CHAPTER ONE

Amateur Radio

AMATEUR radio is silent now — its keys stilled, its microphones lifeless. Dust gathers in scores of thousands of radio shacks, their operators off to war.

Amateur radio is silent now — but it is not dead. The radio hams of yesterday are working toward a different purpose, but fundamentally their work now is much the same as their hobby was before. And underlying their thoughts as they give their best in the uniformed services or in industry or research is the hopeful assurance that one day they will be back on the air as amateurs again.

To a hundred thousand people the world over, amateur radio represents the most satisfying, the most worth while of all hobbies. To communicate freely with other amateurs the world around at the mere touch of a key or microphone switch, on home-owned and usually home-built equipment, was for many years the supreme thrill to thousands of private citizens in every country on earth. Such freedom of communication, however, is characteristic of peace; it cannot continue in time of war. Thus, until peace again returns, amateur radio can exist only in the hearts of its followers, waiting for that day when free institutions again may flourish, when free men walk again in safety and confidence, when free speech is restored to all the peoples of the earth, and when free communication between them again becomes not a dream of the future but a matter-of-fact reality.

Not that amateur radio ever was really matter-of-fact. Every owner of a short-wave receiving set knows the thrill that comes from hearing a distant station broadcasting from some foreign land; the radio amateur has known the even-greater thrill of *talking* with people at these distant points! On one side of your radio amateur's table would be his high-frequency receiver; on the other his private transmitter, ready at the throw of a switch to be used in calling and "working" other amateurs in every corner of the globe. High power or expensive equipment was not required. Even a low-power transmitter made it possible to develop friendships in every State of the Union. Experience in the adjustment of apparatus, in using the right frequency band at the right time of day when foreign amateurs were on the air, and increasing operating skill on the part of the individual, enabled regular communication with other amateurs in every continent.

Nor has the personal enjoyment that comes from amateur radio been its only benefit. Putting together apparatus by one's own skill is a source of enduring satisfaction. The process of designing and constructing radio equipment has developed real engineering ability in thousands upon thousands of young men — and young women, too — throughout the country, an ability which serves them and the radio industry in time of peace and which is now serving their country to an inestimable extent in time of war. In peacetime, many an operator, engineer and executive in the commercial radio field got his practical background and much of his training from his amateur work; during the present conflict many thousands of amateurs are in communications work in the Army, Navy, Marines and Coast Guard, both in the field and in training centers (where entire staffs are made up almost wholly of amateurs), and additional hundreds possessing more advanced training are engaged in electronic research and development, particularly in connection with secret devices for aircraft detection, and in other confidential assignments requiring a high degree of specialized operating skill which, it has been found, is best possessed by the experienced amateur operator.

Amateur radio is as old as the art itself.

There were amateurs before the present century. Shortly after the late Guglielmo Marconi astounded the world with his first experiments proving that telegraph messages actually could be sent between distant points without wires, they were attempting to duplicate his results. Marconi himself probably was the first amateur — indeed, the distinguished inventor so liked to style himself. But amateur radio, as it has come to be known, was born when private citizens first saw in the new marvel a means for personal communication with others, and set about learning enough of the new art to build home-made stations.

Amateur radio's subsequent development may be divided into two periods: the period up to our entrance into World War I, in 1917, and the period between that war and our entrance into the present conflict — 1919–1941.

Amateur radio prior to 1917 bore little resemblance to radio as we know it to-day, except in principle. The equipment, both transmitting and receiving, was of a type now long obsolete. The range of even the highest-powered transmitters, under the most favorable conditions, would be scoffed at by even the least-informed person to-day. No United States amateur had ever heard the signals of a foreign amateur, nor had any foreigner ever reported hearing an

American. The oceans were a wall of silence, impenetrable, isolating us from every signal abroad. Even cross-country communication could be accomplished only by relays. "Short waves" meant 200 meters; the entire wavelength spectrum below 200 meters was a vast silence — no signal ever disturbed it. Years were to pass before its phenomenal possibilities were to be suspected.

Yet the period was notable for a number of accomplishments. It saw the number of amateurs in the United States increase to approximately 4,000 by 1917. It witnessed the first appearance of radio laws, licensing, wavelength specifications for the various services. ("Amateurs? — oh, yes — well, stick 'em on 200 meters; they'll never get out of their backyards with it.") It saw an increase in the range of amateur stations to such unheard-of distances as 500 and, in some cases, even 1,000 miles. U. S. amateurs were beginning to wonder, just before the war, if there were other amateurs in other countries across the seas and if — daring thought! — it might some day be possible to span the Atlantic with 200-meter equipment. Because all long-distance messages had to be relayed, this period saw relaying developed to a fine art — an ability that turned out to be a priceless accomplishment later when the government suddenly needed hundreds of skilled operators for war service in 1917. Most important of all, the period witnessed the birth of the American Radio Relay League, the amateur organization whose fame was to travel to all parts of the world and whose name was to be virtually synonymous with subsequent amateur progress and short-wave development. Conceived and formed by the famous inventor and amateur, the late Hiram Percy Maxim, the League was formally launched in early 1914. It was just beginning to exert its full force in amateur activities when the United States declared war in 1917, by that act sounding the knell for amateur radio for the next two and one-half years. By presidential direction, every amateur station was dismantled. Within a few months three-fourths of the amateurs of the country were serving with the armed forces of the United States as operators and instructors — a movement that was to be duplicated in striking manner a quarter of a century later.

