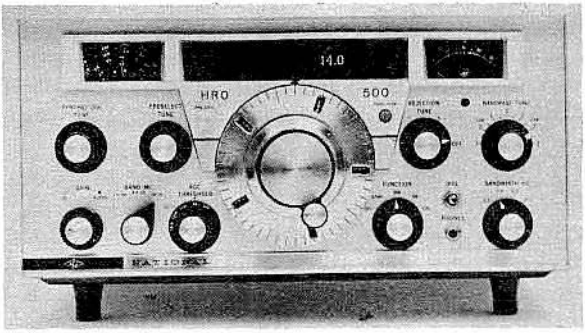
Any of the sets in this class represent a modest beginning in ham reception. They use from five to nine tubes, start at the broadcast band and go up to about 30 mc, have good bandspread, and contain enough circuits to assure respectable selectivity.

General Coverage—$100 to $200

Here we get into the real "communications" receiver class, with such features as adjustable selectivity, accurately calibrated bandspread scales for the ham frequencies, multiple tuned circuits, ten tubes, specific provision for single-sideband reception, noise limiter, etc. Many hams of modest means get along very well for years with sets of this caliber.

General Coverage—$200 Up

This is the luxury class, embodying features and refinements beyond those of the preceding group. The num-



Using a total of 57 solid-state devices and covering the enormous tuning range of 5 kc to 30 mc, the National HRO-500 is probably the most sophisticated communications receiver available to the public. It tunes sixty segments, each 500 kc wide, with identical dial calibration throughout. The dial itself is direct reading.

ber of tubes runs to sixteen or more, with accompanying improvement in sensitivity, selectivity, stability, etc. Sets of this type are virtually lifetime investments.

The National HRO-500, at a price in four figures, is special. It contains no tubes at all, but instead uses 37 transistors and 20 other solid-state devices.

Ham-Band-Only Receivers

Even in this category there is a wide price range. Experienced hams tend to favor the models at the upper end of the scale. These generally have such high reputations that they cost almost as much secondhand as they do new, which is a very good indication of their quality.

General Coverage—Up to $50

Knight-Kit Ocean Hopper	$39.95	Knight-Kit Span Master	24.95
Lafayette Explor-Air	22.95	Knight-Kit Star Roamer	39.95

General Coverage—$50 to $100

Knight-Kit R-55-A	$59.95	Lafayette HA-230	89.50
Lafayette HA-63	64.50	Knight-Kit R-100-A	99.95
Hallicrafters S-120	69.50	Hallicrafters S-118	99.95
National NC-77X	69.95		

General Coverage—$100 to $200

Hallicrafters SX-140K (kit)	$114.95	Hallicrafters SX-110	169.50
Lafayette HA-225	139.50	Hammarlund H-100A	189.00
National NC-121	139.95	National NC-140	189.95

General Coverage—$200 Up

Hammarlund HQ-100AC	$209.00	Hallicrafters SX-62	430.00
National NC-190	239.95	Hammarlund HQ-180A	449.00
Hammarlund HQ-145XC	289.00	National HRO-500	1500.00
Hallicrafters SX-122	295.00		

Ham-Bands-Only

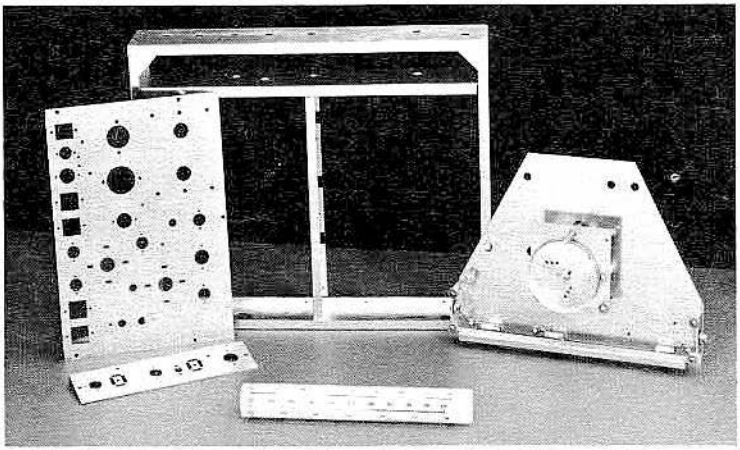
Heathkit HR-10	$ 79.95	Drake R-4	379.95
Hallicrafters SX-140	114.95	Hammarlund HQ-170A-VHF	419.00
Lafayette HA-350	189.50	Clegg Interceptor (2/6 meters)	495.00
Li'l Lulu (6 meters)	250.00	Collins 75S-3B	620.00
Heathkit SB-300	265.00	Squires-Sanders SS-1R	895.00
Hammarlund HQ-110A-VHF	299.00		
Hallicrafters SX-117	379.50		

CHAPTER 3

THE TRANSMITTERS USED BY HAMS

You might think that for every receiver there would be a matching transmitter. Some manufacturers do offer paired units, but by the actual count they make a greater variety of transmitters than of receivers.

If you bought a factory-built receiver, as recommended in Chapter 2, you should by all means build your own



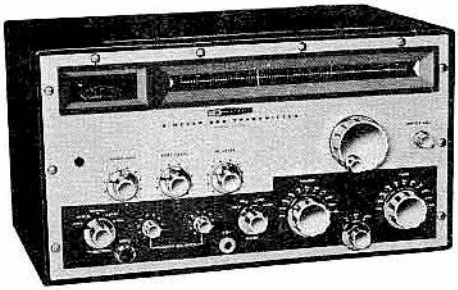
This is why kits are popular. The heavy metal parts are preformed and prepunched in a manner that cannot be duplicated in most home workshops.

The kit builder is now free to devote his time to doing the important electrical part of the construction. In sight are just some of the components of a Heathkit transmitter.

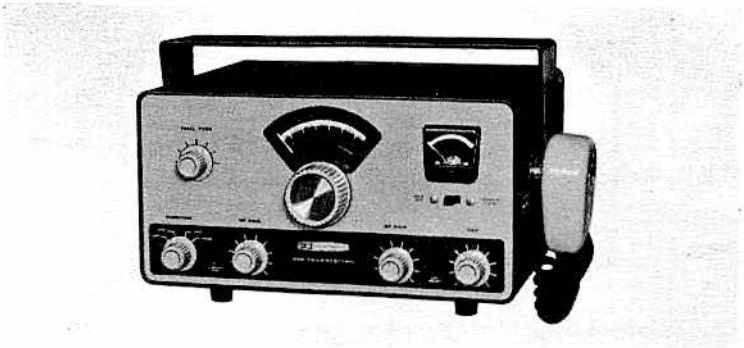
Popularly known as the "Benton Harbor Lunch Boxes," the Heathkit HW-30 for 2 meters and the HW129A for 6 meters are lightweight, low-power transceivers widely favored by hams for short-distance voice communication. A-c power supply is built-in; 12-volt supply for car use is a separate accessory.

The Heathkit DX-60 is a general-utility cw/am-phone transmitter, rated at 90 watts. It has four positions for crystal control, and provision for connection of an outboard variable-frequency oscillator (vfo).

first transmitter from a kit. The assembly work is great fun and requires only hand tools. You learn how to solder, how to identify various components, how to understand and follow diagrams, and how to align circuits. The experience is of inestimable value in preparing you for the license examination, because the latter deals more with transmitters than with receivers. This is to be expected;



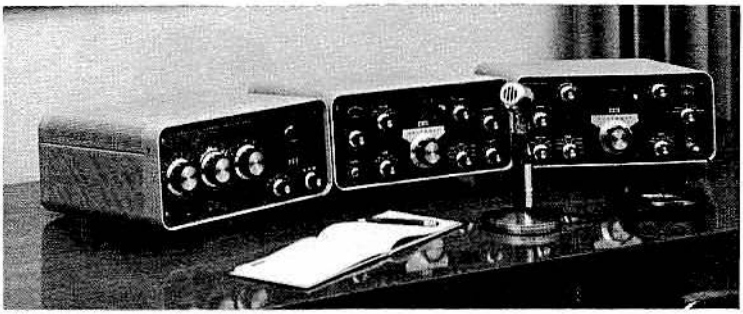
An advanced ssb transmitter for 6 meters only, the Heathkit HX-30 will appeal to hams who like to concentrate on this interesting band. Large slide-rule dial gives accurate frequency readings.



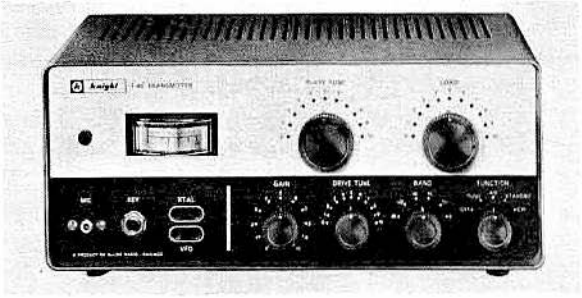
The Heathkit "Single-Bander" transceivers are made for 20, 40, and 80 meters individually. In the absence of complex switches, the construction and assembly are unusually easy. These sets represent an economical approach to ssb.

a misadjusted receiver does no one any harm, but an off-tune transmitter can cause serious and widespread interference.

Kits are highly popular for several good reasons: (1) The preformed and prepunched chassis, panel, and other hardware save a great deal of difficult metalworking. (2) The builder is left free to concentrate on the much



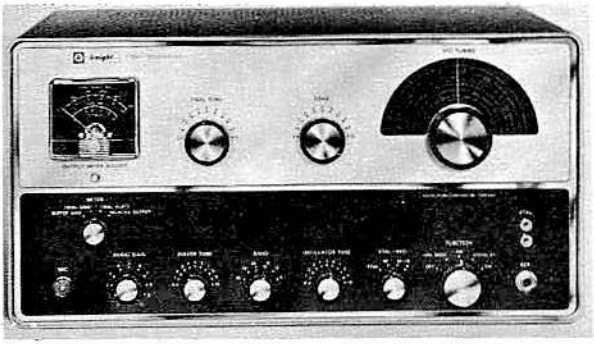
This line-up of professional-looking equipment was made from three matching Heathkits: (left to right) SB-200 linear amplifier, SB-300 receiver, and SB-400 transmitter. A deluxe ssb station that you build yourself.