Few amateurs to-day realize that World War I not only marked the close of the first phase of amateur development but came very near marking its end for all time. The fate of amateur radio was in the balance in the days immediately following the signing of the Armistice, in 1918. The government, having had a taste of supreme authority over all communications in wartime, was more than half inclined to keep it; indeed, the war had not been ended a month before Congress was considering legislation that would have made it impossible for the amateur radio of old ever to be resumed. President Maxim rushed to Washington, pleaded, argued; the bill was defeated. But there was still no amateur radio; the war ban continued in effect. Repeated representations to Washington met only with silence; it was to be nearly a year before licenses again were issued.

In the meantime, however, there was much to be done. The League's offices had been closed for a year and a half, its records stored away. Three-fourths of the former amateurs had gone to France; many of them would never come back. Would those who had returned be interested, now, in such things as amateur radio? Mr. Maxim determined to find out, and called a meeting of such members of the old board of directors of the League as he could locate. Eleven men, several still in uniform, met in New York and took stock of the situation. It wasn't very encouraging: amateur radio still banned by law, former members of the League scattered no one knew where, no organization, no membership, no funds. But those eleven men financed the publication of a notice to all the former amateurs that could be located, hired Kenneth B. Warner as the League's first paid secretary, floated a bond issue among old League members to obtain money for immediate running expenses, bought the magazine *QST* to be the League's official organ, and dunned officialdom until the wartime ban was lifted and amateur radio resumed again. Even before the ban was lifted, in October, 1919, oldtimers all over the country were flocking back to the League, renewing friendships, planning for the future. When licensing resumed, there was a headlong rush to get back on the air.

From the start, postwar amateur radio took on new aspects. Wartime needs had stimulated technical development in radio. There were new types of equipment. The vacuum tube was being used both for receiving and transmitting. Amateurs immediately adapted the new apparatus to 200-meter work. Ranges promptly increased; it became possible to bridge the continent with but one intermediate relay. Soon stations on one coast were hearing those on the other, direct!

These developments had an inevitable result. Watching DX come to represent 1,000 miles, then 1,500 and then 2,000, amateurs began to dream of trans-Atlantic work. Could they get across? In December, 1921, the ARRL sent abroad one of its most prominent amateurs, Paul F. Godley, with the best amateur receiving equipment available. Tests were run, and thirty American amateur stations were heard in Europe. The news electrified the amateur world. In 1922 another trans-Atlantic test was carried out; this time 315 American calls were logged by European amateurs and, what was more, one French and two British stations were heard on this side.

Everything now was centered on one objective: two-way communication across the Atlantic by amateur radio! It *must* be possible — but somehow they couldn't quite make it.

Further increases in power were out of the question; many amateurs already were using the legal maximum of one kilowatt. Better receivers? They already had the superheterodyne; it didn't seem possible to make any very great advance in that direction.

Then how about trying another wavelength, they asked? What about those wavelengths *below* 200 meters? The engineering world thought they were worthless — but then, that had been said about 200 meters too. There have been many wrong guesses in history. And so, in 1922, the assistant technical editor of *QST* (Boyd Phelps, now a lieutenant-commander in the Naval Reserve) carried on tests between Hartford and Boston on 130 meters. The results were encouraging. Early in 1923 the ARRL sponsored a series of organized tests on wavelengths down to 90 meters, and it was noted that as the wavelength dropped the reported results were better. A growing excitement began to filter into the amateur ranks.

Finally, in November, 1923, after some months of careful preparation, two-way amateur communication across the Atlantic became a reality, when Schnell, 1MO, and Reinartz, 1XAM (now W9UZ and W3IBZ respectively, and both commanders in the Naval Reserve), worked for several hours with Deloy, 8AB, in France, all three stations using a wavelength of 110 meters! Additional stations dropped down to 100 meters and found that they, too, could easily work two-way across the Atlantic. The exodus from the 200-meter region started.

By 1924 the entire radio world was agog, and dozens of commercial companies were rushing stations into the 100-meter region. Chaos threatened, until the first of a series of national and international radio conferences partitioned off various bands of frequencies for the different services clamoring for assignments. Although thought still centered on 100 meters, League officials at the first of these conferences, in 1924, came to the conclusion that the surface had only been scratched, and wisely obtained amateur bands not only at 80 meters but at 40 and 20 and 10 and even 5 meters.

Many amateurs promptly jumped down to the 40-meter band. A pretty low wavelength, to be sure, but you never could tell about these short waves. "Forty" was given a try, and responded by enabling two-way communication with Australia, New Zealand and South Africa.

How about 20 meters? This new band immediately showed entirely unexpected possibilities by enabling an East Coast amateur to communicate with another on the West Coast, direct, at high noon. The dream of amateur radio — daylight DX! — had come true.

From that time to the advent of World War II — when amateur radio again was closed down "for the duration" — represents a period of unparalleled accomplishment. The short waves proved a veritable gold mine. Country after country came on the air, until the confusion became so great that it was necessary to devise a system of international intermediates in order to distinguish the nationality of calls. The League began issuing what are known as WAC certificates to stations proving that they had worked all the continents. Over five thousand such certificates have been issued. Representatives of the ARRL went to Paris and deliberated with the amateur representatives of twenty-two other nations. On April 17, 1925, this conference formed the International Amateur Radio Union — a federation of national amateur societies.