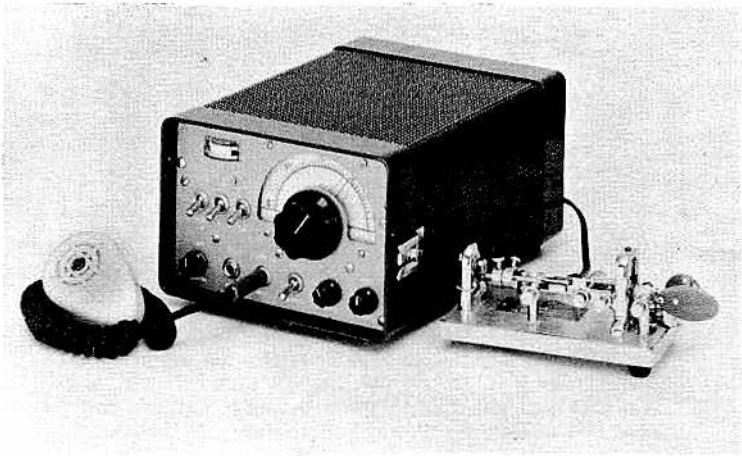
Intended specifically for the Novice, but a good second rig for old-timers too, the Knight-Kit T-60 is a reliable 60-watt am/cw transmitter at a low price.

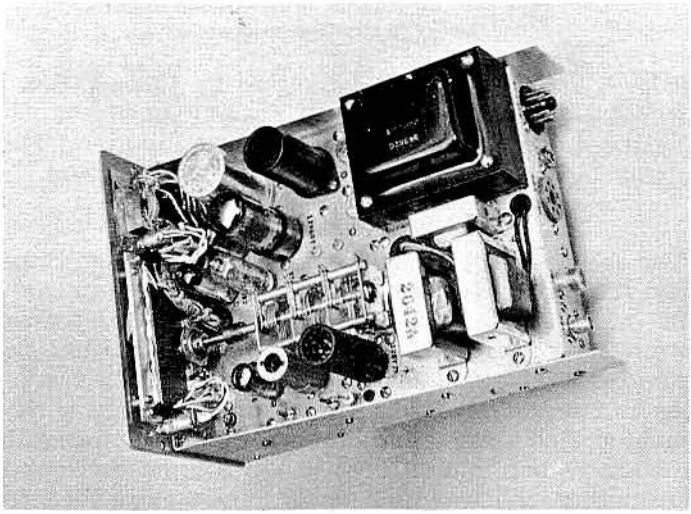
more important job of wiring the parts and becoming familiar with the circuitry. (3) If the instructions are followed, the finished unit is sure to work. (4) The sets have an attractive professional air. (5) If the time involved is not counted, there is a considerable saving in cost.

Some of the simpler kits can be put together in an evening, others can easily take a whole winter of evenings. The basic transmitters are made for cw, but they

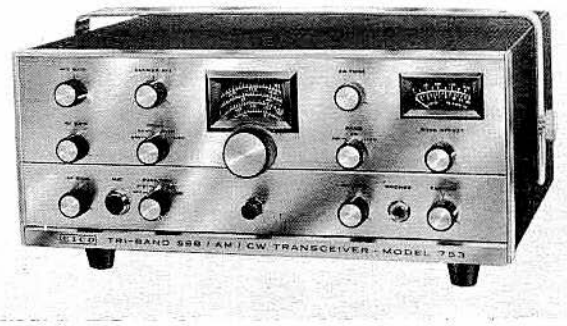


The Knight-Kit T-150A transmitter covers six bands on cw and a-m phone, has a built-in variable-frequency oscillator, an a-c power supply, and punches out a strong 150-watt signal.





The "Li'l Lulu" is an unusually compact 6-meter am/cw transmitter. Built in depth rather than width, it mounts inconspicuously under the dash of a car, or on a shelf at home. The integral power supply works on 12 volts dc or 117 volts ac. Key on the right is a "Vibroplex," used by speedy operators. Power, antenna, and receiver connections to "Li'l Lulu" are all made on back apron of chassis.



The Eico Tri-Band Model 753 is a 180-watt ssb transmitter taking in the 20, 40, and 80 meter bands, is available as a kit or factory-wired, and is suitable for fixed and mobile use. Power supplies are not included. An interesting feature is an offset receiver-tuning control that permits a 10-kc shift without disturbing frequency in the transmit mode.

can be adapted for phone operation by the addition of external *modulators,* which are nothing more than big audio amplifiers very much like those used in high-fidelity systems. Most sets have a-m phone facilities built in.

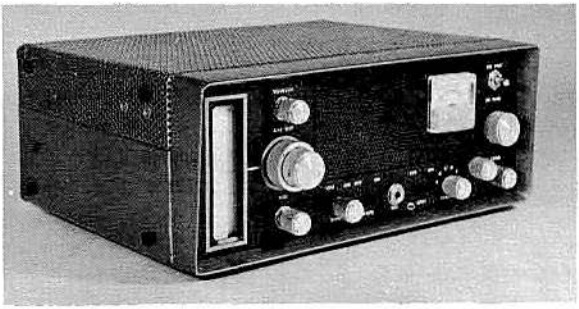
SSB—WHAT IT MEANS

The letters *ssb* appear frequently in ham literature. They stand for *single sideband,* an advanced form of voice modulation that minimizes interference between stations and therefore makes for better transmission. Under some circumstances, it actually permits two stations to operate on exactly the same frequency without jamming each other. The circuits that accomplish this trick are rather complicated, so ssb equipment for both transmission and reception tends to cost more than conventional a-m (amplitude-modulated) sets.

As a beginner, you should start with low-power cw, add a-m phone as you become more experienced, and then graduate to ssb after a year or so. Single-sideband theory is quite complex, and you really need a good technical background to grasp it.

Main units on the desk of a neat ham shack in a corner are matching Collins 75S-3 ssb receiver (left) and 32S-1 transmitter, (right). Built-up shelf holds Heathkit 2-meter transceiver (left), power supply and speaker for Collins gear, antenna indicator, and a Heathkit monitor scope. This is the home station of the author of this book.

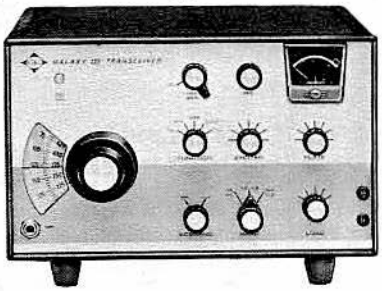
Operating on ssb, am, and cw, the Gonset "Sidewinder" 2 is a versatile 2-meter transceiver for mobile or fixed use. Separate transistorized power supplies latch on to the back of the chassis to form a neat package, or can be connected remotely. Receiver section is all-transistor; transmitter section uses mixture of transistors and tubes.



Available in 2- and 6-meter models, the Gonset Communicator IV is an a-m transceiver of long reputation. It is mostly transistorized, and has a built-in convertible 12/117-volt power supply for mobile or fixed operation.

TRANSCEIVERS

Separate transmitters and receivers provide maximum operating flexibility. However, with the development of transistors and other tiny solid-state devices suitable for communications equipment, there is a growing trend toward the use of *transceivers*. This term is applied to units that employ the same circuit elements for both transmitting and receiving; the changeover is made by a multipole relay actuated by a button on the operator's microphone. Transceivers are used almost entirely for phone rather than c-w purposes. They are extremely compact compared to equivalent transmitter/receiver



"Galaxy III" and "Galaxy V" are similar ssb/cw transceivers; the first covers 20, 40, and 80 meters, the second 10, 15, 20, 40, and 80. Rated at 300 watts. With proper external power supply, suitable for fixed and mobile service.

The Drake T-4X is fixed-station ssb/am/cw transmitter, rated at 200 watts; four bands, 15, 20, 40, and 80 meters separate a-c power supply is required.

combinations, and lend themselves conveniently to fixed-station, portable, or mobile application. Some of them have dual-purpose power supplies that work just as well on a car's storage battery as from an a-c outlet.

TRANSMITTER PRICE RANGE

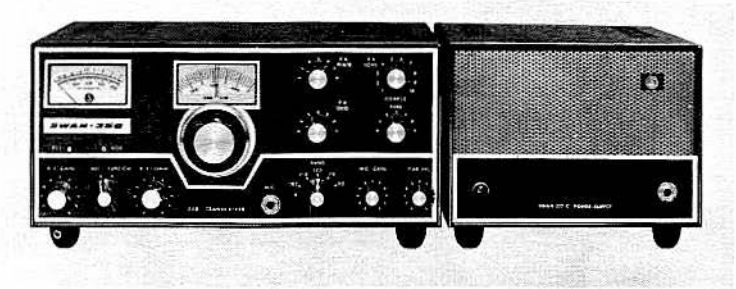
As in the case of receivers, you get just about what you pay for in transmitters. The holder of a Novice license who wants to make only a minimum initial investment can spend as little as $20 for the Ameco AC-1T kit, which uses two tubes and is rated at the low power of 15 watts. The components of this transmitter are in open sight on the top of a chassis about the size of a cigar box, without front panel or cabinet. The set doesn't look very impressive, but with the proper antenna it enables the builder to make c-w contacts with hundreds of hams near and far.