Nor was experimental development lost sight of in the enthusiasm incident to international amateur communication. The experimentally minded amateur was constantly at work conducting tests in new frequency bands, devising improved apparatus for amateur receiving and transmitting, learning how to operate two and three and even four stations where previously there was room enough for only one.

In particular, the amateur experimenter pressed on to the development of the higher frequencies represented by the wavelengths below 10 meters, territory only a few years ago regarded even by most amateurs as comparatively unprofitable operating ground.

The amateur's experience with five meters is especially representative of his initiative and resourcefulness and of his ability to make the most of what is at hand. In 1924, first amateur experiments in the vicinity of 56 Mc. indicated that band to be practically worthless for distance work; signals at such frequencies appeared capable of being heard only to "horizon range." But the amateur turns even such apparent disadvantages to use. If not suitable for long-distance work, at least the band was ideal for "short-haul" communication. Beginning in 1931, then, there was tremendous activity in 56-Mc. work by hundreds of amateurs all over the country, and a complete new line of transmitters and receivers was developed to meet the special conditions incident to communicating at these very-high frequencies (then known as the "ultrahighs"). In 1934 additional impetus was given to this band when experiments by the ARRL with directive antennas resulted in remarkably consistent two-way communication over distances of more than 100 miles, without the aid of "hilltop" locations. While atmospheric conditions still are found to affect 5-meter DX, thousands of amateurs, as of the time of the close-down in December, 1941, were spending much of their time on the 56- and 112-Mc. bands, many of them having worked hundreds of stations at distances up to several thousand miles; even transcontinental distances were being spanned when conditions were right. To-day's concept of v.h.f. propagation was developed almost entirely through amateur research.

The amateur is constantly in the forefront of technical progress. Many developments by

amateurs have come to represent valuable contributions to the art, and the articles about them are as widely read in professional circles as by amateurs. At a time when only a few broadcast engineers in the country knew what was meant by "100 per cent modulation," the technical staff of the ARRL published articles in *QST* urging amateur 'phones to embrace it and showing them how to do it. This is only one example; the complete record of such accomplishments would more than fill this chapter alone. From the League's laboratory in 1932 came the "single-signal" superheterodyne — the world's most advanced high-frequency radiotelegraph receiver. In 1936 the "noise-silencer" circuit for superheterodynes was developed, permitting for the first time satisfactory high-frequency reception through the more common forms of man-made electrical interference.

Currently, hundreds of skilled amateurs are contributing their knowledge to the development of secret wartime radio devices, both in government and in private laboratories. Equally as important, the prewar technical progress by amateurs has provided the keystone for the development of modern military communications equipment. The sets now in use by the armed forces closely resemble the best prewar amateur equipment. This is only logical, because the problems of military communications in modern warfare — extreme congestion, special operating requirements, the need for compactness and efficiency — closely resemble the problems peculiar to the amateur service before the war, and for which the amateurs were forced to devise their own specialized solutions. The fact that amateurs on the staffs of the Signal Corps and Naval Research laboratories have been closely allied with the design of this new military communications equipment has been a vital factor.

On the fighting fronts their operating skill is equally valuable. Sharpened to the highest degree by years of communicating experience under the severest conditions of congestion, and with low-powered equipment, the amateur has the ability to hear signals so faint that they are inaudible to the average ear; and to read signals so confused with interference that for ordinary operators they are completely garbled. These abilities make the amateur a key figure in military communications.

Amateur radio is one of the finest of hobbies, but this fact alone would hardly merit such whole-hearted support as was given it by the United States government at past international conferences. There must be other reasons to justify such backing. One of these is a thorough appreciation by the Army and Navy of the value of the amateur as a source of skilled radio personnel in time of war. The other is best described as "public service."

We have already seen 3,500 amateurs contributing their skill and ability to the American cause in the Great War. After the war it was only natural that cordial relations should prevail between the Army and Navy and the amateur. Several things occurred in the next few years to strengthen these relations. In 1924, when the U. S. dirigible *Shenandoah* made a tour of the country, amateurs provided continuous contact between the big ship and the ground. In 1925, when the United States battle fleet made a cruise to Australia and the Navy wished to test out short-wave apparatus for future communication purposes, it was the League's Traffic Manager who was in complete charge of an experimental amateur-type set on the U.S.S. *Seattle* and proved for all time the superiority of the high frequencies.

Definite friendly relations between the amateur and the armed forces of the Government were cemented in 1925. In this year both the Army and the Navy came to the League with proposals for amateur coöperation. The radio Naval Reserve and the Army-Amateur Net are the outgrowth of these proposals. Thousands of amateurs in the Naval Reserve now are on active duty with the Navy, from the rank of captain on down, while other thousands are serving in the Army, Air Forces, Coast Guard and Marine Corps. Altogether, more than 25,000 radio amateurs are in the armed forces of the United States, while many more thousands are engaged in vital electronic research, development and manufacturing.

The public service record of the amateur is a brilliant one. These services can be roughly divided into two classes: emergencies and expeditions. It is regrettable that space limitations preclude detailed mention of amateur work in both these classes, for the stories constitute highlights of amateur accomplishment.