In the price bracket from $50 to $100 there are straight c-w transmitter kits of 50, 60, and 90 watts, and several

A rugged sideband transceiver rated at 300 watts, the Drake TR-3 takes in the bands from 10 through 80 meters. Intended for fixed-station use, with a husky external power supply.

that include a-m phone as well as cw. They have nice panels and cabinets and present a neat appearance. One in this group is the Knight-Kit T-150A, rated at a power of 150 watts and tuning 6, 10, 15, 20, 40, and 80 meters.

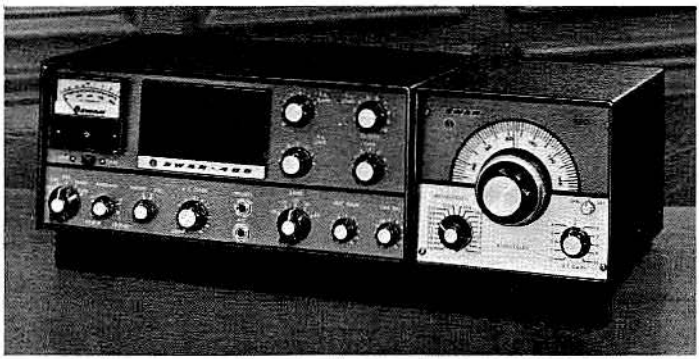
Completely self-contained, including speaker and dual-voltage power supply, the Sideband Engineers SB-34 is so compact that it really can be carried by the handle on its side. Mostly transistorized, it is rated at 135 watts, and covers 15, 20, 40, and 80 meters. Plug in a microphone, an antenna, and a power connection and it is on the air.



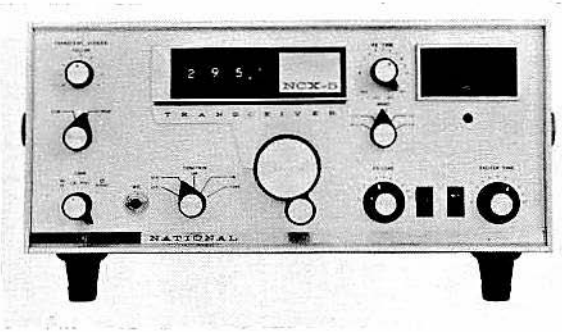
A five-band ssb transceiver rated at a powerful 400 watts, the Swan-350 lends itself to either mobile or home use, with the appropriate power supply. Photo shows the a-c unit (right). Circuit is partially transistorized, for battery economy.

Above $100, the kits become more elaborate and the circuitry more sophisticated. For example, the Heathkit HX-10 has both ssb and a-m phone in addition to cw. Its wiring and adjustment require a fair amount of previous construction experience on the part of the builder.

Some firms market transmitters and transceivers in both kit and factory-wired forms. It is illuminating to compare the respective prices. The factory sets cost as much as 40% more than the kits themselves, which is one reason why many hams prefer to "roll their own."



The Swan-400 is a 400-watt ssb transceiver with built-in speaker, but a separate vfo; the latter is transistorized.



This handsome transceiver, with its direct digital readout dial, is the National NCX-5. It is rated at 200 watts for ssb and cw, and 100 watts for am. Power supply and speaker are not included.

Manufactured transceivers are all fairly high-priced because of the large amount of hand wiring required by the transmit-receiver changeover facilities. This doesn't seem to discourage prospective buyers. Probably the most widely heard-of ssb rig is the Collins KWM-2, with a price well up in four figures! This transceiver is widely used as either a mobile or home-station rig.

The Clegg "Venus" is a deluxe ssb transceiver for 6 meters. It is rated at 85 watts, and works also on am and cw. Power supply and speaker are outboard accessories.

THE MATTER OF POWER

The average power rating of the transmitters listed in the accompanying charts is about 150 watts. There are no single-unit transmitters in either kit or manufactured form rated at the FCC's legal maximum of 1000 watts. Most hams start with the lower power, and later, if they have the money and if the power lines in the house can

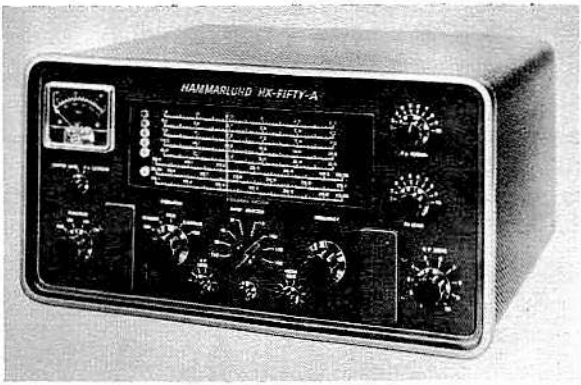
The Clegg Zeus is a special 2-band a-m transmitter, putting out 185 watts on 2 and 6 meters. The modulator and power-supply sections are in a separate cabinet, which can be put out of the way on a shelf.

stand the extra load, they add *linear* amplifiers that boost the signals to the "full gallon" limit. Prices of linears run as high as $1800.

Power by itself poses special problems in most residential communities, and it takes an advanced ham to handle them to the satisfaction of himself and his neighbors. In most cases it is smarter to spend the extra money on improved antennas rather than on more watts.

TRANSMITTER ACCESSORIES

Transmitters are generally sold without such necessities as keys, microphones and crystals. These are all



The Hammarlund HX-50A is rated at 200 watts P. E. P. ssb input and covers all amateur bands from 80 to 10 meters. There is also a built-in provision for radioteletype.

available in a wide choice, as you can tell by checking dealers' catalogs. There are numerous other accessories that can be piled on the operating table: variable-frequency oscillators, monitor scopes, electronic keyers, antenna tuners, interference filters, cooling fans, etc. Ham radio is a veritable paradise for chronic gadgeteers.

Transmitter Kits

Ameco AC-1T (cw)	$ 19.95
Knight-Kit T-60 (am/cw)	49.95
Eico 723 (cw)	59.95 ($89.95 wired)
Viking Adventurer (cw)	69.95
Heathkit DX-60 (am/cw)	79.95
Eico 720 (cw)	89.95 ($129.95 wired)
Hallicrafters HT-40 (am/cw)	89.95 ($109.95 wired)
Knight-Kit T-150A (am/cw)	99.95
Viking Challenger (cw)	124.75 ($169.75 wired)
Heathkit VHF-1 (am/cw, 2 & 6 m)	179.95
Heathkit HX-30 (ssb, 6 m)	189.95
Heathkit HX-20 (ssb mobile)	199.95
Viking Ranger II (am/cw)	249.50 ($395.50 wired)
Heathkit SB-300 (ssb/cw)	325.00
Heathkit HX-10 (ssb/am/cw)	334.95
Viking Valiant II (am/cw)	375.00 ($495.00 wired)

The Hallicrafters HT-44 is a phasing-type am/cw/ssb transmitter which operates transceive or independently with the SX-117 receiver. The coverage is 80 through 10 meters.

Transceiver Kits

Heathkit HW-29, HW-30 (am, 2 or 6 m)	44.95
Heathkit HW-12 (ssb, one band)	119.95
Eico 753 Tri-Band (ssb/am/cw)	179.50 ($299.95 wired)
Heathkit HW-10, HW-20 (am, 2 or 6 m)	199.95

Transmitters

Ameco TX-62 (am/cw, 2 & 6 m)	$146.95
Li'L Lulu (am, 6 m)	225.00
Drake T-4X (am/cw)	369.95
Hallicrafters HT-44 (ssb/am/cw)	395.00
Hammarlund HX-50 (ssb/cw)	449.00
Collins 32S-1 (ssb/cw)	750.00

The Hallicrafters SR-150 is an 80- through 10-meter transceiver for fixed/portable/mobile operation on ssb/cw. Input power on ssb is 150 watts P. E. P.; 125 watts on cw.

Transceivers for 10-80 Meters (All SSB)

Hallicrafters SR-160	$ 349.50
Galaxy III	349.95
National NCX-3	369.50
Swan 400	395.00
Side Band Engineers SB-34	395.00
Swan 350	395.00
Galaxy V	469.95
Drake TR-3	550.00
National NCX-5	685.00
Collins KWM-2	1250.00

Transceivers for 2 and 6 Meters

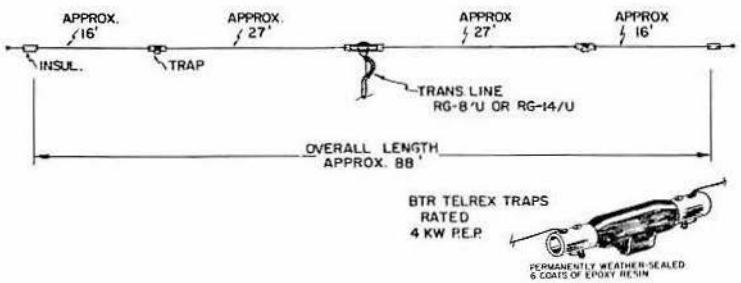
Lafayette HE-45B (6 m)	$119.95
Clegg 99'er (6 m)	179.00
Hallicrafters SR-46 (6 m)	179.95
Clegg 22'er (2 m)	239.50
Clegg Thor VI (6 m)	260.00
Polycomm 6 (6 m)	329.50
Polycomm 2 (2 m)	349.50
Gonset Communicator G-50 (6 m)	367.30
Gonset Sidewinder 900A (ssb, 2 m)	399.50
Gonset Sidewinder 910A (ssb, 6 m)	399.50
Gonset Communicator IV (2 or 6 m)	409.95
Clegg Venus VI (6 m)	495.00

CHAPTER 4

HAM ANTENNAS

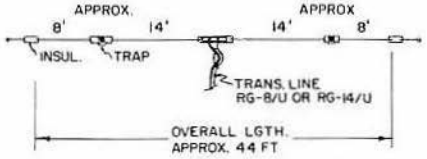
For the most effective reception and transmission of the short waves, the *antenna* (or *aerial*) should be of a specific physical length for a particular operating frequency or wavelength. (The relationship between frequency and wavelength is described in Chapter 1.) For reception alone the dimensions are not really critical, but for transmission on most ham bands, they must be held to fairly close tolerances. In some respects an antenna can be likened to a piano or violin string, which vibrates at a high frequency ("pitch" is the musical term) if it is short, and at a lower pitch if it is long.