Since 1913, amateur radio has been the principal, and in many cases the only, means of outside communication in more than one hundred storm, flood and earthquake emergencies in this country. Among the most noteworthy were the Florida hurricanes of 1926, 1928 and 1935, the Mississippi and New England floods of 1927, and the California dam break of 1928. During 1931 there were the New Zealand and Nicaraguan earthquakes, and in 1932 floods in California and Texas. Outstanding in 1933 was the earthquake in southern California. In 1934 further floods in California and Oklahoma resulted in notable amateur accomplishment. The 1936 eastern states flood, the 1937 Ohio River valley flood, and the 1938 southern California flood and Long Island-New England hurricane disaster saw the greatest emergency effort ever performed by amateurs. In these disasters and many others — tornadoes, sleet storms, forest fires, blizzards — amateurs played a major rôle in the rescue work and earned wide commendation for their resourcefulness in effecting communication where all other means had failed.

During 1938 the ARRL inaugurated a new emergency-preparedness program, providing

for the appointment of regional and local Emergency Coördinators to organize amateur facilities and establish liaison with other agencies. This was in addition to the registration of personnel and equipment in the Emergency Corps. A comprehensive program of coöperation with the Red Cross, Western Union and others was put into effect. During the three years before the wartime close-down of amateur activity, this emergency organization proved the effectiveness of its planning and the proficiency of its personnel in more than a dozen important emergencies.

Although normal participation in such activity now is impossible, because of restrictions on amateur operation, the peculiar ability of the amateur to perform in such work has been notably recognized by the government in providing for amateur participation in the War Emergency Radio Service, established by the Federal Communications Commission to furnish emergency communication to local communities in connection with the Office of Civilian Defense. The background and functions of WERS are described in detail in Chapter Sixteen. Here it need only be noted that, by official statement, without the reservoir of amateur operators in this country to serve as a nucleus, the War Emergency Radio Service would have been an impossibility.

In mid-1943 the scope of WERS, limited before to war-created emergencies, was broadened to include the supplying of emergency communications in connection with natural disasters or other situations involving civilian defense or national security. Under this extension of its activities, amateurs in WERS again are in position to render emergency communications service in their traditional fashion.

Amateur coöperation with expeditions goes back to 1923, when a League member, Don Mix of Bristol, Conn., (now acting technical editor of *QST*) accompanied MacMillan to the Arctic on the schooner *Bowdoin* with an amateur station. Amateurs in Canada and the United States provided the home contact. The success of this venture was such that other explorers made inquiry of the League regarding similar arrangements for their journeys. In 1924 another expedition secured amateur coöperation; in 1925 there were three, and by 1928 the figure had risen to nine for that year alone; altogether, during subsequent years, a total of perhaps two hundred voyages and expeditions were thus assisted.

Emergency relief, expeditionary contact, experimental work and countless instances of other forms of public service — rendered, as they always have been and always will be, without hope or expectation of material reward — made amateur radio an integral part of our peacetime national life. To-day, the importance of amateur participation in the armed forces and other aspects of national defense emphasize more strongly than ever that amateur radio is vital to our national existence.

The American Radio Relay League

The American Radio Relay League is to-day not only the spokesman for amateur radio in this country but it is the largest amateur organization in the world. It is strictly of, by and for amateurs, is non-commercial and has no stockholders. The members of the League are the owners of the ARRL and *QST*.

The League is organized to represent the amateur in legislative matters. It is pledged to promote interest in two-way amateur communication and experimentation. It is interested in the relaying of messages by amateur radio. It is concerned with the advancement of the radio art. It stands for the maintenance of fraternalism and a high standard of conduct. One of its principal purposes is to keep amateur activities so well conducted that the amateur will continue to justify his existence.

With normal amateur activity suspended for the duration of the war, the ARRL Headquarters establishment is largely devoted to activities designed to advance the war effort — in training, and in personnel and apparatus procurement.

The operating territory of the League is divided into fourteen United States and six Canadian divisions. The affairs of the League are managed by a Board of Directors. One director is elected every two years by the membership of each United States division, and a Canadian General Manager is elected every two years by the Canadian membership. These directors then choose the president and vice-president, who are also directors. No one commercially engaged in selling or manufacturing radio apparatus or literature can become a member of the Board or an officer of the League.

The president, vice-president, secretary, treasurer and communications manager of the League are elected or appointed by the Board of Directors. These officers constitute an Executive Committee which, under certain restrictions, decides how to apply Board policies to matters arising between Board meetings.

The League owns and publishes the amateur's magazine, *QST*. *QST* goes to all members of the League each month. It acts as a monthly bulletin of the League's organized activities. It serves as a medium for the exchange of ideas. It fosters amateur spirit. Its technical articles are renowned. *QST* has grown to be the "amateur's bible," as well as one of the foremost radio magazines in the world. The profits *QST* makes are used in supporting League activities. Membership dues to the League include a subscription to *QST* for the same period.

Members of the League are entitled to write to Headquarters for information of any kind, whether it concerns membership, legislation, or general questions on the construction or operation of amateur apparatus. If you don't find the information you want in *QST* or the *Handbook*, write to ARRL Headquarters,

West Hartford 7, Connecticut, telling us your problem. All replies are made directly by letter; no charge is made for the service.

If you come to Hartford, drop out to Headquarters at 38 LaSalle Road, West Hartford. Visitors are always welcome.

From 1927 to 1936 the League operated its headquarters station, W1MK, at Brainard Field, Hartford's municipal airport on the Connecticut River. During the disastrous flood of 1936 this station was devastated. From the spring of 1936 until early summer of 1938 a temporary station was operated at the headquarters offices, at first under the old auxiliary call, W1INF, and later as W1AW. The call W1AW, held until his death by Hiram Percy Maxim, was issued to the League by special order of the FCC for use as the official headquarters station call.