The basic ham antenna is a straight conductor cut to *half* of the wavelength figure. This is called a *dipole*. It



The Telrex Model BTR-48 antenna is an easily strung trap dipole for operation on both 40 and 80 meters. The use of traps reduces the normal length of about 130 feet to only 88 feet.

can be a stretch of ordinary wire supported at the ends, or a rigid tube or rod supported in the center. Why a *half* wave? Because this represents the time-distance of one alternation of the alternating-current cycle; the two alternations are identical except for polarity, and only one alternation occurs at a time. Such a wire possesses properties of inductance and capacitance, in distributed rather than concentrated form, and it can therefore be thought of as a conventional resonant circuit just like any of the combinations of coils and tuning capacitors in receivers and transmitters. In actual practice, these properties of an antenna are often affected by nearby con-



For 20 and 40 meters, the Telrex Model BTR-24 trap dipole is 44-feet long overall. Both this antenna and the BTR-48 are available as kits.

ductive objects, which may change the resonant frequency from the theoretical value based on the physical length alone.

It is easy to visualize the approximate lengths of dipoles. For the 2-meter band, for example, a half wave is only one meter long, or about three inches more than three feet. For 10 meters it is five meters long, or a bit over 16 feet. When we get to 80 meters, we find that the length has stretched to about 130 feet.

It is entirely possible to make a dipole much shorter than its fundamental half-wave length by inserting small, concentrated tuned circuits in it. Called "traps," they consist usually of a few turns of heavy wire, with or without small capacitors connected across them. When put into a dipole at certain distances, these traps offer a very important additional advantage: they permit the antenna to function independently on several wave-

Readily mounted on a chimney, the Cush Craft ground-plane antenna left is a vertical pole with two traps near the top. It works on 10, 15, and 20 meters. Three pairs of radials at the bottom also act as guy wires.

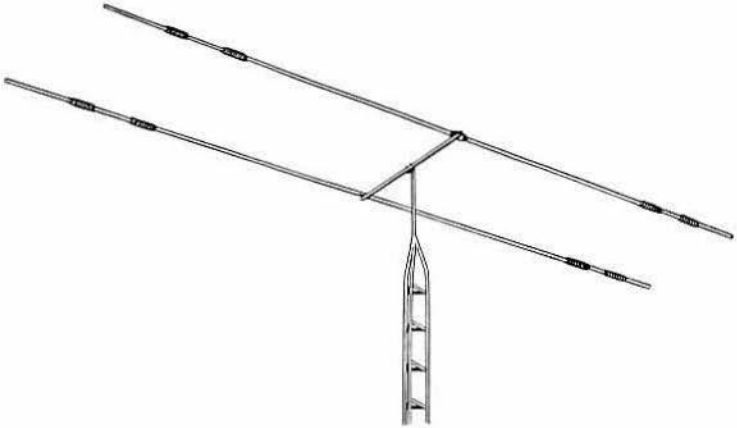
Fifty feet high, slim, and completely self-supporting, the Hy-Gain "Hy-Tower" is an unusual multiband vertical antenna. Without adjustment, it works equally well on 10, 15, 20, 40, and 80 meters.

lengths that are shorter than the fundamental. For example, a simple wire dipole only 88 feet long operates on both 40 and 80 meters with a trap connected 16 feet from each end. A dipole only 44 feet long works on both 20 and 40 meters with the traps 8 feet from the ends.

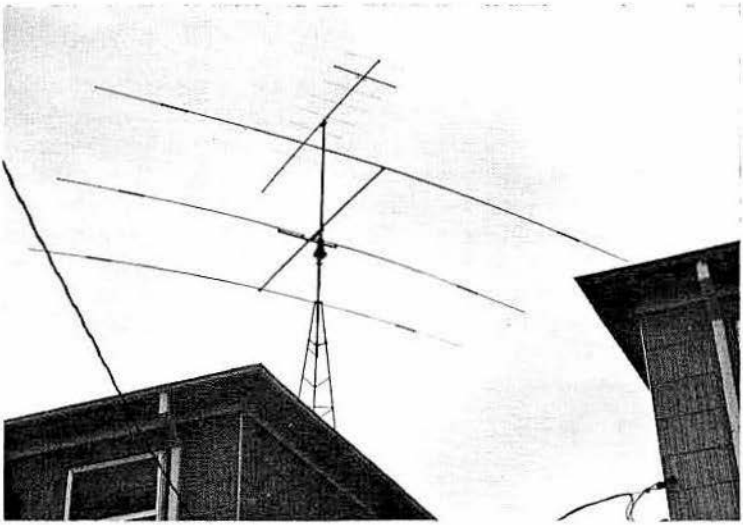
The antennas mentioned so far are all assumed to be horizontal affairs. However, the equivalent of a dipole can be had with a *vertical* conductor (invariably a rod or tube, for physical reasons) that is only one-quarter wavelength long; the other quarter-wave section is provided, in effect, by the ground or by several radial wires fanning out from the base of the structure. The same trapping principle can be applied, or a simple, straight rod can be designed for a single frequency. Vertical antennas, often called *ground planes*, are useful because they are light, inexpensive, unobtrusive, and easy to put up in limited space. They radiate energy uniformly in all horizontal directions.

DIRECTIONAL ANTENNAS

A dipole in free space tends to radiate better at right angles to its length than off its ends. With a basic half-wave element the effect is more theoretical than noticeable. However, the directional property can be enhanced greatly by the addition of one or several extra elements placed parallel to the radiating dipole and on both sides of it, but not usually connected to it. Their length and especially their spacing determine their effect on the signals radiated by the dipole, which, because it is connected to the transmitter, is called the *driven* element. The energy from the latter induces energy in the added elements, which are called *parasitic*, and these in turn reradiate it. Parastic elements that bounce the signals back toward the driven element are called *reflectors*, and those that radiate forward in step, or phase, are *directors*. Such an antenna is called a *beam*, and it is always mounted on a mast or tower with a rotator of some kind, so that the entire antenna assembly can be swung around in a horizontal circle.



This Hy-Gain Model TH-2 is a representative two-element, three-band trap antenna for 10, 15, and 20 meters.



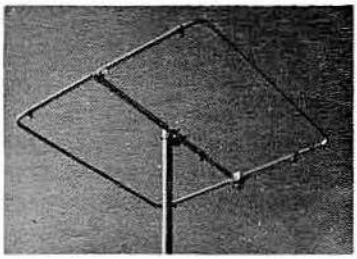
A very popular combination used by hams who like to work both local and DX stations. On a 15-foot three-legged tower bolted to the roof, is a Mosley TA-33 Jr. three-element trap beam for 2 meters. Rotator is just under the cross beam of the larger antenna.

The beam is by far the most popular type of ham antenna because the energy it funnels in the forward direction is greater than that radiated in the same direction by a bare dipole *with the same transmitter*. This increase is called the *gain* of the antenna.

Physical considerations are the only limit to the size of beam antennas. Because of its light weight, aluminum tubing is an obvious choice for the various elements. For 2 and 6 meters, it is common to find beams containing a dozen or more directors and reflectors in additon to the driven dpole. The most widely used beam of all is a three-element trap job, designed for 10, 15, and 20 meters, and having an overall length of 26 feet. This is still light enough to be handled by an inexpensive rotator made for TV antennas.

There are relatively few beams for 40 and 80 meters because their sizes make them difficult to erect. Anyway, at these wavelengths the directional action is less marked than on the other bands, so many hams revert to half-wave dipoles.

At the very short wavelengths below 2 meters (the ultrahigh frequencies), the required radiators are so small that it is practical to use them with bowl-shaped reflectors rather than with straight elements. The reflecting surface need not be solid; hardware cloth or ordinary metal screen material serves very well. With the driven element properly focused, such an antenna gives enormous gain, with virtually no energy lost to the rear. This is a great field for experimentation.

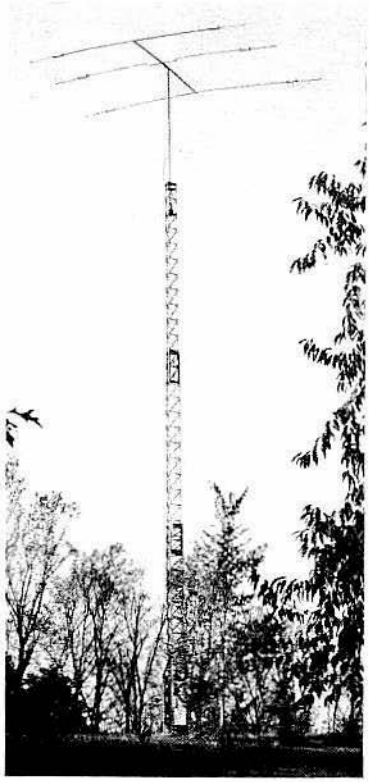


Cush Craft "Squalo" is a novel horizontal dipole in square format, and is completely omnidirectional; that is, it transmits equally well in all directions. The Model ASQ-6 for 6 meters is only 30 inches square and makes an ideal car-top antenna for mobile work. Other sizes range from 50 inches square for 10 meters to 192 inches for 40 meters.

All features of an antenna that make it effective for transmission also make it effective for reception. The directional quality of a beam is especially useful in strengthening signals from a desired direction while at the same time reducing unwanted signals from other directions. This is equivalent to improving both the sensitivity and the selectivity of the receiver.

FEEDING THE ANTENNA

The equipment of a ham station is in a room of the house; the antenna of necessity is outside, perhaps on the roof. How to hook them together? Virtually all trans-



Perched majestically on a tower 64 feet above the ground, this Mosley TA-33 "Trap-Master" three-element beam really puts out the signals for Edward J. Bock, WØEKT, of St. Louis, Mo. Tower is of the telescoping, fold-over type. Ed does not have to climb it to fix a loose wire.

mitters and receivers are designed to use *coaxial cable* (*coax*) for the purpose. This consists of an outer flexible shell of copper wire braid, usually tinned and covered with a weatherproof plastic; a single inner conductor of solid or stranded wire; and an insulating core of some plastic material. Coax for low-power transmitters is only about ¼ inch in diameter and can be snaked around corners and through small holes.

Many transmitters have built-in relays that switch the coax from the antenna between the receiving and transmitting units. These relays are also available as separate accessories.

CHAPTER 5

YOUR LICENSE TO OPERATE

By offering four different grades of licenses, the FCC encourages people with an interest in electronics to become hams and to go on the air with their own shortwave stations. In this connection, the first question prospective applicants usually ask is, "What is the age requirement?"

The answer is simple: "There isn't any."

With the coaching of parents who are themselves hams, many boys and girls in the subteens obtain their "tickets." Under the supervision of faculty advisers, members of junior and senior high-school radio clubs in large number qualify for licenses every year. By the time they get to college they are experienced operators, with technical backgrounds that prove to be extremely valuable if they pursue engineering courses.

At the other end of the age scale, there are many retired men and women who find ham radio a way of making new friends and opening up new horizons. These same opportunities make life bearable for the blind and the bedridden, for whom the FCC makes special provisions in its license regulations.

An official general-information bulletin that is well worth having is available free of charge from the Federal Communications Commission, Washington, D.C. 20554. Just ask for a copy of "Amateur Radio Service."

THE GENERAL CLASS LICENSE

The General Class license is by far the best one to have, because it gives the holder the maximum privileges in terms of frequency, power, and type of operation; it is therefore the license for which most newcomers apply. To

To his family he is Curtis R. Williams, but to his ham radio friends everywhere he is W5DTR. The major unit of his station in Little Rock, Ark., is a Collins KWM-2 transceiver, just behind his left shoulder. The large unit on the right end of the shelf, above the table, is a separate receiver. A crack operator, W5DTR favors cw over phone.

obtain one, you must appear *in person* at an FCC office or temporary examination point, fill out a simple application form, and pay a filing fee of $4.00, preferably in the form of a check or money order made out to the Federal Communications Commission. You will then be seated at a small table, given a pair of earphones, and told to copy some clear text material sent in the International Morse Code by a machine adjusted to a speed

of 65 characters per minute. This is equivalent for purposes of the test to 13 words per minute. The transmission runs for five minutes, but here is a cheerful note: You pass if you transcribe *any one-minute* portion correctly. Instead of starting to scribble nervously the moment you hear the signals, you can afford to listen for a little while and get into the swing of the automatic keying. Then when you start to copy you will be relaxed and confident.

The FCC examiner will gather up your paper quickly and check it. If you flunk, you're finished, temporarily. Your money is not refunded, but you can return in 30 days, pay another $4.00, and try again, and again, and again! If you pass, the examiner will listen for a few moments to your sending with a telegraph key, and then he will hand you the written part of the test.

This written test actually requires very little writing, as the questions are of the multiple-choice type. All you have to do is mark a pencil line under a letter that represents one of five possible answers for each question. The test deals with the technical operation of ham equipment and with FCC rules and regulations. These subjects are covered in detail in many "license manuals," which are quite similar to the review booklets used in schools. The manuals are available from all dealers in ham supplies.

Some of the questions are fairly easy, and you can almost guess the right answers; others require that you really know the subject.

The examiner will check your written test and notify you on the spot if you pass or fail. Even if you pass, you are due for a small disappointment. Your license is not issued at the examining point, but instead will be sent to you by mail from the FCC's central license bureau in Gettysburg, Penna. This may take several weeks. The General ticket runs for a period of five years and is renewable repeatedly, so in effect it is a lifetime document.

The permanent regional offices of the FCC are listed in the free bulletin "Amateur Radio Service." Temporary offices are set up in various other areas, in accordance

with schedules published in the ham magazines. Before traveling to an FCC office, check in advance by telephone or mail to make sure it can take you. In telephone directories, look for the FCC listing under *United States Government*. You are not required to take your General examination at the FCC office nearest you; you can take it at any one at all.

Generals may use cw in all of the bands listed in Chapter 1, and they may also use phone, facsimile, and television in certain sections of them. You read that correctly—television! This takes some fancy equipment, but there are actually hams on the air who see each other while they converse.

Except on one or two extremely high frequencies and on several low frequencies in certain parts of the country, Generals are permitted a maximum transmitter power of 1000 watts. Popularly known as a "full gallon," this is quite high for ham purposes, and most operators manage to circle the globe with much less.

THE CONDITIONAL CLASS LICENSE

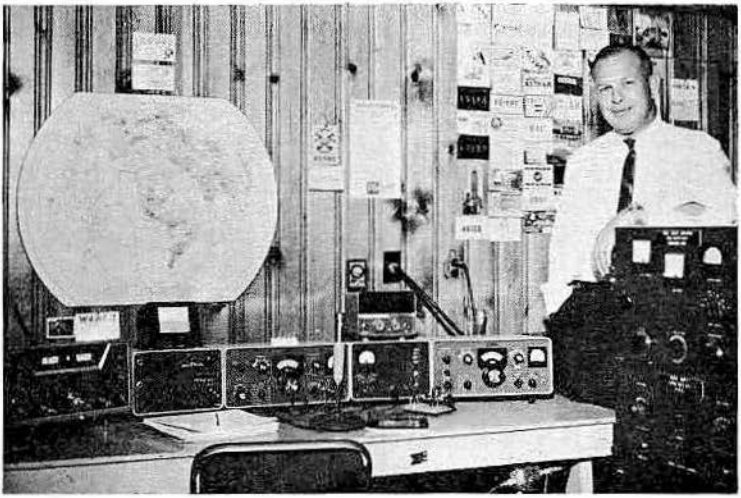
This is a mail-order version of the General, and is available only under one of these conditions: (1) The applicant's residence and proposed station site are more than 175 miles airline distance from the nearest location at which examinations are conducted by an authorized FCC employee or representative at intervals of not more than six months. (2) The applicant is physically disabled, cannot travel, and has a physician's affidavit to this effect. The FCC makes special arrangements for ham tests for the blind. (3) The applicant is shown by certificate from his commanding officer to be in the Armed Forces of the United States and for that reason is unable to appear in person at an FCC office. (4) The applicant is living for a continuous period of at least 12 months outside the continental limits of the United States, its territories or possessions.

For many years, the minimum distance requirement for the Conditional test was 75 miles. With its extension

to 175, only a few sparsely populated sections of the United States remain open to Conditional licensing.

The operating privileges under a Conditional are exactly the same as those under a General, so it follows that the examinations are also alike. However, in the absence of an FCC employee, the Conditional is given by a voluntary examiner, 21 years of age or older, who must have, as a minimum, a General class amateur license. He (or she) need not be a ham if he holds a Commercial class radiotelegraph ticket or is a U.S. Government radiotelegraph operator.

The entire problem in qualifying for a Conditional is merely to locate such an examiner. The chances of finding a commercial or government operator in spots more than 175 miles from FCC points are pretty thin. Your best bet is to concentrate on finding a ham. Inquire at the nearest high school or college; if it doesn't have a ham club, perhaps one of the instructors in the physics or sci-



Who wouldn't be happy in this pine-panelled den, with its elaborate kilowatt transmitter? The proud owner is Edward J. Bock, St. Louis, Mo., whose call is WØEKT. The big map on the wall, to the left, shows the call-letter prefixes of all the countries of the world.

ence department is an amateur. Check with the nearest broadcasting or television station; there is sure to be one ham in the crews. Try a station of the state police; the maintenance man there might have a ham ticket.

Also write to the editor of the local daily or weekly newspaper, explain your problem, and ask him to run a little "Ham Wants Help" item. This might bring replies from the most unlikely people. Scan the same newspapers closely for announcements of radio club meetings. Finally, write to the American Radio Relay League, Newington, Conn., 06111, the ham's national organization, and ask 'em to give you the name of the nearest club.

When your code speed is up to about 10 words per minute (and 13 is only a matter of a little more practice) address a letter to the Federal Communications Commission, Gettysburg, Penna., 17325, and ask for a Form 610, which is an application blank for an amateur license. This is free, but if you expect to receive it make sure your name and full address are written legibly. When you think you are ready, ask the volunteer examiner to give you the 13-wpm code test. Within ten days after you pass this, give him a check or money order for $4.00 made out to the FCC, and your filled-out Form 610. He will forward these items to Gettysburg, along with a written request for the Conditional examination papers; a statement of his qualifications as a licensed operator; and a statement that you passed the code test. The FCC License Unit in Gettysburg will send the requested papers to him. Full instructions as to their use are on the cover.

The examiner opens the envelope, and you do the exam in his presence without assistance. When you are finished, he does not grade your answers, but he sends the papers back to Gettysburg for marking. If you flunk, you will be notified. If you pass, your notification will be the receipt of your actual license.

As in the case of personal appearance at an FCC office, the filing fee is not refunded if you fail. You can apply all over again in 30 days, and again and again until you make it.

If after obtaining a Conditional license you move within 175 miles of an FCC test point, you are not required to appear in person for re-examination. However, it is to your advantage to do so, as the Conditional doesn't carry quite the status or the permanance of the General.

THE NOVICE CLASS LICENSE

If you want to get into ham radio quickly, consider the Novice license. The required code speed is only 5 wpm, which most people can achieve in a week of practice; and the written part is so elementary that it is passed with high marks by lads of 10 and 11. Of course, there are several catches: (1) You are restricted to three narrow bands for CW, 3700-3750 kc, 7150-7200 kc, and 21,000-21,250 kc.