From September, 1938, until the wartime closing of all amateur stations, the Hiram Percy Maxim Memorial Station at Newington, Conn., was in operation as the headquarters station. Operating on all amateur bands, with separate transmitters rated at the legal maximum input of one kilowatt and elaborate antenna systems, this station was regularly heard with good strength in every part of the world. The building in which it is housed was designed by order of the Board of Directors as a permanent memorial to the League's founder-president, Hiram Percy Maxim.

¶ Joining the League

Every person interested in amateur radio should join the League and start reading *QST*. Inquiries regarding membership should be addressed to the Secretary. There is a convenient application blank in the rear of this *Handbook*. An interest in amateur radio is the only qualification necessary in becoming an associate member of the ARRL, but according to a constitutional requirement only those members who possess an amateur operator license are entitled to full membership and voting privileges in director elections.

Learn to let the League help you. It is organized solely for that purpose, and its entire headquarters' personnel is trained to render to you the best assistance it can in matters concerning amateur radio.

Every amateur should read the League's magazine, *QST*, each month. It is filled with the latest developments in the radio field, with "ham" news from your particular section of the country. Each issue contains valuable instructional material of aid to the student of radio, as well as both practical and theoretical technical articles. One of its most valuable features at present is a monthly compilation of information on all known available jobs or assignments for which amateurs are especially qualified, particularly in the government service and the armed forces. A sample copy of *QST* will be sent for 25 cents, if you are unable to obtain one at your local newsstand.

¶ The Amateur Bands

Discussion of the frequency bands assigned to and formerly used by amateurs may seem academic at a time when all amateur operation is prohibited; yet, although a special order of the FCC has temporarily suspended amateur operation, the bands normally open for amateur operation still appear in the regulations of the Commission and a knowledge of them is necessary in order to pass the amateur operator examination, which is still being given to interested persons who may wish to qualify for their amateur operator licenses. For this reason, a brief discussion of the characteristics of the various amateur bands is in order.

As will be observed in Fig. 101, the amateur bands constitute narrow segments in that part of the radio spectrum lying between 1700 kc. and 300,000 kc. (or 300 Mc.). During the time when operation was permitted, amateurs distributed themselves throughout these frequency bands according to their operating objectives and the special operating characteristics of the bands themselves. Briefly, these were as follows:

The 1750-kc. band, which carried all amateur activity before the higher-frequency

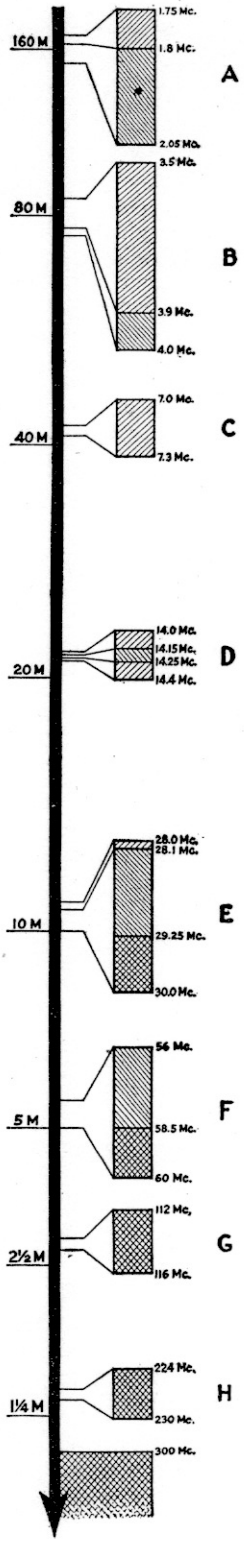

Fig. 101—The amateur bands. Areas shaded with diagonal lines sloping to left were open to c.w. telegraphy only. Areas with diagonal lines sloping to right were also open to amplitude-modulated telephony (and c.w.). Cross-hatched areas were open to frequency-modulated 'phone (as well as to regular a.m. 'phone and c.w.).

bands were opened, always served well for general contact all over the country, although during the height of the higher-frequency development there was some dwindling of activity. It was especially popular for radiotelephone work, but also was used for short-haul c.w. nets and code-practice transmissions for beginners. It was useful primarily for distances up to 400–500 miles, at night, but much longer distances were covered under good conditions.

The 3500-kc. band was regarded, in recent years, as best for consistent domestic communication and as good for coast-to-coast work at night except for a few summer months. Much of the friendly human contact between amateurs and most of their domestic message-handling took place in this band.

The 7000-kc. band was the most popular band for general amateur work for years, both domestic and international, and was useful mainly at nights for contacts over considerable distances as well as being satisfactory for distances of several hundred miles in daylight.

The 14,000-kc. or 14-Mc. band was the one used mostly for covering great distances in daylight, and in fact was the only band generally useful for daylight contacts over coast-to-coast and greater distances. It was, however, subject to sudden changes in transmitting conditions.

The 28,000-kc. (28-Mc.) band combined both the long-distance characteristics of the 14-Mc. band and some of the local advantages of the 56-Mc. band, but was popular chiefly because of its remarkable long-distance characteristics. Its disadvantage was lack of reliability because of seasonal effects and more sudden changes in transmitting conditions even than on 14 Mc.