(2) You are restricted to 145-147 mc for voice.

(3) Maximum allowable transmitter power is 75 watts, with crystal control of the frequencies.

(4) The license is good for one year, cannot be renewed, and cannot be obtained a second time.

This "apprentice" license, as it is sometimes called, is intended to give you a taste of the hobby and practical experience with live equipment. *It is not a prerequisite for the higher grade General or Conditional.* You can apply for either of the latter (depending on where you live) at any time whatsoever during the 12-month life of the Novice license, or any time after it expires.

Regardless of where you live, you *must* take the Novice test with a voluntary examiner, exactly as with the Conditional except that there is no filing fee.

The frequency and power limitations mentioned above are not as bad as they sound; they afford plenty of opportunity for local and DX communication.

As a Novice, you are not limited to talking exclusively to other Novices, as some newcomers seem to think. You can transmit on one frequency and another license holder on a different frequency; you simply tune your receiver to his setting and he tunes his to yours.

THE TECHNICIAN CLASS LICENSE

This is another mail-order ticket and, like the Conditional and the Novice, *must* be taken with a voluntary examiner. Its requirements are a bit odd in that they combine the 5wpm code test of the Novice with the relatively advanced written test of the General/Conditional. Many hams consider this license superfluous. If a man knows enough to pass the written, they say, all he needs is a few more hours of code practice to be able to hit 13 wpm, and then he obtains the General/Conditional with its full operating privileges. As the Technician license now stands, its holders can operate on only two of the many popular ham bands, 2 and 6 meters, and with complete freedom only in the relatively unexplored bands from 220 mc and up.

CALL SIGNS

All radio stations licensed by the FCC are given *call signs,* also known as *call letters* or simply *calls.* Ham calls consist of the prefix *W* or *K,* a number from Ø (zero) to 9, and two or three suffix letters. The letters *W, K,* and *N* are allotted to the United States by international agreement, but all calls starting with *N* are reserved for Navy stations. The character Ø is read as "zero," never as "oh."

The number following the prefix indicates the approximate geographical location of a station. Districts 1, 2, 3, and 4 take in the Atlantic Seaboard states; 5, the Southwest; 6, the state of California alone; 7, the western states minus California; 8, 9, and Ø, the Midwest.

In some places ham activity is so great that all single-prefix W calls have been exhausted, so the two-letter prefixes *WA* and *WB* are used for new General, Conditional, and Technician licensees.

Because of the short-term nature of the Novice ticket, Novice calls are a little different. They begin with *WN* or *WV* and are followed by the district number and three suffix letters. When a Novice qualifies for a General, Conditional, or Technician, the prefix changes to *WA* or *WB.*

There is very little chance of obtaining specific combinations of suffix letters, such as names or initials. At the time this book was prepared more than a quarter of a million licenses were in effect, and the FCC was having difficulty keeping up with new applications. To discourage requests for special calls, the Commission charges $20 just for looking into its records to see if a desired combination is available, and even if it isn't, the fee is not returned.

OPERATING RESPONSIBILITIES

A ham license carries many privileges, and also some responsibilities. The most important responsibility is frequency observance. As long as you keep your signals within the assigned ham bands and follow a few commonsense rules of behavior, you can do pretty much what you please. This freedom enables you to perform endless experiments with your equipment to improve its performance and to widen your contacts with other hams. While the FCC cannot possibly police the hundreds of thousands of radio stations of many kinds on the air daily, it does

Some representative calls are shown in this collection of QSL cards, which are kept clean in a transparent plastic packet. Holding 20 cards, the packet is supported at its top edge by string or pins into the wall. The young lady does not come with it.

have a monitoring service and it does occasionally find a ham off base. It then issues a warning notice, unpopularly called a "pink ticket," and if the recipient values his license he takes all necessary corrective action.

Amateurs as a class are well behaved, and virtually all their violations of FCC regulations are accidental and minor. Actual cancellations of operating privileges are extremely rare.

Once you go on the air, you are also required to keep a record of all transmissions and contacts. This is called a "log." Printed forms for the purpose are available at low prices. In cases involving off-frequency operation or interference with television reception, you may be asked by an FCC inspector to show your log.

CHAPTER 6

LEARNING 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 the chart.

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:

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

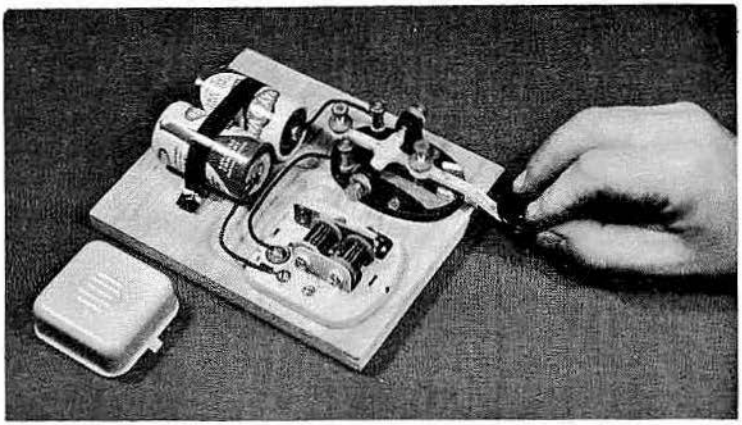
1—di-dah-dah-dah-dah
2—di-di-dah-dah-dah
3—di-di-di-dah-dah
4—di-di-di-di-dah
5—di-di-di-di-dit
6—dah-di-di-di-dit
7—dah-dah-di-di-dit
8—dah-dah-dah-di-dit
9—dah-dah-dah-dah-dit
0—dah-dah-dah-dah-dah

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-dit



Mounted on a piece of plywood, the three components of this simple but effective code-practice set are merely connected in series. Note natural, comfortable position of fingers on the knob of the key.

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*.

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 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 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

This transistor code-practice oscillator, made from a kit, is powered by a self-contained flashlight battery. The audio tone issues from the speaker on the left. A practice set of this kind can also be used as a keying monitor in connection with a c-w transmitter, and is therefore a good investment.

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 little 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.

For about fifteen dollars you can buy a line-powered code-practice unit with volume and pitch controls. Such a unit is a good investment because you can use it later as a transmitter monitor when you go on the air. (A monitor responds to your keying and indicates how it sounds to the operator at the receiving end.)

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.

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.

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 the code chart, note that in Group 1 the letter *E* is represented by one dit, and tap the key smartly once.

These students at South Side High School, Rockville Center, N. Y. learn the code quickly, get their licenses, and then operate the school's club station, K2LAK.

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.

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, immedi-

ately 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

Mass instruction in code and theory of mixed groups of all ages is very successful in courses conducted as a free service by Allied Radio Corporation, Chicago. A high percentage of the students obtain "tickets" on the first try.

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 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 message. 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.

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.

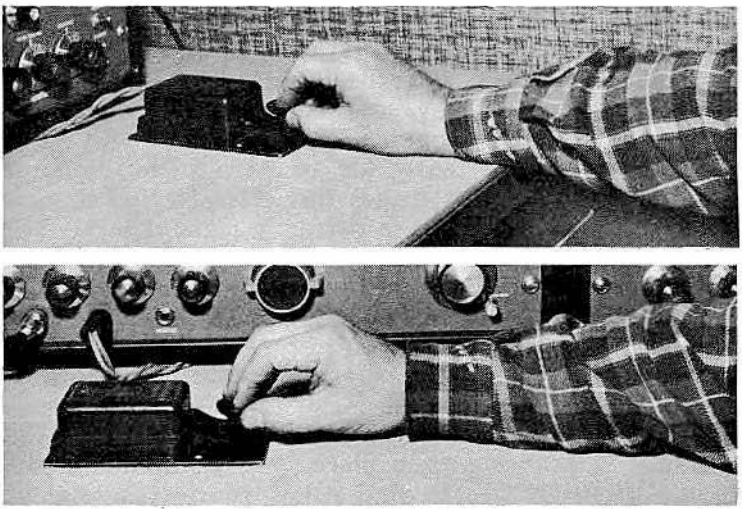
After your co-worker has made perfect copy of the first five sentences, switch places and let him send the second group of five to you. Allow yourself a total of about an hour for Group 1, and don't attempt the other groups the first night. It's a mistake to cram too much into one session. If you stick 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



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 relaxed.

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 2.)

You can't possibly imagine how many c-w 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 machines. 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

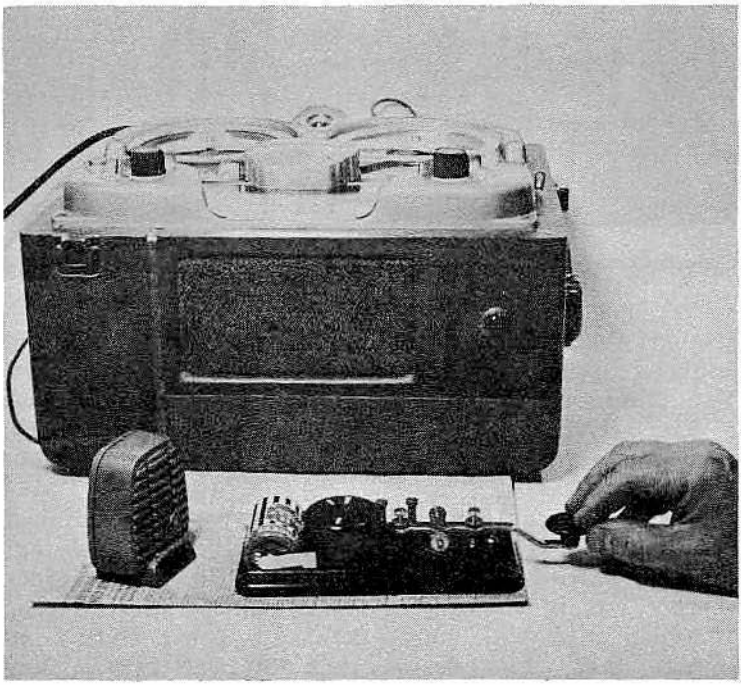
Code courses with phonograph records containing practice sessions are good for the student who works alone.

stations that send accurately timed practice text, at announced speeds, for the specific benefit of beginners. You'll find these schedules in publications that carry news of ham activities, such as *QST, CQ, Popular Electronics, Electronics Illustrated, Electronics World,* and *Radio-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 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 farther 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.