The 56,000-kc. (56-Mc.) band was used largely for local and short-distance work over distances of ten to fifty miles. Because of compactness and ease of construction of the necessary apparatus, hundreds of stations operated "locally" there. Experiments by the ARRL technical staff beginning in 1934 disclosed that consistent two-way work could be done over distances of a hundred miles or more with suitable conditions and equipment, and such contacts became common by 1940–41. Occasional periodic "sky-wave" work over several thousand miles also was accomplished.

The 112,000-kc. (112-Mc.) band was the newest addition to the amateur spectrum, and before the close-down was attaining widespread popularity for the local work previously carried on in the 56-Mc. band. This band now figures prominently as the chief field of operations for the War Emergency Radio Service (WERS), in which hundreds of amateurs are employing their apparatus and skill on behalf of their communities for civilian-defense work.

The 224-Mc. band and the experimental region above 300 Mc. were not in widespread use for general communication, but were becoming increasingly of interest to the pioneering experimenter. The 224-Mc. band may be called on to carry part of the WERS load.

¶ Memorizing the Code

Amateur *operator* licenses are still being issued by the Federal Communications Commission, despite the cessation of amateur on-the-air activity. This is being done in part at the request of the military services, to whom possession of amateur license is practically equivalent to a certification of proficiency in radio, and in part to encourage future amateurs to prepare themselves for postwar operation.

Apart from the technical and regulatory phases of the examination, the most important requirement for obtaining an amateur operator's license is an ability to send and receive the continental code at the rate of 13 words per minute. Aside from that, knowledge of the code is especially desirable during wartime; it is not putting it too strongly to say that everyone should know the code and be able to use it.

The serious student of code — sending, receiving, operating practices, copying on the typewriter, etc. — would be best advised to purchase a copy of the ARRL booklet, *Learning the Radiotelegraph Code* (price, 25 cents, postpaid), and, in fact, anyone desirous of learning the code is advised to do so via the method outlined in this booklet. However, the following suggestions will suffice to enable one to acquire the rudiments of code ability.

The first job is *memorizing* the code. This is no task at all if you simply make up your mind to apply yourself to the job and get it over as quickly as possible. The complete Continental alphabet, most-used punctuation marks and numerals are shown in the table in Fig. 102. All the characters shown should be learned, starting with the alphabet and then going on to the numerals and punctuation marks. Take a few at a time, but as you progress review all the letters learned up to that time.

One suggestion: Learn to think of the letters in terms of *sound* rather than their appearance as printed dot-and-dash combinations. This is an important point; in fact, successful mastery of the code can be acquired only if one thinks always in terms of the sound of a letter, right from the start. Think of A as the sound "di*dah*" — not as a printed "dot-dash." The sound "dit" is pronounced as "it" with a "d" before it. The sound "dah" is pronounced with "ah" as in "father." The sound "dah" is always stressed or accented — not in a different tone of voice, but slightly drawn out and the least bit louder. The sound "dit" is pronounced as rapidly and sharply as possible; for purposes of easy combination, as a prefix, it is often shortened to "di." When combinations of the sounds appear as one letter, say them smoothly but rapidly, remembering to make the sound "di" staccato, and allowing equal stress to fall on every dah. There should never be a space or hesitation between dits and dahs of the same letter.

If someone can be found to send to you, either by whistling or by means of a buzzer or code oscillator, the best way is to enlist his co-

A	·—	didah
B	—···	dahdididit
C	—·—·	dahdidahdit
D	—··	dahdidit
E	·	dit
F	··—·	dididahdit
G	——·	dahdahdit
H	····	didididit
I	··	didit
J	·———	didahdahdahdah
K	—·—	dahdidah
L	·—··	didahdidit
M	——	dahdah
N	—·	dahdit
O	———	dahdahdah
P	·——·	didahdahdit
Q	——·—	dahdahdidah
R	·—·	didahdit
S	···	dididit
T	—	dah
U	··—	dididah
V	···—	didididah
W	·——	didahdah
X	—··—	dahdididah
Y	—·——	dahdidahdah
Z	——··	dahdahdidit

1	·————	didahdahdahdah
2	··———	dididahdahdah
3	···——	didididahdah
4	····—	dididididah
5	·····	dididididit
6	—····	dahdidididit
7	——···	dahdahdididit
8	———··	dahdahdahdidit
9	————·	dahdahdahdahdit
0	—————	dahdahdahdahdah

Period	·—·—·—
Comma	——··——
Question mark	··——··
Error	·····—·
Double dash	—···—
Wait	·—···
End of message	·—·—·
Invitation to transmit	—·—
End of work	···—·—

Fig. 102 — The Continental (International Morse) Code.

operation and learn the code by listening to it. It is best to have someone do this who is familiar with the code and who can be depended on to send the characters correctly. Learning the code is like learning a new language, and the sooner you learn to understand the language without mental "translation" the easier it will be for you. You don't think of the spoken letter U, for example, as being composed of two separate and distinct sounds — yet actually it is made up of the pure sounds "ee" and "$\overline{oo}$," spoken in rapid succession. You learned the letter U as a sound unit itself. Similarly, you should learn code letters as sounds themselves, and not as combinations of other sounds.

Don't think about speed at first; your first job is to learn all the characters to the point where you know them without hesitation.

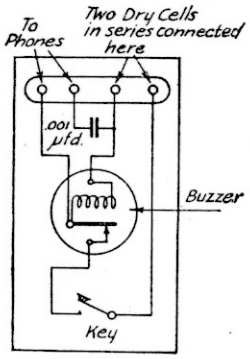

Fig. 103 — Wiring diagram of a buzzer code-practice set. The headphones are connected across the coils of the buzzer, with a condenser in series. The size of this condenser determines the strength of the signal in the 'phones. If the value shown gives an excessively loud signal, it may be reduced to 500 $\mu\mu$fd. or even 250 $\mu\mu$fd.

¶ Acquiring Speed by Buzzer Practice

When the code is thoroughly memorized, you can start to develop speed in receiving code transmission. Perhaps the best way to do this is to have two people learn the code together and send to each other by means of a buzzer-and-key outfit. An advantage of this system is that it develops sending ability, too, for the person doing the receiving will be quick to criticize uneven or indistinct sending. If possible it is a good idea to obtain the assistance

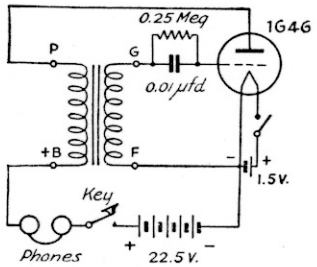

Fig. 104 — Wiring diagram of a simple vacuum-tube audio-frequency oscillator for use as a code-practice set.

of an experienced operator for the first few sessions, so that you will learn how well-sent characters should sound.

Either the buzzer set shown in Fig. 103 or one of the audio oscillators described will give satisfactory results as a practice set. The oscillator more closely simulates actual radio signals.

The battery-operated audio oscillator in Figs. 104 and 105 is easy to construct. However, it employs batteries, which are difficult to acquire in wartime. If nothing is heard in the headphones when the key is depressed, reverse the leads going to *either* transformer winding (not both).

The sets shown in Figs. 106 and 107 operate directly from the 115-volt a.c. or d.c. power line. That of Fig. 106 employs a neon-bulb oscillator functioning from rectified d.c.; almost any tube having a 5- or 6.3-volt filament, such as an 01A, 71A, etc., can be used as the half-wave rectifier (grid and plate connected together). If the tone is fuzzy, wind a single turn of insulated wire around the top of the neon bulb and connect it as shown by the dotted line. The oscillator in Fig. 107 uses a combination diode-pentode tube, the pentode section being used as a vacuum-tube oscillator.

After the practice set has been built, and another operator's help secured, practice sending turn and turn about to each other. Send single letters at first, the listener learning to recognize each character quickly, without hesitation. Following this, start slow sending of complete words and sentences, always trying to have the material sent at just a little faster rate than you can copy easily; this speeds up your mind. Write down each letter you recognize. Do *not* try to write down the dots and dashes; write down the letters. Don't stop to compare the sounds of different letters, or think too long about a letter or word that has been missed. Go right on to the next one, or each "miss" will cause you to lose several characters you might otherwise have gotten. If you exercise a little patience you will soon be getting every character, and in a surprisingly short time will be receiving at a good rate of speed. When you can receive 13 words a minute (65 letters a minute), have the sender transmit code groups rather than English text. This will prevent you from recognizing a word "on the way" and filling it in before you've really listened to the letters themselves.

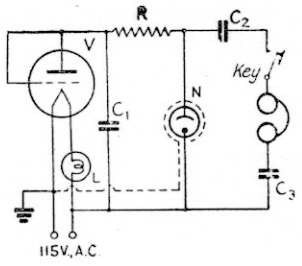

Fig. 106 — Neon-bulb audio oscillator code-practice set for 115-volt a.c.-line operation.
C_1 — 1.0 μfd.
C_2, C_3 — 0.002 μfd.
R — 3 megohms.
L — 25-watt lamp.
N — Neon bulb.
V — Any 5- or 6.3-volt triode.

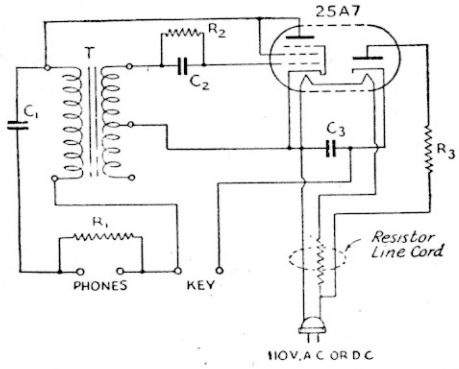

Fig. 107 — A.c.-d.c. vacuum-tube audio oscillator.
C_1 — 100-μμfd. midget mica.
C_2 — 250-μμfd. midget mica.
C_3 — 8-μfd. 200-volt electrolytic.
R_1 — 0.5 megohm, ½-watt. (A lower value, or a variable resistor, may be used to reduce volume.)
R_2 — 1 megohm, ½-watt.
R_3 — 50 ohms, 1-watt.
T — 3:1-ratio midget push-pull audio transformer.
Line cord resistor — 310 ohms. (A 300-ohm, 50-watt wire-wound fixed resistor may be used instead.)

After you have acquired a reasonable degree of proficiency, concentrate on the less common characters, as well as the numerals and punctuation marks. These prove the downfall of many applicants taking the code examination under the handicap of nervous stress.