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 thoroughly; then they can



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

usually be sold—or donated, if you feel magnanimous—to other newcomers.

Tape, of course, has the advantage that it can be erased and reused time after time, almost indefinitely. You can

place the microphone close to the speaker and record live signals from a transmitting station. Then they can be played back at your convenience. A tape recorder can also be used for a very instructive and illuminating experiment, as follows:

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

CHAPTER 7

HAM ORGANIZATIONS

For more than fifty years, the interests of hams have been promoted by a strong national organization to which a great many active amateurs belong. This is the *American Radio Relay League,* with headquarters in Newington, Conn., 06111. For short, it is called the *ARRL* or simply the *League.* Among hobby groups, it is unique in that it is officially recognized by various branches of the United States Government, including the FCC, the Army, the Air Force, and the Navy. At international telecommunications conferences, League representatives are always part of the United States delegation, and on the whole are very successful in defending ham rights and frequencies against encroachments by commercial firms and foreign governments.

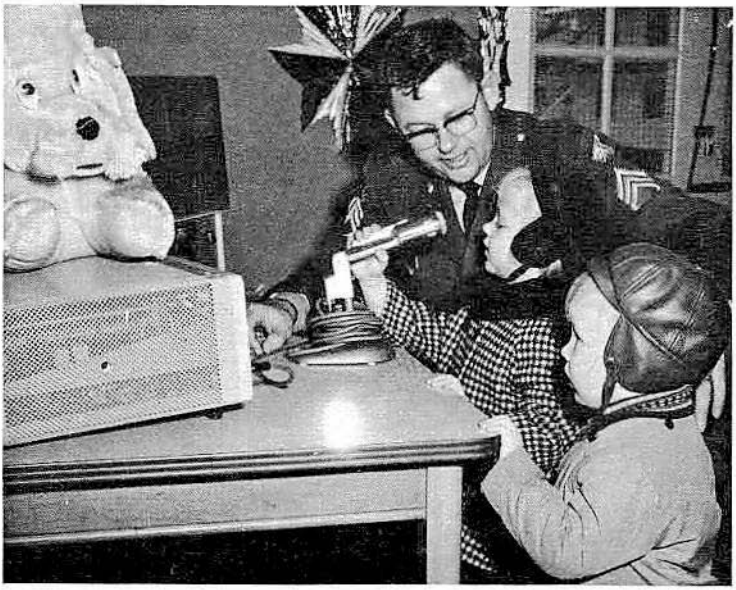
THE ARRL

The League publishes a monthly organ, "QST," which has long been regarded as the "Bible" of the game. This contains news of ham activities, articles on the construction and operation of receiving and transmitting equipment of all kinds, and educational material of great value to hams of all degrees of technical background. It is hardly possible for an amateur to keep up with developments in ham radio without belonging to the League and reading every issue of QST from cover to cover. Membership, including the magazine, costs $5.00 a year. Only the administrative staff of the League at Newing-

ton is salaried. The major officers and all the regional directors serve without pay. The ARRL was founded in 1914 by Hiram Percy Maxim, noted inventor and early "wireless amateur." At the time this book was prepared, the president was Herbert Hoover, Jr., W6ZH, a former assistant Secretary of State and a ham of long standing.

At the local level, there are hundreds of League-affiliated clubs scattered throughout the country. They are always open to new members. Most of them make a particular project of giving code practice to newcomers and assisting them in obtaining licenses.

The individual clubs run numerous "hamfests" throughout the year, and the League itself stages national con-



As morale builders for military families at far-flung bases, "MARS" ham stations serve a highly important function. Here at K2USA/AA2USA, the station at Fort Monmouth, N. J., Staff Sergeant William Scott initiates a couple of youngsters into the art of saying hello to grandma and grandpa at the other end of a shortwave phone circuit.

ventions in different cities. At these affairs there are equipment displays, talks on many subjects, code-speed contests, and various social activities. They are well worth attending, especially since it is common practice for manufacturers and dealers to contribute valuable door prizes, ranging sometimes all the way up to a $2000 transceiver.

MARS

No, not the planet! This acronym stands for *Military Affiliate Radio System* and represents the official recognition by the Armed Services of ham ability and achievements. The Army, the Air Force, and the Navy compete

What does a busy young mother of four growing sons do in her spare time? In the case of Mary Jo Hallberg there is a multiple answer: (1) as KØTGU, she shares this well-equipped ham station with her husband Chet, who is KØTCB. (2) She is in Navy MARS as NØUXC, he in Air Force MARS as AFAØTCB. (3) She is a licensed practical nurse. (4) She is treasurer of the Lee's Summit Radio Club. (5) Three nights a week she is controller of two ssb nets.

openly with each other to enroll operators, who must be at least 16 years old, the holders of valid license, and the owners of actve stations. Membership is entirely voluntary and carries no obligation to serve in any military capacity. So why join? You get a special call, are authorized to work on special *MARS* frequencies outside the crowded regular bands, and receive instruction in general electronics and in advanced operating procedures.

The Army calls use the prefix *A, AB, AC, AD, AE,* or *AL,* the district number, and the two or three suffix letters of the regular FCC call. The Air Force combinations are similar, and have the prefix *AF, AFA, AFB,* etc. The Navy assignments are specifically *NØRAA* to *NØZZZ.*

Army and Air Force *MARS* are pretty well coordinated; Navy *MARS* works independently. For further details and application blanks, write to any of the following: Chief, Military Affiliate Radio System. Department of the Army, Washington 25, D.C.; Chief, Military Affiliate Radio System, Department of the Air Force, Washington 25, D.C.; Director, NAVY MARS, Office of the Chief of Navil Operations, Washington 25, D. C.

Operating on cleared frequencies, *MARS* stations form an extremely important emergency communications network of world-wide scope.

CHAPTER 8

FROM HOBBY TO CAREER

An early interest in amateur radio is often the start of a lifetime career in the fascinating field of electronics. Today, there are thousands of successful and highly placed engineers and executives who speak glowingly of their initial experiments with shortwave receivers and transmitters. In their mature years, a surprisingly large number of them go back to the hobby and find both excitement and relaxation in operating elaborate stations at home or in their cars.

SOME HISTORY

Guglielmo Marconi, who in 1901 thrilled the world with the first trans-Atlantic "wireless" transmission, once called himself "merely a lucky amateur." Edwin H. Armstrong, who invented the regenerative, superregenerative and superheterodyne circuits, and popularized FM broadcasting, started as a teenage amateur in the attic of his home. Frank Conrad, a Pittsburgh ham whose station *8XK* was in a backyard garage, was directly responsible for initiating sound broadcasting in the 1920's. Allen B. DuMont, whose development of the cathode-ray tube made television possible, began as a licensed operator with a typical workshop and shack in his basement. In 1965, the 114-year-old Western Union Telegraph Company picked as its president the youngest man ever to hold the job: Russell W. McFall, 43, also

Russell W. McFall, at 43 the youngest president of the Western Union Telegraph Company, has long been an active c-w operator, with the call W3JAB.

known as "Russ", a crack CW operator using the call *W3JAB*.

The manufacture of ham equipment is in itself a big business. Almost everyone in it, from the boss down to the office secretaries, is likely to wear a call-letter pin. To name just a few: William J. Halligan, founder of the

Hallicrafters Company, is *W9AC;* Arthur A. Collins, head of Collins Radio, is *WØCXX;* and Carl Mosley, the antenna man, is *WØFQY.*

THE SERVICING BUSINESS

When word gets around the community that you have obtained an official government license from the FCC and have built your own radio station, it is almost certain that neighbors will soon ask you to "look at" ailing radio and TV receivers, record players, hi-fi amplifiers, and even an assortment of household appliances. By "look at" they really mean, "Can you fix this for me?"

About 85% of the trouble in most entertainment equipment can be traced merely to dead tubes, so your chances of effecting quick cures (and thereby building up a reputation as a wizard) are pretty good.

Don't under any circumstances fall into the "free-of-charge" trap. People don't appreciate anything done for them for nothing, and they'll only think you foolish if you say, "Oh, that's all right. I'm glad to help out."

You should get back the list-price cost of new tubes or other replacement parts, expenses for travel in obtaining them, and a minimum fee for labor; one dollar is a good beginning. Since you work at home, your overhead is nil and every repair, no matter how small, should yield a profit.

If you stick to the relatively easy jobs involving broadcast and sound equipment, and leave the difficult TV and transistor sets to the professional servicemen in your area, you can readily build up a good spare-time or weekend business.

With the profits from basement enterprises of this kind, many hams enlarge their shacks, buy specialized servicing instruments to enable them to handle additional jobs, pay part of their college tuition, acquire a hot rod, or spend it on girls.

There is another way of capitalizing on ham background: Make yourself available for outside part-time work. Have an understanding with local professionals so

that they can call on you when they're rushed and drop you when things are quiet. This is a good deal all around, because it gives you valuable experience as well as cash in pocket, and it keeps their overhead down.