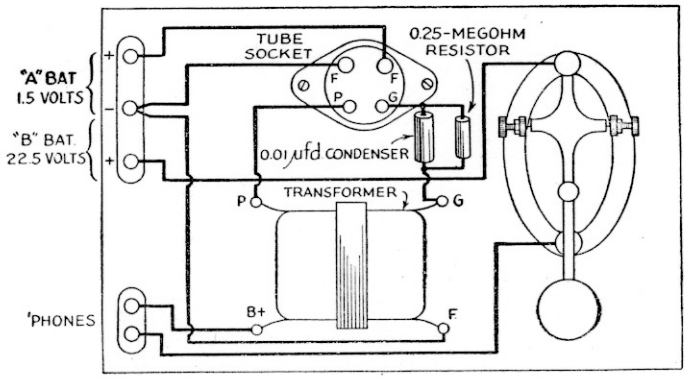

Fig. 105 — Layout of the audio-oscillator code-practice set. All parts may be mounted on a wooden baseboard, approximately 5 × 7 inches in size.

Using a Key

The correct way to grasp the key is important. The knob of the key should be about eighteen inches from the edge of the operating table and about on a line with the operator's right shoulder, allowing room for the elbow to rest on the table. A table about thirty inches in height is best. The spring tension of the key varies with different operators. A fairly heavy spring at the start is desirable. The back adjustment of the key should be changed until there is a vertical move-

ment of about one-sixteenth inch at the knob. After an operator has mastered the use of the hand key the tension should be changed and can be reduced to the minimum spring tension that will cause the key to open immediately when the pressure is released. More spring tension than necessary causes the expenditure of unnecessary energy. The contacts should be spaced by the rear screw on the key only and not by allowing play in the side screws, which are provided merely for aligning the contact points. These side screws should be screwed up to a setting which prevents appreciable side play but not adjusted so tightly that binding is caused. The gap between the contacts should always be at least a thirty-second of an inch,

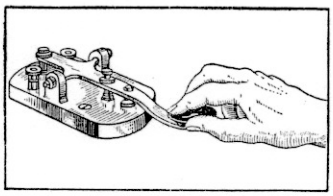

Fig. 108 — This sketch illustrates the correct position of the hand and fingers for good sending with a telegraph key.

since a too-finely spaced contact will cultivate a nervous style of sending which is highly undesirable. On the other hand too-wide spacing (much over one-sixteenth inch) may result in unduly heavy or "muddy" sending.

Do not hold the key tightly. Let the hand rest lightly on the key. The thumb should be against the left side of the key. The first and second fingers should be bent a little. They should hold the middle and right sides of the knob, respectively. The fingers are partly on top and partly over the side of the knob. The other two fingers should be free of the key. Fig. 108 shows the correct way to hold a key.

A wrist motion should be used in sending. The whole arm should not be used. One should not send "nervously" but with a steady flexing of the wrist. The grasp on the key should be firm, but not tight, or jerky sending will result. None of the muscles should be tense but they should all be under control. The arm should rest lightly on the operating table with the wrist held above the table. An up-and-down motion without any sideways action is best. The fingers should never leave the key knob.

Good sending may *seem* easier than receiving, but don't be deceived. A beginner should not attempt to send fast. Keep your transmitting speed down to the receiving speed, and bend your efforts to sending *well*. Do not try to speed things up too soon. A slow, even rate of sending is the mark of a good operator. Speed will come with time alone. Leave special types of keys alone until you have mastered the knack of handling the standard key. Because radio transmissions are seldom free from interference, a "heavier" style of sending is best to develop for radio work. A rugged, heavy key will help in developing this characteristic.

¶ Obtaining Government Licenses

It may occur to many readers that there is little point in obtaining an amateur operator license when amateur radio is not permitted. Far from it! An amateur operator license is a valuable possession, as many people engaged in the war effort have learned. In the Army, it may serve as a passport to a preferred position in the Signal Corps or Air Forces; in the Navy and Marine Corps, the holder of an amateur license (provided he also has had a high-school education and can pass the physical requirements) may be eligible for a rating as a petty officer. Even among officer candidates, in some branches possession of an amateur operator license is accepted as indicating certain proficiency in respect to special radio qualifications. This also applies to positions in various branches of the radio industry engaged in war work. Among women, possession of an amateur operator license is specified as one of the requirements for certain government positions open to feminine applicants. Both industry and Civil Service give preferred attention to amateur licensees.

When you are able to copy 13 words per minute, have studied basic transmitter theory and have familiarized yourself with the radio laws and amateur regulations, you are ready to give serious thought to securing the government amateur operator license which is issued you, after examination at a local district office, through the Federal Communications Commission at Washington, D. C.

Because a discussion of license application procedure, license renewal and modification, exemptions, and detailed information on the nature and scope of the license examination involves more detailed treatment than it is possible to give within the limitations of this chapter, it has been made the subject of a special booklet published by the League. At this point the prospective amateur should possess himself of a copy and settle down to a study of its pages, in order to familiarize himself with the intricacies of the law and prepare himself for his test. The booklet, *The Radio Amateur's License Manual*, may be obtained from ARRL headquarters for 25¢, postpaid. One of the most valuable features of this book is its representative examination questions with their correct answers.

Amateur licenses are issued entirely free of charge. They can be issued only to citizens of the United States, but the requirement of citizenship is the only limitation, and licenses are issued without regard to age or physical condition to anyone who successfully completes the examination.

A brief summary of the basic Communications Act and the amateur regulations and special orders current at the time this *Handbook* went to press will be found in Chapter Twenty-Two. All pertinent extracts from both the Communications Act and the FCC regulations are published in the *License Manual*.