There is a wide gap between weekend and full-time servicing. When you work at home and do not depend on the income for the major support of either yourself a family, your main concern is keeping up with technical developments. Although the money you earn is subject to taxation, even the net amount is essentially "gravy." However, when you set up a professional shop you have to divide your time unequally between technical and administrative duties. Many a highly skilled serviceman goes broke in a few months because he becomes so involved with the business of rent, taxes, insurance, bills, collections, etc., that he doesn't have time to handle the actual repair of customers' equipment.

THE ELECTRONICS TECHNICIAN

There is a large and continuing demand in industry for "electronic technicians." This is the term applied to men (and women) who can show high-school diplomas and have had practical experience with electronic gear as self-taught hams or repairmen, or who are graduates of trade, correspondence, or military schools. A young man who goes into the Army, the Navy, or the Air Force with a ham ticket, and comes out with any one of a variety of "electronic technician" ratings, finds civilian jobs waiting for him in many parts of the world. He can do installation, maintenance, and repair on communications, telemetering, radar and scores of other kinds of electronic apparatus. He might supervise assembly, testing, and quality-control operations in a factory; or he can readily find himself immersed in the fabulous space program, in which electronics plays a major role.

THE ELECTRONICS ENGINEER

The space age needs technicians, but it needs engineers even more, because the latter must first design the equip-

ment that the technicians will put into service. To rate as an "engineer," a man must be a graduate of a recognized college and hold at least one degree. College means four years of study following high school, but the science of electronics is expanding so widely that most engineers never really stop studying. Some big firms encourage their employees in this direction by giving them time off to attend courses leading to advanced degrees, and they even pay part or all of their tuition. So many former and present licensed amateurs are found in engineering circles that formal classes devoted to highly technical subjects often end up as informal hamfests in nearby coffee shops.

Men who cannot afford to go to college as full-time students can still qualify for engineering degrees by attending night classes while they work days as servicemen or technicians. This is a long and often hard grind, but in the end it pays off because engineers make much more money than technicians do.

SCHOOLS

Every high school has faculty advisors to assist seniors in selecting colleges. If you don't care for college but realize that you need further education to get ahead, you have a wide choice of resident "institutes," which are really short-term trade schools, and of correspondence schools. The technical training offered by some of the latter is almost equivalent to that given at many top-level colleges, but it still does not lead to an engineering degree; instead, it qualifies you as a very advanced "technician." You are not an "engineer" in the eyes of the personnel director of any electronic firm unless you have a degree from a good school.

The resident institutes and the correspondence schools advertise extensively in the various ham and technician magazines. A letter to any one of them will bring you a brochure giving details and costs of the available courses.

CHAPTER 9

THE HAM ON WHEELS

Most newcomers think of amateur radio in terms of a cozy little station in a corner of a bedroom or the basement. They are pleasantly surprised to learn that the regular FCC license also permits them to operate *mobile* in any vehicle of their choosing. While this is generally the family car, there are also numerous installations on private boats, quite a few in private airplanes, and even one in a United States Navy submarine.

The power of a mobile transmitter is limited by the capacity of the vehicle's electrical system; that is, the rating of the storage battery and the associated charging generator. Also, the size and the shape of the antenna are severely limited by mere physical considerations; if it sticks up too far it tangles with tree branches and garage doors. In spite of all this, mobile operators enjoy many truly remarkable contacts. In fact, they often do better on the road than in their home shacks, because in driving around they are able to take advantage of clear, quiet locations. However, even some sites that look hopeless from the communications standpoint may turn out unexpectedly to be sensationally effective.

For example: The Times Square area of New York City, long known as the "Great White Way," is a narrow canyon ringed by tall buildings and illuminated by thousands of blinking lights. The street surface itself is only

a thin cover over a busy network of subway lines. The whole atmosphere is saturated with electrical interference; a worse spot for demonstrating a puny 50-watt mobile transmitter in an ordinary sedan cannot be envisioned. Yet under these very conditions, in the presence

Typical mobile installation of a transceiver under the dashboard of a car. An external speaker has been secured to the instrument panel by means of tape, and directs its sound straight toward the driver-operator. This unit is the Heath "Pawnee" for 2 meters, assembled from a kit.

of three incredulous witnesses, the author of this book once worked stations in Germany, England, North Africa, Alaska, and the Canal Zone—one after another in less than an hour!

Multistation hook-ups often develop spontaneously. A notable one involved a high-ranking Air Force general, who happens to be an avid ham, when he was flying from a base in the midwest to Washington. While over

Indiana and Ohio, he established contact with the ham captain of a freighter far out in the Pacific; with a man in his car, about 25,000 feet directly below him; and with an amateur in Washington who "patched" him through to his daughter at home. By the time his plane was making its final approach to the airport, scores of other hams in half a dozen countries were calling in.

MOBILE PRIVILEGES

Operating privileges on mobile are exactly the same as those allowed under each grade of license. Generals can use any band; Technicians and Novices must stay within their frequency and power confines. While most mobile work is done on voice, there is nothing to prevent you from using cw.

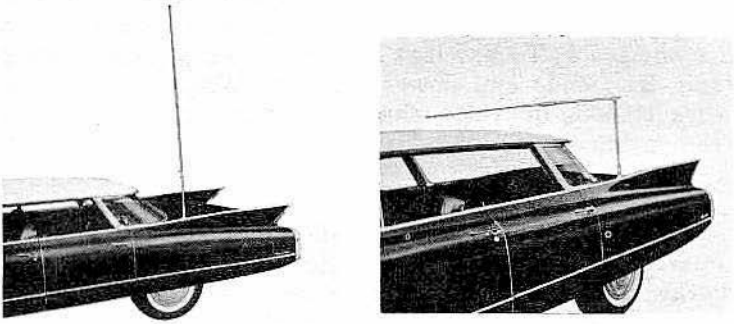
EQUIPMENT FOR MOBILE

Early mobile installations generally consisted of three separate elements: (1) a short-wave converter that worked into the broadcast receiver of the car, or an independent ham-band receiver with its own power supply, (2) a multiband a-m transmitter, without power supply, and (3) for the transmitter, a high-voltage power unit of the vibrator or dynamotor type. The receivers and transmitters tended to be rather bulky and, when mounted under the dash (the usual position), often deprived both driver and passenger of valuable leg room. The transmitter power supplies were invariably put in the engine compartment or the trunk, since they did not require adjustment. Much equipment of this type is available at low prices, but it is quite obsolete and therefore no bargain.

The development of the transistor and other solid-state devices has made possible dramatic reductions in the size of mobile gear, with much great economy of operation from the battery standpoint. Most modern equipment is of the *transceiver* type, as described in Chapter 3. Because only one set of circuit elements is used for both reception and transmission, there is a

marked saving in space and weight over previous designs.

While some transceivers require external power supplies, the strong trend is toward the use of self-contained units that work on both 12 volts from the car's battery and on 115 volts from any a-c outlet. The great advantage of these dual-voltage supplies is that they permit the transceiver to be used readily at home, in the car on a trip, or in a hotel or motel with a window-type



Mounted on a fender well, the "Hustler" mobile antenna radiates efficiently. In different lengths, it can be used on 10, 15, 20, 40 and 80 meters. Jointed a short distance from the bottom, the "Hustler" antenna can be folded over quickly to allow the car to enter any garage. The trick is to remember to fold it down before driving in.

antenna. It takes only a few minutes to dismount and disconnect the unit and to set it up in a new location. The proper power connection is made automatically by means of special cords and plugs. The cord with the 12-volt plug remains permanently in the car; the cord with the 115-volt plug is a separate accessory.

In their efforts to make transceivers ultra-compact, manufacturers tend to leave the loudspeakers out of them. The more expensive the equipment, the smaller the chance of finding the speaker built in. Probably the easiest thing to do in a car set-up is to use the speaker that is part of the vehicle's broadcast receiver. You only have to find the ungrounded lead from the output transformer

to the voice coil and to insert in it a single-pole double-throw toggle switch. This mounts quickly in any of the various holes already available on the underlip of most dashboards, and it makes for simple changeovers between the ham rig and the BC set.

For 2 and 6 meters, manufacturers generally make one-band transceivers. These are intended primarily for a-m phone, but some have provision for cw.

For 10 through 80 meters there is a wide choice of mobile equipment: one band, three band and five band. These are basically ssb transceivers, some with optional a-m and c-w facilities. The simpler sets are fixed for upper sideband on 20 meters and lower sideband on 40 and 80 meters; the more advanced ones offer choice of sideband on all frequencies. The three-band jobs are generally for 20, 40, and 80 meters; the five-band jobs for 10, 15, 20, 40, and 80.

THE MOBILE ANTENNA

Because most people don't like to make holes in the bodies of their cars, the most popular mounting spot for the mobile antenna is on the rear bumper. An assortment of hardware for the purpose is available.

On some cars, dual whip antennas for the broadcast receiver are found on the rear deck, over the wheels. If one of these is removed, the hole can be used for the antenna. Being higher and clearer than a bumper-mounted whip, an antenna in this position usually gives somewhat better results. However, it may also be too tall for garages, trees, toll booths, etc. One answer to this problem is the foldover antenna.

Straight whips are standard for 10 through 80 meters. For 2 and 6, most hams use *halos*, which are really dipoles bent into circular form.

CALL-LETTER PLATES

Most of the 50 states issue special call-letter plates, for a small extra charge, to applicants who can merely show their FCC licenses. There are highly distinctive,

A conversation piece everywhere: distinctive call-letter license plate on a ham's car.

and are a sure way of attracting the attention of other hams wherever you travel. Obtain further details from your nearest state motor vehicle office.

RULES OF THE ROAD

Ordinary driving in most parts of the United States is hazardous enough by itself. Don't make it worse by attempting to tune a transceiver, talk, listen, and make entries in a log book, all while you're keeping one eye on the traffic. Some municipalities have ordinances against the use by a driver of car radiotelephones of any sort while in motion. Of course, the situation is different if the driver and the operator are two different people.

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